MONASH University

Facilitating Collaborative Learning in the Context of Large-Scale Shared Digital Spaces

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Abstract

This thesis examines the development of a new Collaborative Instructional Systems Design (CISD) model to facilitate the development of collaborative learning applications, specifically in the context of Large-Scale Shared Digital Spaces (LSSDS). Collaboration is an active process where two or more learners are engaged to create, develop and accomplish something together. However, much of the current literature regarding the development of learning applications has focused on Instructional Systems Design, a process to assist in the design of individual learning materials. For the instructional designer designing learning applications this design model does not cater for collaborative considerations, nor does it provide for the unique challenges and opportunities presented with the arrival of synchronous collaborative face-to-face digital learning environments.

This research aims to create a CISD model to facilitate instructional design in collaborative learning environments particularly LSSDS. The CISD model provides interdependent phases, sub-phases and three new taxonomies, to guide designers through a process that assists them in identifying collaborative opportunities through the analysis of learners, the content and the collaborative tasks involved. These three new taxonomies complement Bloom's Learning Taxonomy and have been designed with collaboration and collaborative learning in mind.

The research approach most appropriate for this research was the Design Science Research approach as it placed specific emphasis on a series of ordered actions that provided a path in which to identify the problem, offer a solution through the design and production of a new artefact, a CISD model, which could then be tested and evaluated. The CISD model was developed to provide a step-by-step framework to assist instructional designers create collaborative learning applications for co-located workspaces such as the LSSDS. For this research, a two-stage testing approach has been adopted.

Stage One was a Student/Teacher observational study which focused on the development of a learning application to test the validity of the model, demonstrate that the model was both functional and sound, and identify areas of the model requiring refinement. The outcome of this stage suggested that the application worked and that collaborative behaviours were evident, but that the model needed to be improved to formalise the development of the desired collaborative behaviours.

Stage Two was an Expert analysis, where experts in instructional design and technology such as the LSSDS were interviewed to evaluate the suitability of the CISD model. Overall, the experts were supportive of the CISD model, and the analysis suggests that the intentions of each phase within the model were clear and precise.

The results indicate that as a collaborative instructional design tool the CISD model can assist Instructional Designers design collaborative learning applications in the context of LSSDS. The Stage One student/teacher observational study indicated that the learning application encouraged and engaged learners to work collaboratively in one sizeable active workspace. Finally, Stage Two, the experts analysis demonstrated that the new design approach, the CISD model, provided a foundation and necessary processes that encouraged design, development and evaluation of a collaborative learning application for a large interactive learning space such as LSSDS.

Declaration

I certify that this thesis/project is my own work and does not incorporate any material previously submitted for a degree or diploma in any tertiary institution; and that to the best of my knowledge and belief it does not contain any material created, published or written by another person except as referred in the text.

[redacted]

Daniela McGivern

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1 Introduction

1.1 Overview

This research examines ways of conceptualising the use of large-scale multi-touch technology to create effective collaborative learning environments. Large-scale multi-touch technology is a new class of learning environment where up to eight learners can interact with a single large digital display at the same time. The aim of this research is to create a Collaborative Instructional Systems Design (CISD) model to facilitate the design of collaborative learning environments on a Large-Scale Shared Digital Space (LSSDS), to replace the current standard Instructional Systems Design (ISD) model. The current standard ISD model was created to assist the design of learning materials for individuals, and therefore, does not assist in the design for synchronous collaborative face-to-face learning environments. The project also examines: i) the benefits of large-scale digital learning spaces in which all participants can be active in an educational environment; ii) ways in which learning tasks can be effectively structured to take advantage of the large-scale digital space; and finally, iii) the structuring of an active interface to support a collaborative approach.

The rationale for the project is based on a comprehensive analysis in five main areas of literature: i) Collaborative Learning; ii) Computer Supported Collaborative Learning; iii) Interactive Technologies; iv) Collaborative Learning Theories; and, v) Instructional Systems Design Model. The research seeks to use active learning processes in a collaborative environment to allow learning and development to occur interpersonally (Sociocultural Theory), which can then be internalised to become intrapersonal. Using an LSSDS in educational activities is anticipated to provide an alternate way of learning that may expand ways of thinking and learning. Just as interactive whiteboard technology has been extensively rolled out into classrooms in the last decade; it is highly likely that LSSDS, based on multi-touch technology, will become increasingly important over the next decade.

The outcomes of the research will detail: i) ways in which learning tasks can be effectively structured in order to take advantage of the shared large-scale digital space, ii) how the interface of such a shared digital space may be structured, and finally, iii) the characteristics of areas of content that might benefit from employing collaborative learning techniques and large-scale shared digital spaces.

1.2 Background of the Study

Traditional networked computer-based learning limits opportunities for direct user collaboration due to the small screen size and single point of input (Morgan & Butler, 2009). Recent advancements in computer technology have provided large-scale shared digital spaces that have opened doors to new research areas, particularly in the field of education by providing unique interactive learning environments. Typically, these devices feature touch-sensitive displays of over 50 inches (diagonal) in size, with a resolution high enough to allow up to eight learners to work synchronously and face-to-face. The unique feature of this new technology is that it allows multiple simultaneous user inputs by touching the surface of the display rather than by using a mouse. Therefore, multiple learners can be active at the same time.

LSSDS's, multi-touch, interactive tabletop, tabletop, augmented tabletop and digital tabletop technologies are all terms that relate to a similar form of horizontal display technology where multiple users directly interact with digital information (Müller-Tomfelde, 2010, p. 4). The term *'large-scale shared digital space'* has been adopted for this research as this describes a digital environment that facilitates collaborative interaction between many (up to eight) users. Historically many forms of LSSDS have been developed for commercial use; these include Microsoft Surface (Microsoft, 2011) and DiamondTouch (DiamondTouch, 2010). However, in recent times, (Higgins, Mercier, Burd, & Joyce-Gibbons, 2012; Mercier & Higgins, 2013) LSSDS are beginning to feature in educational areas as well. Figure 1-1 demonstrates some current examples of the possible use of LSSDS technology in a work environment, as well as in a learning environment.

Figure 1-1: (a) Sectra Table (Sectra, 2017) (b) WePlaySmart (Hatch, 2017b)

Other large interactive technologies such as vertical interactive whiteboard technology (IWB) and SMART Interactive Whiteboards (SmartTechnologies, 2011), do not fall under this definition due to their lack of multiple simultaneous inputs.

The interactivity on IWB's only allows up to two users to interact, with a registration of dual touch, therefore limiting collaborative interaction (see Figure 1-2). Also, several reservations have been expressed by researchers in the field of IWB. For example, Haldane (2007) questions the significance of the term ‘interactive’ in ‘interactive whiteboard’, stating that “it is a medium through which interactivity may, to a greater or lesser extent, be afforded” (pp. 258-259). Therefore, the IWB is a medium with limitations that raises some concerns.

Figure 1-2: Screen Shot depicting two students working together on the interactive whiteboard (SmartTechnologies, 2011)

While the IWB technology is considered to have affordance that allows some interactive capacity, it does not mean that the outcome would produce meaningful interactions or learner collaboration. The restricted interactivity, in practice, results in technology that is considered to be more teacher centred, and without good design, being unlikely to produce meaningful collaboration between the learners. Hesselbein (2014, February 24) writes, “Digital whiteboards were designed to be teacher centered tools. (If they were designed to be student centered, they would be mounted on the floor, and everyone could use one at the same time.).” There is a need to move away from the teacher-student paradigm and encompass “interactive teaching and learning, where users are physically, verbally and conceptually engaged, or interactive with manipulable learning resources and content” (Twiner, 2010, p. 38). This would coordinate and strengthen their understanding. The IWB can be seen as a limited example of this paradigm. However, this may be improved by enabling multiple users to interact at the same time—collaboratively—and supported by rich digital interactions.

To-date, research in relation to an LSSDS has related to the development of participatory activities in various educational contexts. Researchers (Antle, Bevans, Tanenbaum, Seaborn, & Wang, 2011; Higgins, Mercier, Burd, & Hatch, 2011; Martinez, Collins, Kay, & Yacef, 2011; Piper & Hollan, 2009; Piper, O'Brien, Morris, & Winograd, 2006; Rick et al., 2009; Schneider et al., 2010; Sluis et al., 2004) have focused on the design of various applications on an LSSDS in the area of education to enhance collaborative learning experiences. Two early papers that are considered significant in the area of multi-touch are centred on Sluis et al. (2004) and Piper, O'Brien, Morris, and Winograd (2006) research. Sluis et al. have cited a number of early researchers, namely, Fitzmaurice, Ishii, and Buxton (1995) and Ishii and Ullmer (1997), who researched the technology, its usability and applications. What these early studies did not investigate are the learning strategies, user strategies, task division or task distribution. Sluis et al. own research observed the potential of using the augmented tabletop to support the development of reading skills for primary school children aged five to seven based on the redesign of the classic game *Memory*. On the other hand, Piper et al. (2006), focused on using tabletop technology on group learning skills using a four-player cooperative computer game. The cooperative tabletop computer game was developed and based on a design process called 'participatory design', to motivate and provide a supportive tool for a special needs population. Participatory design is an approach where all stakeholders play an essential role in the design of the system, where computers and computer-based applications are viewed in a workplace environment as a process, and not as an individual entity (Schuler & Namioka, 1993, p. xi).

Piper and Hollan (2009) cited many articles of research on tabletop displays in areas of gaming and entertainment, manipulating photos, communication, interaction techniques, territoriality, social protocols and education. Piper and Hollan's research focused on understanding the use of tabletop displays in an educational context and how it integrates with, and augments, in existing educational ecologies. More recently, research by Higgins et al. (2011) identified the design relationship between technological characteristics of large-scale shared digital spaces and the learning possibilities in classroom settings (see Figure 1-3).

Figure 1-3: Multi-touch surfaces in a classroom (Higgins et al., 2011)

Antle et al. (2011) explored the "novel design space" (p. 93), of the multi-touch tabletop collaborative learning used in public venues (see Figure 1-4). Antle et al. (2011) introduced an interactive collaborative learning game about sustainable development, called FUTURA. The development of

FUTURA was based on theoretical perspectives: experiential learning, constructivist learning, collaborative learning and game theory.

Figure 1-4: Interactive multi-touch tabletop game – FUTURA (Antle et al., 2011, p. 95)

This previous research discusses the collaborative nature of this new LSSDS, although currently there is no formal method that can be used to guide an instructional designer to design learning applications for an LSSDS. Therefore, to facilitate collaborative learning in the context of LSSDS, this research will develop a Collaborative Instructional System Design (CISD) model to provide design strategies based on relevant educational theory. The proposed CISD model will also take into account the affordances of an LSSDS to assist in the design of the above-mentioned systems. A CISD model will facilitate instructional designs that allow users to be interactively engaged, both verbally and physically, to strengthen their knowledge in specific content domains such as literacy, mathematics or science. An LSSDS in the form of a multi-touch table will be used as a development platform to allow the creation and evaluation of one educational application to validate the output of the CISD model. A significant challenge will be the organisation of activities that cater for multiple users to create effective learning experiences. Additional challenges relate to the creation of an interface to cater for multiple users.

Section 1.3 includes a discussion of the development of Instructional Systems Design and how it has been used to design learning materials for large groups of individual learners. LaMotte (n.d.) described learning objectives as the “core of the instructional design process”, as they define the content and activities necessary for designing learning materials for the individual learner. In education, the term *learning objectives* is a description of the expected goals of a learning activity instruction in which a student is expected to achieve at the end of the lesson, curriculum and semester.

Bloom (1956) defines educational objectives as “explicit formulations of the ways in which students are expected to be changed by the educative process” (p. 26). Bloom’s “explicit formulation” was in the form of three classification systems which became known as Bloom’s Learning Taxonomy or Bloom’s Taxonomy. The three classification systems are the cognitive, the affective and the psychomotor domains. The cognitive domain is described by Bloom (1956) as, “… objectives which deal with the recall or recognition of knowledge and the development of intellectual abilities and skills” (p. 7). The domain mostly related to this research is the first domain—the cognitive domain. As a classification system, the cognitive domain assists instructors and instructional designers to create learning material coursework at an appropriate cognitive level to meet the learners needs. The proposed CISD model would address shortcomings in the standard Instructional Systems Design (ISD) model. The CISD model will also include three new taxonomies which have been designed to complement Bloom’s. The ISD model and Bloom’s Taxonomies were created to cater for individual learners and were not created to facilitate the design of collaborative learning environments. The CISD model should provide a new conceptual model to accommodate the design, construction, implementation and evaluation of interactive artefacts in these specific interactive, collaborative learning environments that are enabled by LSSDS.

This new model will be specifically designed to promote user learning by working not as individuals, but collaboratively (or face-to-face) on an LSSDS. To frame the research questions, the Literature Review examines learning theories, Sociocultural Theory, Activity Theory and Distributed Cognition Theory, as well as collaborative learning theories. These theories will provide the theoretical foundations required to investigate new collaborative learning approaches enabled by LSSDS technologies.

This PhD research topic emerged from an Honours thesis, *Utilising multi-touch display technology for remedial phonics instruction involving collaboration*, completed in 2010. The purpose of this Honours project was to examine the use of multi-touch display technology used to deliver collaborative learning experiences in phonics instruction for remedial learners. During the course of this research, some further questions emerged. While the technology and the techniques employed showed potential in improving learning outcomes, there were aspects of collaborative learning, activities involving multiple learners, and designing for collaborative learning that was not well understood as a learning design process.

Therefore, to further understand how to design for such learning environments, there is a need to investigate and evaluate the appropriate learning theories to recognise the mechanisms behind the learning, and to guide the design process.

1.2.1 Overview of Relevant Literature

This research topic concerns ways to utilise large-scale multi-touch technology to create educationally effective collaborative learning environments in several content domains.

To achieve these research objectives, three principal areas of literature need to be examined;

1. Sociocultural Theories of Learning - the cultural and social aspects of learning, including the role of using technology in cognition and learning,
2. Collaborative Learning Techniques and Technologies - current examples of collaborative learning techniques and the technologies that enable them, which can then be compared to emerging collaborative technologies such as large-scale multi-touch displays,
3. Application Areas - characteristics of areas of educational content that may apply to collaborative learning environments that utilise large-scale shared digital spaces such as multi-touch technologies.

The aim of the literature analysis is to ground the research project in the appropriate learning theory as the basis for an effective collaborative learning environment design process using emerging digital technologies.

1.3 Impact of the Research

As discussed in Section 1.2, interactive technologies such as the LSSDS have been around for a number of years, with no specific design practices put in place to assist Instructional Designers design and develop collaborative learning applications. This research will impact a number of fields of research including Interactive Technologies relating to multi-touch screen technologies such as the LSSDS. This research will also provide a further enhancement for the research fields of Educational Technology and Human-Computer Interaction (HCI). Instructional Systems Designers will benefit from this research as the CISD model creates structure and puts principles in place to assist in designing meaningful collaborative learning applications.

The purpose of ISD models is to facilitate the production of high-quality learning materials. This idea began in the 1940s where learning materials were designed to be delivered consistently to large groups of individual learners. With the arrival of computer technology, the ISD model is still considered to be a feasible model that can be used when developing and delivering learning materials to the individual on a single user space such as the personal computer. However, with the advent of large screen interactive technology such as the LSSDS, the standard ISD model does not provide the instructional designer with the necessary steps and processes to develop collaborative learning applications. The beauty of the LSSDS is that several learners can work synchronously and be active on the screen at the same time. The technology enables multiple and simultaneous user inputs through touch on an interactive surface in one co-located space.

To develop high-quality learning materials for a large interactive environment such as the LSSDS, the instructional designer will require a new systematic approach that will assist them to design for learner collaboration. This new instructional design approach will need to look at and understand the characteristics of multiple learners, the learning task and how it, or if it, can be divided and distributed amongst the learners. This new approach will need to understand areas such as teamwork and interpersonal skills, i.e. communication and negotiation. Finally, this new collaborative instructional design approach will include a specific stage that provides support to guide the instructional designer in interface design, layout and look at what affordances are possible. This new instructional design model will be called, Collaborative Instructional Systems Design (CISD).

1.4 Research Questions

The aim of this research is to develop a model which will provide Instructional Systems Designers with a design method to facilitate designing collaborative learning applications that will deliver collaborative learning experiences on an LSSDS.

To understand the aspects of learning, collaborative learning and designing for collaborative learning, the primary research question to be addressed by this thesis is:

> P1. How can an instructional design model assist in the design of collaborative learning environments based on large-scale shared digital spaces?

In order to answer the primary research question, the following sub-questions need to be addressed.

> S1. What are the educational affordances of large-scale shared digital spaces?
>
> S2. What educational issues need to be considered when designing a Collaborative Instructional Systems Design model for large-scale shared digital spaces?
>
> S3. For a learning application designed using the Collaborative Instructional Systems Design model, what is the experience of the students and teachers in the classroom?
>
> S4. How can a model influence the structure of learning tasks in an application in order to

facilitate effective collaborative learning activity in a large-scale shared digital space?

S5. How can a model guide the design of an interface on a shared digital space to facilitate effective collaborative learning activity?

S6. What is the perception of Instructional Systems Designers of the utility of a collaborative design model?

1.5 Overview of Methodology

To investigate the problem and answer the research questions the methodological approach adopted for this research is Design Science Research (DSR). Weber (2013) describes the goals of the DSR approach in this way, "Researchers who undertake design-science research have the goal of producing artefacts (human-made objects) that are useful" (p. 247). The human-made object or the artefact created during this research process is the CISD model. The DSR approach can be any one of four forms: Constructs, Models, Methods and Instantiations. The best type selected to address and answer the research questions is Methods. Methods provide a set of ordered actions that aim to produce or achieve an outcome such as a product or service (Weber, 2013). The Methods investigated during the research process will be distilled into a CISD model to facilitate their distribution to Instructional Designers.

DSR proposes a six-step process that will be used to manage and answer the research questions.

1. Identify the problem and the research motivation. This task is achieved in the literature review. The problem identified is the processes required for the instructional designers to be able to develop collaborative learning applications for multiple learners in one interactive space, the LSSDS.
2. This is followed by defining the objectives of the solution. The objective proposed is the need for a new artefact, a CISD model. This artefact will allow Instructional Designers to design a collaborative learning application allowing many users to work in one shared space.
3. The new artefact, the CISD model, is then designed and developed and will need to be validated.

To validate this CISD model, a two-stage evaluation process is proposed. These evaluation processes are iterative, whereby any necessary updates to the CISD model will be completed prior to moving onto the next stage.

4. Stage One is the demonstration step that involves a design process and includes a student/teacher observational study. Stage One will focus on the development of a learning application for the LSSDS to demonstrate that the output of the new CISD model works. This stage tests the model's functionality and its architecture. The learning application developed using the CISD model will then be tested with students, and with teachers present in an observational capacity. Stage One is the first step of validating the model in its early state through observation of the collaborative learning activity generated. On completion of the analysis, any necessary updates to the CISD model will be completed, and this forms the first iterative process of the CISD model validation. The updated CISD model will then enter its second stage of evaluation.
5. Stage Two is the evaluation step that involves an expert analysis of the CISD model. A number of experts in instructional design and in educational technology, such as the LSSDS, were invited to participate. Given that this area is relatively new, the experts will have to have experience in either instructional design and/or in both instructional design and LSSDS technology. The experts will be interviewed individually and presented with the CISD model and phase-by-phase visuals of the development of the learning application. In addition, video from Stage One will demonstrate the students interacting with the learning application on the LSSDS. The experts interviews mark the end of the Stage Two iteration of the validation process.

The interview data will be analysed, any necessary updates to the CISD model will be completed and reported in the final step; Communication.

6. Communication of the data is the last step of the process and will be achieved primarily through this thesis, followed by scholarly research publications such as journals and books.

The purpose of this methodology is to validate the CISD model.

1.6 Research Design

The research process begins with the literature review, investigating theoretical ideas that will help to identify areas assisting with the design and development of the artefact, the CISD model. The theoretical areas to be covered are; Computer Supported Collaborative Learning, Collaborative Learning Theories such as Sociocultural Theory, Activity Theory and Distributed Cognition Theory and how they are used in learning, and finally the underlying theories of individual learning in the Instructional Systems Design model. The research questions that relate to this area are S1 and S2.

On completion of the developed artefact—the CISD model—the next steps of the proposed experimental design will be via a two-stage approach. Stage One begins with an observational study where a research instrument in the form of an instantiation of a phonics learning application is developed. This stage will test the validity of the CISD model and ensure that each phase of the model works. The learning application will then be presented to young primary school students in a classroom environment with teachers observing the students interacting on the LSSDS. The research question that relates to Stage One is question S3.

Student interaction with the teachers observing will be videotaped, and at the conclusion of this study, the students and the teachers will be interviewed. The students will participate in a five-minute interview at the end of their game session to talk about their experiences. Whereas, the teachers will be individually interviewed and audiotaped to talk about what they observed while the students were playing the game and interacting with the LSSDS. The teachers questions will begin with general items such as the children interacting on the LSSDS, and then more specific questions concerning the design influence and the way the students interacted. In addition, any specific collaborative aspects to the way the game made them interact, and if the technology influenced the way the students interacted, will also be addressed.

The video and audio data collected will be transcribed and thematically analysed. The expected data analysis for Stage One will be qualitative, and some quantitative. Based on the outcomes of this stage of analysis and on what this Researcher observes, any necessary changes to improve on the CISD model will be implemented. This is then followed by Stage Two; an expert analysis.

Stage Two is an expert analysis which will be designed to gather their professional views and responses to the new CISD model. The experts will be shown the video of the children interacting with the learning application on the LSSDS from Stage One. Simultaneously, the experts will be presented with each phase of the model and will be shown expected resulting outputs of each phase of the model, including individual design mock-ups of the design of the learning application from Stage One. The research questions that relate to Stage Two are questions S4, S5 and S6. These questions seek to gain the experts opinions and are explicit in that they relate specifically to the CISD model and the way it has influenced (1) the learning tasks in the application, (2) guide the interface design and (3) seek the experts opinions on the model’s functionality.

The experts will be interviewed individually, and the interview format will be semi-structured and face-to-face. These interviews will be video and audiotaped. This qualitative data will be transcribed and thematically analysed.

The purpose of this stage of analysis is to validate the CISD model. Any feedback or suggested improvements by the experts will be incorporated into the model and marked for future research.

1.7 Scope

The scope of this research relates to the following contexts:

The technology that is used in this research is the LSSDS, which is also known as multi-touch technology. This technology allows learners to manipulate and touch objects, all at the same time, using basic hand gestures. LSSDS creates a learning community where learners are working and discussing their task at hand face-to-face. Other collaborative technologies, such as collaboration through networked computers are beyond the scope of this project.

The focus of this research was on the research artefact, which was the CISD model and not the application development, i.e. the research instrument. The research instrument, or the phonics learning application, was an output of the model and was developed as part of the process to validate the CISD model. This was used in the student-teacher observational study to test how the students collaborated in the interactive learning environment and to provide a working/learning application example to present to experts in ISD.

In testing the learning application, learning gains will not be included in this research. The student's learning gains are beyond the scope of this thesis.

The expert evaluation was restricted to experts who worked in the field of instructional design and/or in instructional design and technologies such as the LSSDS. The purpose of the expert evaluation was to validate the CISD model in its current state prior to it being supplied and released, for use, to instructional designers.

1.8 Thesis Structure

This thesis contains nine chapters and is structured as follows:

Chapter 1 introduces the background of the research, outlines the research questions, discusses the significance of the research and defines the terminology used.

Chapter 2 provides a comprehensive literature review of the relevant literature in the fields of learning, collaboration, collaborative technologies and application areas.

Chapter 3 discusses the research methodology adopted to examine the research questions, outlines the methods used, the experimental design and the development of various data collection instruments.

Chapter 4 presents the steps of the processes involved in creating the new CISD model to be used in developing learning applications for the LSSDS.

Chapter 5 presents a more in-depth description of each of the phases, the elements, and sub-elements within the CISD model.

Chapter 6 describes the development of the research instrument, the Phonics Learning Application, and aligns the steps of the design process with each phase of the CISD model.

Chapter 7 addresses the outcomes of the Stage One student/teacher observational study analysis and results.

Chapter 8 reports the results of Stage Two Experts experimental results and analysis. This chapter reports the results of the Experts interviews that have been collected and analysed.

Chapter 9 is the concluding chapter of the thesis and will report the major outcomes, address the research questions and the main contributions. Any further avenues for research arising from this thesis are suggested under Recommendations for Further Research. The chapter ends with a final concluding statement summing up the research outcomes.

2 Literature Review

2.1 Introduction

This research topic concerns the impact of designing learning applications for collaborative technologies. As such, this literature review will investigate and discuss three crucial areas: the research in context; the theoretical background; and finally, the practical context.

The literature review will explore collaborative learning environments in general and, in particular, learning environments enabled by collaborative technologies. Specific collaborative technologies will be discussed to identify the characteristics and opportunities of such systems in enabling collaborative learning interactions. Large-scale multi-touch technologies, namely; *Large-Scale Shared Digital Spaces* (LSSDS), will be compared to other technologies to identify possible opportunities to create innovative and effective collaborative learning environments.

To begin, this literature review will place the research in context and explore the theories related to collaborative learning beginning with *Collaborative Learning*. Following this is a discussion on *Computer-Supported Collaborative Learning* (CSCL), described by Stahl, Koschmann, and Suthers (2006) as an emerging learning science which studies how people can learn together with the aid of a computer. This is then followed by a discussion on *Interactive Technologies,* specifically LSSDS and the affordances of shared interactive systems.

Due to the collaborative nature of the intended learning environment, the next section relates to the theoretical background literature, beginning with Vygotsky's *Sociocultural Theory*. *Sociocultural Theory* looks at the role of culture and the social context in the learning process, and focuses on how individuals share information in a social context, either through parents, teachers, and/or older children. The second theory discussed is *Activity Theory*. *Activity Theory* concerns the relationship between a number of areas: the activity, the action and how the process (the operation) is achieved. *Activity Theory* is dynamic and adjusts itself as the conditions change. Finally, there is a discussion of *Distributed Cognition Theory*. This theory links the design and use of technology to Sociocultural learning theory. Vygotsky saw the role of culture, social interactions and language as tools that shape the individual's way of thinking and their cognitive processes. Bringing multiple individuals together in social contexts is where personal knowledge and experiences are shared and distributed across the social group, as well as artefacts, and tools. In the context of this research, with an environment such as LSSDS, it is therefore important to consider *Distributed Cognition Theory*. These theoretical perspectives are features that contribute to collaborative learning approaches. These theories are then applied to this research, as the technology employed in the learning interaction enables the creation of a social learning environment in which multiple learners can be active.

Lastly, this literature review will focus on the practical context of *Instructional Systems Design* (ISD) from a collaborative perspective. This section will examine how well the research in the theoretical background integrates into each phase of the ISD through a lens of collaboration.

2.2 Collaborative Learning

Historical research (Gillies & Ashman, 2003) has demonstrated that the behaviours of people in groups change when exposed to others. Their research suggests that individuals could become competitive towards each other. Gillies and Ashman (2003) state that May and Doob (1937) were the first to develop a comprehensive theory of the distinction between cooperative and competitive behaviour. May and Doob (1937) state that on a social level,

> … individuals compete with one another when: (1) they are striving to achieve the same goal that is scarce; (2) they are prevented by the rules of the situation from achieving this goal in equal amounts; (3) they perform better when the goal can be achieved in unequal amounts; and (4) they have relatively few psychologically affiliative contacts with one another.
>
> [and] … individuals cooperate with one another when: (1) they are striving to achieve the same or complementary goal that can be shared; (2) they are required by the rules of the situation to achieve this goal in nearly equal amounts; (3) they perform better when the goal can be achieved in equal amounts; and (4) they have relatively many psychologically affiliative contacts with one another. (p. 49)

Deutsch (1949) observed that students placed in co-operative situations presented a stronger sense of group centeredness, whereas students placed in a competitive situation are demonstrated to be more self-centred and that this approach is based on traditional individual learning. Studies by Johnson, Johnson, and Smith (1991) have shown that cooperative learning enhanced both competitive and individual learning.

While much of the discussion above is related to competitive learning and cooperative learning, *collaborative learning* is another social learning approach that encourages the social aspects of learning (Hevner, March, Park, & Ram, 2004). Myers (1991, p. 19) explains that cooperative learning and collaborative learning have different origins. Cooperative learning has American roots that were based on John Dewey's philosophical approach to the nature of learning and Lewin's scientific work on group dynamics (Schmuck, 2013, pp. 1-2). Alternatively, collaborative learning has British roots based on the work of British secondary school teachers in the 1950s and 1960s, where teachers explored and encouraged students to respond to literature and take on a more active role in their learning, and was then adopted in the 1980s, by the American college teachers (Bruffee, 1984, p. 636).

Barkley, Cross, and Major (2005) state that there are various ways to describe collaborative learning, which includes cooperative learning, as well as team learning, group learning, or peer-assisted learning (p. 4). All these terms indicate that there is some form of group work. The subsequent discussion refers to collaborative learning and cooperative learning, as being two separate learning approaches.

Bruffee (1995, p. 12) describes the two learning approaches as two versions of the same thing, and that experts of both groups may disagree among themselves about terms and methods, principles and assumptions, but their long-range goals are strikingly similar. Given that there are so many interpretations of the two, the following discussions will explore and evaluate literature in the context of collaborative learning and cooperative learning and conclude with definitions for each that are specific to this research.

Barkley et al. (2005, p. 5) discuss the terms 'cooperative' and 'collaborative', stating that, for lexicographers, these terms have similar meanings. Goodsell, Maher, Tinto, Smith, and MacGregor (1992) support this statement by writing, " … although cooperative and collaborative learning derive from different traditions, they both provide structured group activities for students and promote the social skills students need to work together" (p. 7). The meaning of the two learning approaches, when applied to group work, have been debated and discussed by many academics, such as Bruffee (1995), Dillenbourg (1999), and Flannery (1994). Watkins, Carnell, and Lodge (2007) describe the term *collaboration* as working to create something "greater between us than would have been achieved separately" (p. 88). They suggest that there is a distinction between cooperation and collaboration. When cooperating, people adjust their actions to each other to achieve their individual goals, but when working in collaboration, they adjust their actions to achieve a shared goal.

The underlying theoretical principles for collaborative and cooperative learning are founded on the constructivist epistemology that is heavily based on Vygotsky's Sociocultural Theory, where learning is inherently the result of social interaction. Barkley, Cross, and Major (2014) write:

> Collaborative learning has its home in social constructivism, which assumes that knowledge is socially produced by consensus among peers. Social constructivists believe that reality is

> not entirely external and independent of individual conceptions but rather is produced and understood through interchanges between people, shared objects, and activities as individuals make and experience meaning together. (p. 8)

Barkley et al. (2005) have described collaborative learning as a means or a way for students to work in pairs or small groups to achieve shared learning goals. For example, students around a table would be cooperating with each other if they each needed to share resources to complete their individual task, whereas they would be collaborating if they worked together to create a product jointly.

Collaborative learning redefines the traditional student-teacher relationship in the classroom, which moves learning from being a teacher-centred approach to a student/group-centred approach. Alternatively, cooperative learning is founded on the traditional methods of instruction where the teacher retains the dual role of subject matter expert and authority in the classroom (Barkley et al., 2005; Flannery, 1994). Flannery (1994) sees cooperative learning as having students in the role of information receivers, not of knowledge creators, and that cooperative learning techniques are a way for students to interact with “discrete pieces of information that the instructor has already identified” (pp. 17-18). Flannery (1994) writes:

> One can, in fact, define cooperative learning (as opposed to collaborative learning) as the use of student learning groups to support an instructional system that maintains the traditional lines of classroom knowledge and authority. (p. 17)

Slavin (1995) discusses a cooperative student team-learning model, called *Student Teams-Achievement Divisions* (STAD), where students were placed into small mixed groups, and the teacher introduced the learning materials. The teacher presented the lesson and the students working in their groups would ensure that all team members mastered the lesson.

Collaborative learning and cooperative learning have similar meanings in that both are related to some form of group work; it is how the final result is achieved that is different.

Based on the above literature analysis, the following are the definitions for the two learning approaches of this research:

- *Collaborative learning* is a learning approach whereby a group of learners work together on a task, towards the same shared goal which could not be achieved individually.
- C*ooperative learning* is a learning approach where a group of learners have been assigned a learning task and where each is allocated a duty necessary in assisting in the completion of the learning task. The learners are working towards their own goal.

If this was in a learning environment supported by a new technology, such as an LSSDS, students could be working face-to-face, socialising, discussing and interacting with the purposefully designed learning material to encourage a joint outcome. The new technology can help mediate and support learning; freeing up the teacher, as they do not have to intervene all the time as it is the technology that supports the way the students interact with the tasks. A well-designed learning task for this new technology will provide a more accurate collaborative approach that will be student-driven. The LSSDS will, with a well-designed task, assist students to achieve and/or move towards a more positive notion of collaboration.

As the primary focus of this research relates to *collaborative learning*, the following sections refer specifically to this topic area.

2.2.1 Collaborative Learning Techniques

An important factor about collaborative learning is that for learning to take place, the topic must be meaningful so that when students are working collaboratively, the learning activity provides information to improve their knowledge and provide a deeper understanding of the learning topic (Barkley et al., 2014). The notion of collaborative learning is also used and encouraged by the Department of Education and Training (Victoria) education system. The Department of Education and Training (Victoria) (2017) state that, "[e]ffective teachers provide opportunities for students to participate in flexible groups that collaborate on meaningful tasks, and respond to questions that support achievement of learning goals" (p. 18).

For a learning group to be successful, collaborative learning is a practice that needs to be taught. Students cannot be thrown together and be expected to work together, and the teacher needs to do more than just allocate students into teams (Vik, 2001, p. 112). Snyder (2009) states that for students to collaborate successfully, they need to be taught and then practice specific skills such as brainstorming and roleplaying, as well as communication skills such as active listening, questioning and restating techniques, so that group ideas form. This will ensure that when the students are discussing the learning task, they are accepting of new ideas and changes. To complete a project on time, students also need to be taught delegation and prioritisation, by establishing a timeline. Finally, teachers should provide the students with specific team building techniques and methods on how to negotiate through difficult situations such as conflict, and also provide students with problem-solving processes to resolve any issues as they arise. Team building skills are encouraged in the school system, where group members are explicitly taught to collaborate, negotiate and contribute to joint assignments through role sharing, or providing members with responsibilities, and that they take ownership of outcomes (Department of Education and Training (Victoria), 2017). Once the students have a basic understanding of the skills and techniques involved in collaboration, they then need to practice these in a collaborative and supportive environment, such as an LSSDS.

Barkley et al. (2014) provide teachers with a list of thirty-five collaborative learning techniques (CoLTs), to engage and challenge students in collaborative learning (see Figure 2-1 and Appendix R for full CoLTs list). These collaborative learning techniques have been categorised into six broad categories:

1	Discussion	Student interaction and exchange is achieved primarily through spoken words.
2	Reciprocal Peer Teaching	Students purposefully help each other master subject matter content and develop discipline-based skills.
3	Problem Solving	Students focus on practising problem-solving strategies.
4	Graphic Information Organizers	Groups use visual tools to organise and display information.
5	Writing	Students write to learn important course content and skills.
6	Games	Students work together in teams to participate in a competitive activity that is guided by a pre-existing set of rules.

Table 2-1: Six collaborative learning techniques (adapted from Barkley et al., 2014, p. 136)

Barkley et al. (2014) have formatted the collaborative learning techniques numerically, and within each category, ordered the techniques from least to most complex. Each category has been given a simple descriptive name; a technique in which each can be used with the students and where it can be used.

Collaborative Learning Techniques (CoLTs) -Reference Guide			
	This CoLT	…is a technique in which students:	It is particularly useful for:
Discussion CoLTs			
1	Think-Pair-Share	think individually for a few minutes, and then discuss and compare their responses with a partner before sharing with the entire class.	preparing students to participate more fully and effectively in whole class discussions.
2	Round Robin	generate ideas and speak moving from one student to the next.	structuring brainstorming sessions and ensuring that all students participate.
3	Buzz Groups	discuss course-related questions informally in small groups of peers.	generating lots of ideas quickly to prepare for and improve whole-class discussion
4	Talking Chips	participate in a group discussion and surrender a token each time they speak.	ensuring equitable participation.
5	Three-Step Interview	interview each other and report what they learn to another pair.	helping students network and improve communication skills.
6	Critical Debates	assume/argue the side of an issue opposite of their personal views.	developing critical thinking and encouraging students to challenge their assumption
Reciprocal Peer Teaching CoLTs			
7	Note Taking	pool information from their	helping students

Figure 2-1: Sample of Collaborative Learning Techniques (CoLTs) (adapted from Barkley et al., 2014, p. 152)

CoLTs is a tool which is adaptable to fit a wide variety of disciplines, instructional goals and learning contexts. It has been designed to suit various educational environments, such as the traditional onsite classrooms, flipped classrooms and online courses. The online learning environments Barkley et al. (2014) included are as follows: *Learning Management Systems*; *Web Conferencing Systems*; *Immersive Worlds*; and *Open Environments*. These four environments have been aligned with the thirty-five CoLTs and have been classified into three levels: *Ease, Enterprise* and *Effort.* An explanation and colour are provided for the three classifications, which are shown in Table 2-2.

Ease	Refers to the *ease* that the CoLT can be taught in that environment. Some familiarity with that learning environment is required. It is very similar to the traditional learning environment.

Enterprise	Refers to the specified environment where some ingenuity and careful planning is necessary to make this activity work. Some familiarity with that learning environment is required.
Effort	Refers to CoLT environments which would take considerable time and energy to make it work and you [the teacher] would be wise to weigh whether implementing it in this environment is indeed worth the effort.

Table 2-2: Three classification levels of CoLTs (adapted from Barkley et al., 2014, p. 136)

These colours are then aligned with Figure 2-2 (for a larger version see Appendix S), which displays the assessment effort required by the teacher to implement each CoLT in the four primary online environments (Barkley et al., 2014, p. 136). Note: The colours have been added by this researcher for ease of reading.

Effort Needed to Implement CoLTs in the Four Primary Online Environments

Barkley, Elizabeth F.; Major, Claire H.; Cross, K. Patricia. Collaborative Learning Techniques: A Handbook for College Faculty (p. 136). Wiley. Kindle Edition.

	CoLT No.	CoLT Name	LMS	Web Conferencing	Virtual World	Open
Discussion CoLTs	1	Think-Pair-Share	Ease	Effort	Ease	Effort
	2	Round Robin	Enterprise	Effort	Enterprise	Enterprise
	3	Buzz Groups	Ease	Effort	Ease	Effort
	4	Talking Chips	Enterprise	Effort	Enterprise	Effort
	5	Three-Step Interview	Ease	Ease	Ease	Enterprise
	6	Critical Debates	Enterprise	Enterprise	Enterprise	Effort
Reciprocal Teaching CoLTs	7	Note-Taking Pairs	Ease	Effort	Effort	Effort
	8	Learning Cell	Ease	Ease	Ease	Enterprise
	9	Fishbowl	Enterprise	Effort	Ease	Effort
	10	Role Play	Effort	Effort	Ease	Ease
	11	Jigsaw	Ease	Effort	Enterprise	Ease
	12	Test-Taking-Teams	Ease	Effort	Effort	Effort
Problem-Solving CoLTs	13	Think-Aloud Pair Problem-Solving (TAPPs)	Effort	Ease	Enterprise	Effort
	14	Send-A-Problem	Enterprise	Effort	Enterprise	Effort
	15	Case Studies	Ease	Effort	Enterprise	Enterprise
	16	Structured Problem Solving	Ease	Enterprise	Enterprise	Enterprise
	17	Analytic Teams	Ease	Enterprise	Enterprise	Ease
	18	Group Investigation	Ease	Effort	Enterprise	Effort
	19	Affinity Grouping	Effort	Enterprise	Effort	Ease
Graphic Organizer CoLTs	20	Group Grid	Ease	Enterprise	Effort	Effort
	21	Team Matrix	Ease	Enterprise	Effort	Enterprise
	22	Sequence Chains	Enterprise	Enterprise	Effort	Ease
	23	Word Webs	Effort	Enterprise	Effort	Ease
Writing CoLTs	24	Dialogue Journals	Ease	Effort	Effort	Ease
	25	Round Table	Ease	Effort	Enterprise	Ease
	26	Dyadic Essays	Ease	Effort	Effort	Open??
	27	Peer Editing	Ease	Effort	Effort	Effort
	28	Collaborative Writing	Ease	Effort	Effort	Ease
	29	Team Anthologies	Ease	Effort	Effort	Ease
	30	Paper Seminar	Enterprise	Enterprise	Enterprise	Effort
Games CoLTs	31	Team Scavenger Hunt	Ease	Effort	Enterprise	Effort
	32	Quizo	Effort	Enterprise	Enterprise	Effort
	33	Team Jeopardy	Effort	Effort	Enterprise	Effort
	34	Friendly Feud	Effort	Enterprise	Enterprise	Effort
	35	Team Games Tournaments	Enterprise	Enterprise	Effort	Effort

Figure 2-2: Requirements to Implement CoLTs into Four Primary Online Environments (adapted from Barkley et al., 2014, p. 136)

Based on the colours, it appears that *Learning Management Systems* (LMS) are the easiest of the four environments for a teacher to implement, such as Blackboard and Moodle, as these are more commonplace in the education system. Virtual World and Open Environments also appear to have some challenges, depending on the activity. Lastly, there is Web Conferencing which is the most challenging.

The CoLTs provided by Barkley et al. are broad and cover a diverse range of activities. These CoLTs have, however, been primarily designed to assist teachers for implementation in direct classroom learning, and implementing CoLTs for online environments also has its challenges. As new technologies, such as LSSDS, are being utilised in classroom learning environments, new strategies are necessary to provide designers of learning environments with a framework to develop collaborative learning activities. When dealing with multiple learners in one shared workspace, specific collaborative learning strategies should be considered to facilitate group learning, interaction, and participation. Other strategies could involve how the interactive activities are to be structured and matched to suit the type of learning strategy. Lastly, there is a need to include observable assessment strategies to determine how well the group worked collaboratively.

2.2.2 Benefits of Collaborative Learning

Barkley et al. (2014) has analysed a large body of data specifically related to the benefits of the collaborative learning approach, grouping the findings into five broad areas: (1) Cognitive learning outcomes; (2) Outcomes related to student engagement, persistence, attitudes and personal development; (3) Good educational practice; (4) Impact on different types of students; and (5) Teacher and student opinions about collaborative learning. Of these five areas, the first three areas are the most relevant to this research. The following is a summary of the Barkley et al. (2014) three main findings:

1. Collaborative Learning Correlates Positively with Cognitive Learning Outcomes

Collaborative Learning was identified to provide students with positive and improved cognitive learning outcomes and encouraged higher order thinking skills through elaboration, comprehension monitoring and critical thinking (Barkley et al., 2014, pp. 20-22).

2. Collaborative Learning Correlates Positively with Student Engagement, Attitudes, Persistence, and Personal Development

Collaborative Learning produced higher learning outcomes than those obtained through traditional competitive methods, such as, when collaborating students are more engaged and active in the learning process. Through this active and engaging process, their attitudes towards their learning experience and subject matter become more positive. This positivity encourages students to persevere, especially following failures, to reach their learning goals. This could relate to group members providing more encouragement and support. Lastly, students within the collaborative groups are considered to have some increased advantage in personal development, better awareness for fine arts and analytical skills, as well as a better understanding of science and technology (Barkley et al., 2014, pp. 22-24).

3. Collaborative Learning Is Good Educational Practice

Collaborative Learning provides good educational practice. Barkley et al. (2014) have based this notion on research by Chickering and Gamson (1987), and Ambrose, Bridges, DiPietro, and Norman (2010). Regarding the work by Chickering and Gamson (1987), Barkley et al. (2014) centred on the first three principles. These principles are: (1) good practice encourages student-faculty contact; (2) good practice encourages cooperation among students, and (3) good practice encourages active learning. Barkley et al. (2014) then focused on Ambrose et al. (2010) two principles which relates to (1) student motivation as a driving force for learning, and (2) students are still developing socially, emotionally, and intellectually. In a student-centred approach, a teacher can have an impact on student learning by providing a positive environment (Ambrose et al., 2010, p. 158). Social interaction within the classroom is valuable as the better students get to know one another the easier it becomes to speak up (Barkley et al., 2014, pp. 25-26).

The role of the teacher, as the instructional designer, is to design the classroom group activity. Students working in a social classroom setting have peer support, and it is this peer support, social interaction and discussion where learning occurs. While the benefits of collaborative learning are well documented, the process does not come without its challenges.

2.2.3 Challenges of Collaborative Learning

Given the documented evidence of the benefits of collaborative learning, the practice also comes with its challenges, for both the teacher and the students. Barkley et al. (2014) write, “The evidence [of students learning collaboratively] is so strong that interactive group learning has multiple advantages if done well that it would be folly not to learn how to operate collaborative learning groups productively" (p. 32). Section 2.2.2 discussed and analysed the benefits of collaborative learning. It is, however, also vital to understand the challenges that can arise when working collaboratively.

According to Panitz and Panitz (1998), there are a number of challenges for teachers, and to a lesser extent, students, when designing collaborative learning activities. Teachers resist the use of collaborative learning techniques as they feel that they are giving up class control by giving students more responsibility and reducing their role from expert to facilitator. Other challenges put forward are a concern of a lack of prepared materials for use in class, or a loss of content coverage. Relating to the teacher/student challenge, the teacher fears that the student's individual accountability will be lost, or they fear the possibility that a student may dominate the group, or even, that one student may complete all the work for the team.

Part of the student-centred approach is for the teacher to provide students with a basis and reason for the need to be working collaboratively. This can be achieved with planning and good instructional design. A model with a structured collaborative approach could provide teachers with a scaffold, a map, to assist in the design of collaborative learning materials, especially in relation to interactive environments such as the LSSDS. The teacher can then see their role being redefined back to expert with the LSSDS as the facilitator.

Students face some similar challenges when working in groups. Panitz and Panitz (1998, pp. 171-172) believe that students face two main challenges: (1) students lack of familiarity with collaborative techniques, and (2) the fear of loss of content and ability to achieve high grades. Panitz and Panitz (1998) state that students lack an understanding of the fundamental values and principles of collaborative learning, as the current system is focused on competition and individual responsibility. The role and interrelationship of the student and teacher are redefined by moving away from the competitive - or a general individual learning environment - to a student and student-collaborative approach guided by the teacher. Panitz and Panitz (1998) also believe that students resent that the burden of learning shifts from a passive role where the teacher presents the information, to a more interactive learning approach where students construct and share their knowledge.

Additional challenges described by Barkley et al. (2014) relate to the students reluctance to accept change, possibly due to poor interpersonal skills and/or group work resistance. Other challenges discussed by Barkley are that students find working with other students difficult due to differing intellectual abilities. Students may feel that this creates an inequitable environment, and that this could affect group participation in which learning may occur at different rates.

Collaborative learning elicits and encourages higher order thinking through elaboration, comprehension monitoring and critical thinking. Students are engaged and active in their education, and this should provide a better and more positive learning experience.

Interestingly, Barkley et al. (2014) state:

> While there are a substantial number of articles on student attitudes toward group work (which includes negative perceptions) and the problems students identify with group work (e.g., inequitable participation and social loafers), there is almost no research on groups that fail. (p. 32)

Collaborative learning comes with some challenges. If a learning activity is well designed, where the workload is evenly distributed, many of these challenges can be overcome. Students need support and instruction to learn the necessary skills required to work in social settings and understand the benefits of working together using a collaborative learning approach. For a traditional classroom learning approach, this is all well and good. However, when put in context, specifically for interactive technologies such as LSSDS, a more structured instructional design approach needs to be considered for optimal collaborative learning.

2.3 Computer Supported Collaborative Learning

Computer Supported Collaborative Learning (CSCL) has been described as a subsidiary of the learning sciences, which explores ways in which people can learn together with the support of computers (Stahl, Koschmann, & Suthers, 2005; Stahl et al., 2006). CSCL is a combination of technology, culture, and society that is cross-disciplinary by moving between the psychology, sociology domains, social sciences and computer science, as well as societal problems, such as education, which are all interdependent (Koschmann, 2017; Ludvigsen & Arnseth, 2017). When working collaboratively with the support of computers, the learners can work, as a member of a paired or small group, or as part of larger group, such as a classroom or part of a community of learners (Jeong, Hmelo-Silver, & Yu, 2014). Olson and Olson (2009) consider the idea that, central to CSCL, are peers interacting and working together to problem-solve at a level that the learners readily understand, with an emphasis on the assistance of technology to support in the facilitation of collaboration. Recent computer technologies such as the LSSDS brings groups of learners together to work in one shared space, which can be a community of learners.

2.3.1 CSCL: History of Technology and the classroom

There is a large body of research which provides detailed studies on the theory related to CSCL. CSCL began at a conference in San Diego, 1983, as a workshop discussion topic, "Joint Problem Solving and Microcomputers" (Cole, 1983), with the first public use of the term *Computer-Supported Collaborative Learning*, used at a NATO-sponsored workshop in Maratea, Italy in 1989 (O'Malley, 1995; Stahl et al., 2006). CSCL came about as classroom practices were changing because of the introduction of computers and software which provided a means for students to learn on their own (Stahl et al., 2005). During this time, the internet was seen to be the saviour, in its potential to connect students to work and learn collaboratively. CSCL combines "*computer* technology, *collaborative* social interaction, and *learning* or education" (Stahl, 2013, p. 44).

In evolutionary terms, Dillenbourg, Järvelä, and Fischer (2009) write that research on CSCL is divided into three ages: The first age (1990-1995) emerged because of the lack of research and understanding in educational technology. The second age (1995-2005) relates to the growth of CSCL and how it has developed into a large community of researchers communicating through research and publications. The final age (2005 – onwards) is where collaborative activities are combined within interactive digital and physical spaces, and where the teacher arranges multiple activities with multiple tools. Stahl et al. (2006) found that as CSCL developed, new ways to design and distribute educational software became apparent and that a rethink of the concept of teaching and learning in schools was necessary. As a consequence, it is essential and necessary to consider how teachers will design for these collaborative activities, in particular for LSSDS, and how to design software so that students work collaboratively within these interactive digital and physical spaces.

2.3.2 CSCL: Learning Theories

Theories of collaborative cognition, which forms the basis for CSCL, were analysed by Stahl on two separate occasions (Stahl, 2006, 2013). Stahl's 2013 version of the individual and social learning theories has been adopted by this researcher to highlight the social learning theories related to this research (see Figure 2-3). Figure 2-3 provides a more detailed and comprehensive look at the different learning theories adapted by Stahl from an earlier paper, (Stahl, 2006). The theories considered most relevant to CSCL concerned the nature of cognition, specifically relating to how learners think when in collaborating groups (Stahl, 2013).

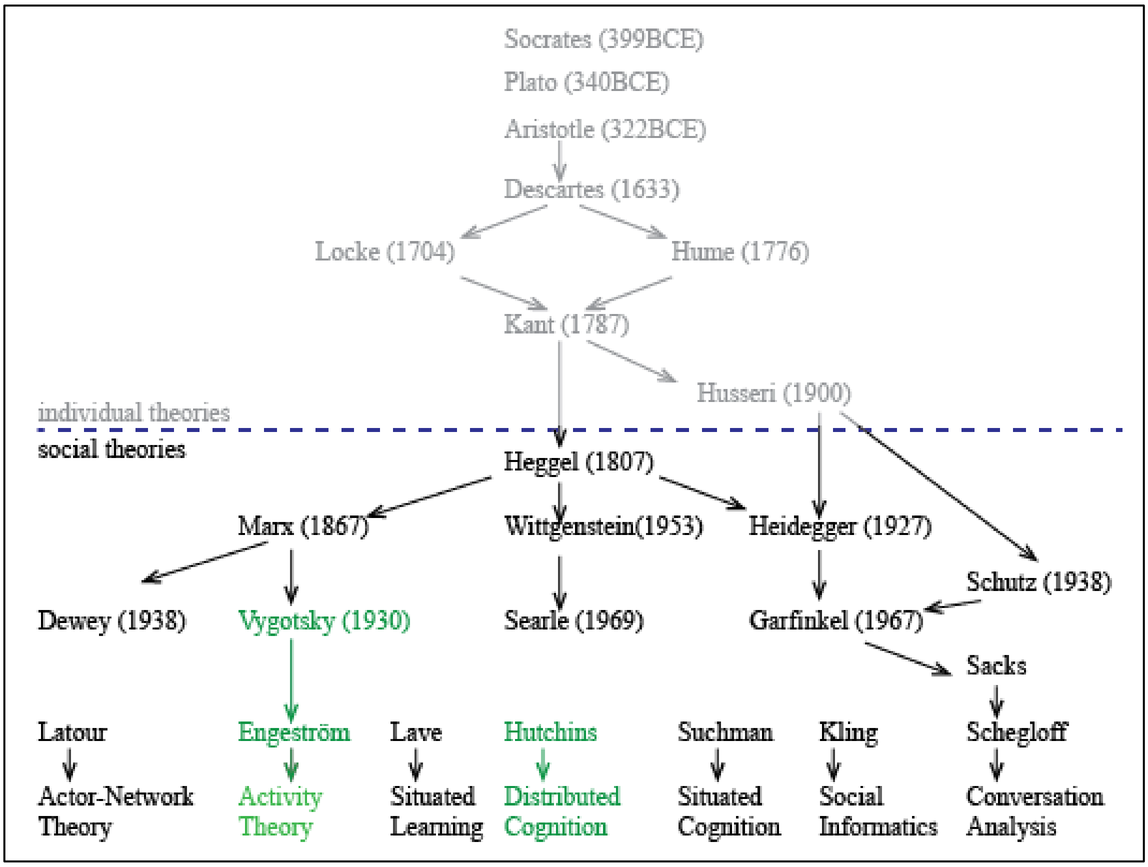


Figure 2-3: Individual and Social Theories of Learning (adapted from Stahl, 2013)

Jeong et al. (2014) examined CSCL methodological practices and frameworks between 2005 to 2009. What Jeong et al. (2014) found was that as a disciplinary research field, CSCL consisted of many different theoretical frameworks and methodological traditions. Ludvigsen and Arnseth (2017) state that this "[s]ocial interaction and collaboration create resources for which people gain the capacities to explore and solve problems together" (p. 47).

Figure 2-3 demonstrates the broad array of social learning theories. The theories related to this research are *Sociocultural Theory* (Vygotsky, 1978), *Activity Theory*, (Engeström, 2001) and with some discussion on *Distributed Cognition Theory*, (Hutchins, 1995a). These theories have been selected for the following reasons: *Sociocultural Theory* assumes that knowledge is produced in a social setting and teachers, parents or mentors contribute to an individual's cognitive development. *Activity Theory* looks at the relationship between the subject [a learner or a group of learners], the mediating artefacts or tools [can mean a physical object such as the LSSDS, a computer] and the object [the objective or the goals of the activity]. *Distributed Cognition Theory* is the belief that cognition is not just with the individual, but can be distributed across the social group, artefacts and tools that redistributes cognition across the system. All these theories highlight the role of tools, activities, social norms and systems (Jeong et al., 2014, p. 313). Further discussion of these three theories occurs at a later stage within this chapter — *Sociocultural Theory* (see Section 2.5.1), *Activity Theory* (see Section 2.5.2), and *Distributed Cognition Theory* (see Section 2.5.3).

2.3.3 CSCL: Design Challenges

Research has shown the potential effectiveness of collaboration improving students ability to problem solve by assisting one another, and by engaging in group discussions (Slavin, 1996; Teasley, 1995). Ludvigsen and Arnseth (2017) state, "CSCL builds on different scientific disciplines and fields, such as the learning sciences, communication studies, computer science and to some extent social sciences" (p. 48). As a pedagogical approach, CSCL can be seen to cover many disciplines, or as in the case of this research, can be considered multidisciplinary, involving technology, psychology and education.

In 1994, Bannon wrote on the issues of the use of CSCL in regards to asynchronous computer communication facilities such as electronic mail, computer conferencing and open bulletin boards (pp. 272-275). What Bannon found was that, from the perspective of a teacher or instructional designer, activities required planning, and that placing students in a physical or electronic connection, such as email, did not guarantee that collaborative learning took place. However, Riel (1985, as cited in Bannon, 1994) found that providing students with more complex and structured activity, such as developing a class newspaper, encouraged new collaborative skills through interaction and completing tasks such as editing and layout.

In 2006, Stahl described six critical issues that dominated CSCL:

1. Learning should not be centred on individual learning, but should focus on the group of students, as one whole unit. Stahl proposed that there be a need to move away from the individual learning theory and search for new sources such as through Vygotsky's Mediated Cognition [*Activity Theory*], which rose from *Sociocultural Theory* (p. 14) and Hutchins *Distributed Cognition* (p. 6).
2. Student groups should not be working on their own activity, but should be working interactively within a team to construct new understanding and meaning (p. 6). In a sociocultural learning environment, it is through discussion, the use of tools and other students that knowledge is shared and created.
3. Learning is not an individual process, but occurs with the aid of computer systems, appropriate software and network (p. 6). Tools, such as the computer system, mediate learning, but as a technology it is aimed more towards individual learning. Even if the computers are networked, the students are still working on their own individual machine, as a form of asynchronous learning.

Whereas, incorporating well-designed software in a synchronous learning environment means learning is happening in one space simultaneously.

4. Learning in a group environment is helpful in constructing/scaffolding personal, meaningful knowledge, and not the transmission of known facts (p. 6).
5. Being collaborative is not competitive, neither is it accidental or ad hoc. Collaborative learning relates to students interacting. Collaboration needs to be carefully thought out and methodical so that students are working, exploring and learning together (p. 6).
6. Collaborative learning is about students participating and interacting in an activity; it is not about drill and practice or procedural learning, such as the behaviourist approach. Knowledge is developed through discussion, debate, argumentation, producing a deeper understanding that is internalised and can be used with existing internal knowledge (schema) (p. 6).

Overall, Stahl (2006) states that all the early work in CSCL was based on the individualistic view of the education and psychology disciplines and that for changes to occur, there was a need to shift away from the traditional ideals of individual learning (p. 6).

Nine years later, Stahl (2015) maintains that much of the CSCL relies on technologies based on a model of individual learning and knowledge transfer where it should, in fact, focus on an understanding of meaning negotiation, collaborative knowledge-building or verbal communication (p. 338). Therefore, when considering collaborative learning, all three features should be considered. Where the word 'negotiation' suggests an agreement has been reached, the words *meaning negotiation* indicates agreement, but there was also a possibility of some disagreement by some group members, with a group consensus being reached (Warglien & Gärdenfors, 2015). Collaborative knowledge-building was an idea originally conceived with the notion that schools should function as knowledge-building communities by facilitating collaborative work for sharing and advancing knowledge and artefacts (Scardamalia & Bereiter, 1994). Within collaborative knowledge-building, the group activity needs to be structured in such a way that learning is shared, expertise is distributed, and each member is building on one another's ideas (Hmelo-Silver & Barrows, 2008; Palincsar & Herrenkohl, 2002). Finally, verbal communication is where multiple students share information and ideas through speech.

In this research, this area will be explored by investigating theories such as Vygotsky's *Sociocultural Learning Theory*, Hutchin's *Distributed Cognition Theory*, and Leont'ev / Engeström's *Activity Theory*, where students are working on the same problem at the same time, sharing cognitive responsibility for the task. All of this will be examined in the context of one large interactive digital space, such as an LSSDS.

2.4 Interactive Technologies

Interactive tools and technologies in education are dated back to the mid-1800s, with universities introducing correspondence courses using print and written materials as the form of communication between the teachers and the students (Spector, 2015). Atkins (1993) describes interactive technologies as a category of systems where users can communicate with each other, and with the material and information presented. Atkins was referring to the standard desktop computer [material] and the software [information] designed for the single user to participate and explore environments such as simulations and microworlds (p. 333).

When designing for collaboration on the standard computer, it is difficult for students to collaborate due to their small display size and single point input of mouse and keyboard (Morgan & Butler, 2009). This early research by Morgan and Butler (2009) stated:

> Multi-touch displays [LSSDS] solve this problem by i) enabling the display of a large shared digital workspace, ii) allowing multiple inputs from several users to be recorded simultaneously, and iii) by providing a large format display for several students to gather around to undertake a shared task. (p. 674)

Therefore, there are many aspects of this large interactive space that require consideration.

2.4.1 Asynchronous and Synchronous Learning

A standard desktop computer is considered to be asynchronous (see Figure 2-4), where learner's communication is generally aided by media [tools] such as email and discussion boards, and can happen at any time (Branon & Essex, 2001; Hrastinski, 2008). These technologies facilitate and mediate communication with the instructor or other learners, but they are separated by both time and space (Belanger & Jordan, 2000; Spector, 2015, p. 58). For learning communities, this can lead to learners feeling isolated, or that they are not part of a learning community, however a feeling of belonging to a learning community is essential for collaboration and learning (Hrastinski, 2008).

Alternatively, there are synchronous interactive tools and technologies that offer real-time communication such as teleconferencing, instant messaging or a virtual online classroom (Spector, 2015). These interactive technologies are dynamic tools which encourage collaboration with students working in teams and are more socially engaging as they are face-to-face. Another feature of synchronous technologies, which are essential for learning, is that peer responses and feedback are instant and in real-time (Branon & Essex, 2001; Hrastinski, 2008). Synchronous learning increases personal participation and motivation, as face-to-face communication is considered to be a natural communication (Hrastinski, 2008; Kock, 2005).

In recent years, interactive technologies have entered a new age with the introduction of synchronous, interactive natural-communication mediums such as e-communication technology(Kock, 2005). Kock (2005) states that natural communication includes: (1) a high degree of co-location, with several individuals placed in the same proximity, to see and hear each, and share in the same environment while doing so; (2) individuals are required to be in the same proximity so that they engage in some form of communication interaction to stimulate and exchange a response from the other individual; (3) the ability to convey [send] and observe [receive] facial expression; (4) the ability to convey [send] and observe [receive] body language; and (5) the ability to convey [send] and observe [receive] speech (p. 121). As a synchronous interactive technology, the LSSDS can also be applied to this natural communication category as shown in Figure 2-4.

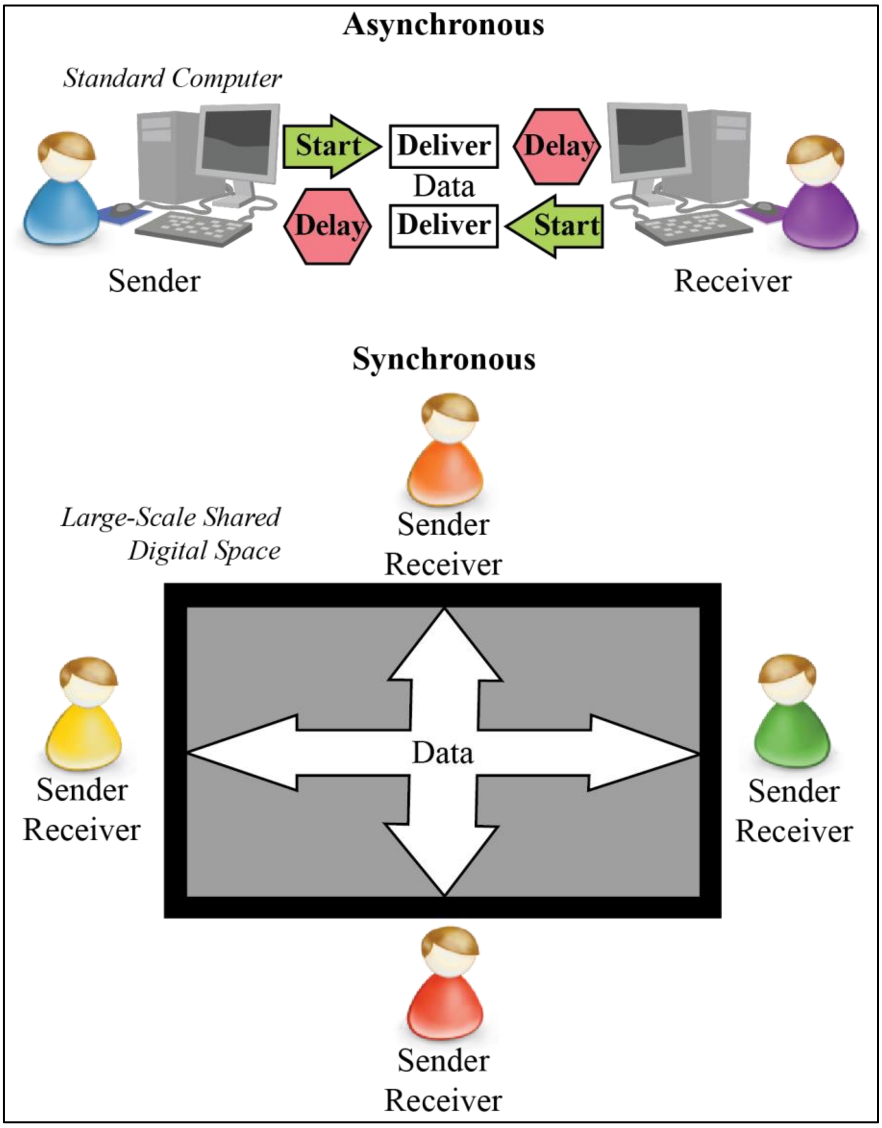


Figure 2-4: Examples of Asynchronous and Synchronous technologies

The LSSDS, as a collaborative face-to-face learning space, has a great deal of naturalness. All users are in one co-located area, all share the same screen interface, and due to the multi-touch nature of the technology, all users can act on and directly manipulate digital objects on the touch surface at the same time. Reisman, Davidson, and Han (2009) describe direct manipulation as an intuitive and controllable mapping experience that gives the user an impression of ‘gripping’ a real object. The user can slide their finger across the touch surface, and objects react by rotating, translating and scaling or moving with the fingertip (see Section 2.4.5 Touch, Gestures and Natural User Interface). Another aspect of the naturalness of the LSSDS relates to the forms of verbal and nonverbal communication. Due to the social nature of humans, the development of verbal and nonverbal communication skills begins from the day we are born. Vygotsky (1978) put forward the theory that a child’s higher mental functions or cognitive development, occurs when they interact with their parents, family, friends and teachers (see Section 2.5.1 Sociocultural Theory). Vygotsky (1978) wrote “ … the most significant moment in the course of intellectual development, which gives birth to the purely human forms of practical and abstract intelligence, occurs when speech and practical activity, two previously completely independent lines of development, converge” (p. 24).

Early childhood development begins with the use of tools and signs, e.g. a child may babble and point to a cup of water indicating they are thirsty. When handing the child the cup, the parent says the word, “water”. Vygotsky writes, “ … as soon as speech and the use of signs are incorporated into any action the action becomes transformed and organize along entirely new lines” (p. 24). As the child’s language develops, the language becomes more important, and the use of gestures and tools are modified. The child may still point to the cup, as a sign, but would be more verbal and say, “water”. The parent's initial action of verbalising “water”, provides new knowledge, sound/object association, is encoded internally by the child and creates a stronger schema (see Section 2.7.1.2.2: Schema Theory).

Verbal communication has been defined by the Oxford Dictionary of Media and Communication as a form of “human interaction through the use of words, or messages in linguistic form” (Verbal communication, 2011). Within verbal communication there exist vocal cues. Vocal cues are any significant variation in the sound of the voice when two or more people are having a discussion. Examples of vocal cues include vocal qualifiers such as rate, rhythm, pitch, tone, articulation, and vocal characteristics such as laughing, crying, yawning etc. Vocal cues can signify dominance, trustworthiness, dynamism, likeableness and competence. Examples such as a sarcastic intonation can represent an ironic expression, loud and fast voices can be associated with anger or excitement, however, adding a deeper voice can be associated with dominance (Vocal cue, 2011).

Just as important as verbal communication is the nonverbal aspects, the unspoken dialogue of communication (Burgoon, Guerrero, & Floyd, 2016). According to Burgoon et al. (2016), nonverbal signals are spread through nearly all acts of communication, primarily when interacting face-to-face. When working in a face-to-face environment, such as the LSSDS, all forms of nonverbal communication or behaviours such as gestures, facial expressions, proximity, posture, and eye contact are exhibited. As a behaviour, gestures discussed here relate to the forms of communication emblems, such as waving to say hello or goodbye or nodding to say yes. As opposed to the gestures addressed in Section 2.4.5: Touch, Gestures and the Natural User Large-Scale Digital Spaces Interface.

To put this into context, the LSSDS shown in Figure 2-4 shows four figures [users] communicating with each other, sending [conveying] and receiving [observing] facial expressions, body language and speech. This team of four are engaged socially; face-to-face. A well-developed learning application that stimulates verbal discussion and nonverbal expression should encourage dynamic interaction, collaboration and learning.

2.4.2 Large-Scale Digital Spaces

Multi-touch surface technology has many name variations such as multi-touch, interactive tabletop, horizontal tabletop, augmented tabletop and digital tabletop technologies (as discussed in Section 1.2). Multi-touch surface technology is a form of horizontal display technology where multiple users directly interact with digital information (Müller-Tomfelde, 2010, p. 4). Multi-touch technologies have had a long and diverse history. The following is a non-technical historical timeline that puts into context the development of display and input technologies and how they provide new and unique systems that may be used to support co-located collaboration. During this development, the systems have ranged from extensions of the standard desktop computer to the electronic whiteboard and to digital tabletop systems (Scott, Grant, & Mandryk, 2003). Prior to the discussion about horizontal touchscreen technology, there will be an analysis of vertical touchscreen technology, the interactive or electronic whiteboard. This will then be followed by an introduction to early concepts of touchscreen technology, with an early touchscreen tablet prototype, and then a summary of four general classes of large-scale digital spaces. The first is *DigiDesk*, where an overhead camera registers and reads the users actions. This is followed by *Responsive Workbench*, a semi-immersive, virtual reality environment that is projected onto a table surface above. Then, there is *The Pond* desk, specifically designed with collaboration in mind, where multiple users can interact with a screen and, finally, *Microsoft Surface*, where multiple users can interact directly with the screen.

Touchscreen technology began in the early 1960s, with the first published historical application of transparent touchscreen for Cathode-ray tube (CRT) air-traffic control terminals (Johnson, 1965). At that time Johnson (1965) described the touch display as:

> A novel input/output device for computer systems has wires, sensitive to the touch of a finger, on the face of a cathode-ray tube on which information can be written by the computer. This device, the 'touch display', provides a very efficient coupling between man and machine. (p. 219)

During the mid-1980s, Hewlett Packard produced a very early commercial version of touchscreen technology with the HP-150 (see Figure 2-5). This computer was described by da Cruz (2001) as the first of its kind to use a 3.5” rigid diskette, an MS-DOS compatible computer and a 9” Sony screen that had infrared, single touch-screen capability.

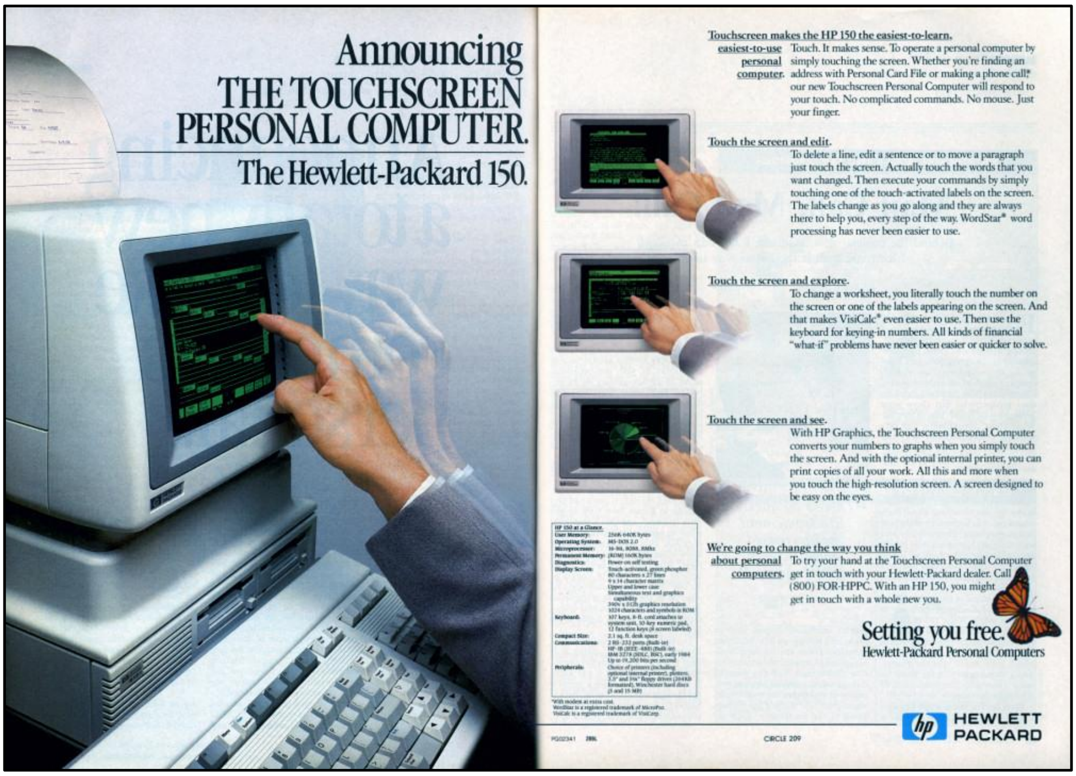


Figure 2-5: The HP-150 Touchscreen Computer (Edwards, 2007)

2.4.2.1 Vertical Interactive technology – The Interactive Whiteboard

In early 1990, large interactive whiteboards such as the *Liveboard* moved out of the lab and into the office and in other domains such as education (Benyon, 2014). The *Liveboard* system (see Figure 2-6) was an interactive, stylus-based, large-area display developed for group meetings, presentations and remote collaboration (Elrod, Bruce, Gold, Goldberg, Halasz, Janssen, Lee, McCall, Pedersen, et al., 1992).

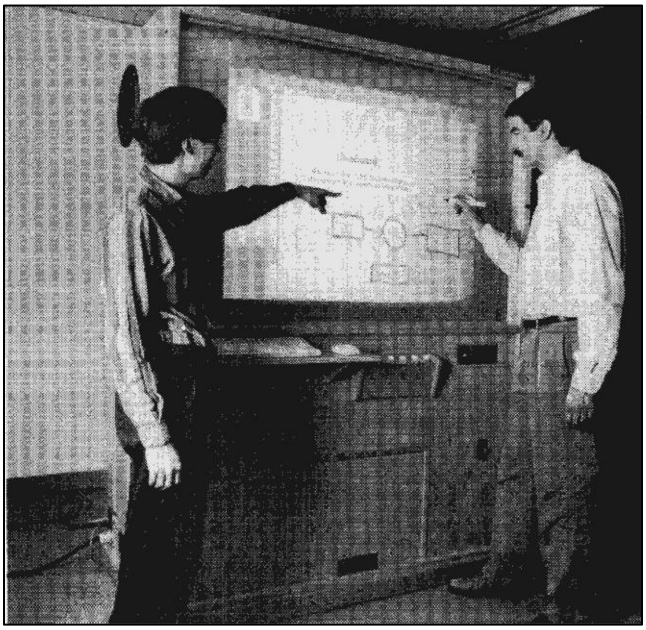


Figure 2-6: The Liveboard in use (Elrod, Bruce, Gold, Goldberg, Halasz, Janssen, Lee, McCall, Pederson, et al., 1992, p. 600)

According to Miller and Glover (2010), within two decades the use of *Interactive Whiteboard* (IWB) systems became widespread and was adopted worldwide in all sectors of the educational domain.

According to Hall and Higgins (2005), the Australian, United States and the United Kingdom governments invested millions and even billions of dollars in information and communication technology (ICT), with the Australian government spending 4.3 billion dollars between 1999 and 2000. Around that same time, the US government invested more than 700 million dollars in Educational Technology, and the UK Government spent 1 billion pounds between 2001 and 2004 (p. 102).

The following studies demonstrate some outcomes from the perspective of teachers. Hall and Higgins (2005) study discovered that, for the implementation of the IWB to be successful, teachers required ongoing technical support and training. A lack of professional training and technical support issues was also identified by Slay, Siebörger, and Hodgkinson-Williams (2008) with teachers in the study preferring to revert to the laptop and data projector. Technical difficulties were also identified by Fekonja-Peklaj and Marjanovič-Umek (2015) as well as teachers feeling that they had less control over the pupils work. This supports an earlier statement (see Section 1.2) where Hesselbein (2014, February 24) discusses the teacher-centred approach of the Digital whiteboards.

On a positive note, Fekonja-Peklaj and Marjanovič-Umek (2015) state that IWB technology comes with its benefits as well, where the dynamic display of the content attracted student attention and motivation. A feature of IWB technology is its interactivity, where the student and teacher can directly interact with the vertical screen. The current IWB technologies, *Smart Technologies* (SMART

Technologies, 2018) and *SmartMedia* (SmartMedia, 2018), allow up to 16 touch points, depending on the model of the screen. The screen dimensions of these IWB technologies come in various sizes, with the largest advertised as being 92 inches (234 cm). A screen that allows 16 touch points is stated to be able to support 16 users writing at the same time (SmartMedia, 2018), but given the vertical nature of the screen, it is hard to imagine 16 users working at the same time in a very small space.

Figure 2-7: Example of an Interactive Whiteboard (SmartMedia, 2018)

An early study by Rogers and Lindley (2004) found that as a collaborative tool, the IWB was difficult for users to work in the same shared space, with the screen becoming overly cluttered, for example, when trying to search for information, drawing up a plan, using a calculator and writing notes (p. 1150).

In summary, the IWB is a medium that has some constraints, e.g. number of interactive touch points, and the number of participants at the screen [as opposed to being around the screen]. The IWB medium is also considered to have some interactive capacity. However, even with a sound design, this may produce more meaningful but limited interactions and collaboration.

2.4.2.2 Horizontal Interactive Technology – Multi-touch Technology

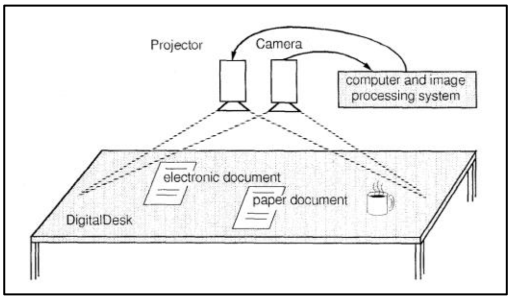
The 1980s proved to be progressive in touchscreen technology. The development of a multi-touch screen, not a tablet, was introduced in 1984. Bob Boie of Bell Labs developed a transparent screen that was overlaid on a CRT monitor. This overlay, known as a capacitive array of touch sensors, allowed users to manipulate graphical objects with their fingers (Buxton, 2016). According to Buxton, Boie did not publish on this work.

Around 1985, *MicroTouch Systems* (acquired by 3M) presented the first commercial surface-capacitive touch system and, in that same year, Lee, Buxton, and Smith (1985) presented a prototype touch-sensitive tablet which was able to sense more than one contact touch point at a time (see Figure 2-8).

(a) (b)

Figure 2-8: Screenshot examples from YouTube video demonstrating two and three contact touch points (Buxton, 1985)

The early nineties saw the introduction of larger multi-touch interactive technologies. Wellner (1991) developed an electronic desktop using a computer-controlled front camera and projector above it (see Figure 2-9). The camera registers and reads where the user is pointing. The *DigitalDesk* demonstrates multi-touch concepts, using two-finger scaling and translation of graphical objects.



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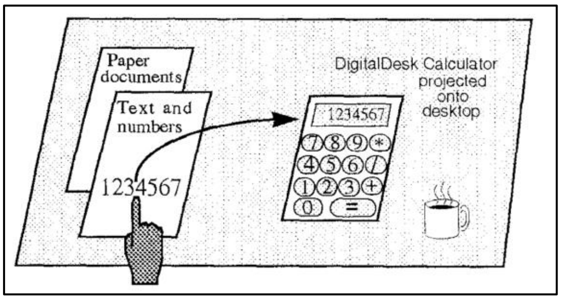
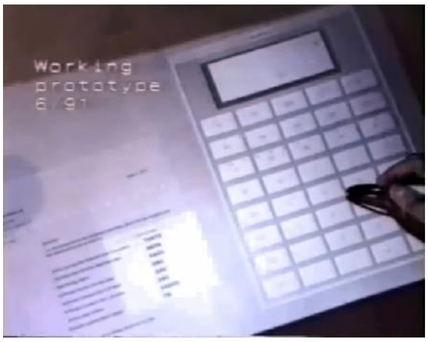


(b)

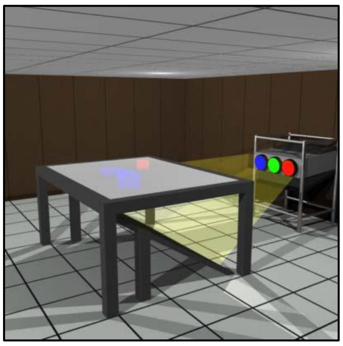
(c)



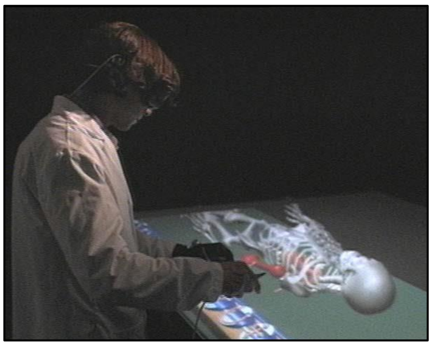
(d)

Figure 2-9: Examples and Screenshots from YouTube video demonstrating the DigitalDesk Calculator (Rivero & Wellner, 2008; Wellner, 1991)

Cutler, Fröhlich, and Hanrahan (1997) presented a *Responsive Workbench*, a virtual environment with Virtual Reality (VR) possibilities. Applications set virtual objects on top of a real table, enabling users to directly interact with the projected environment bringing the user into a natural working environment. These above systems were designed to cater for a single user and do not allow groups of learners to work collaboratively.



(a)



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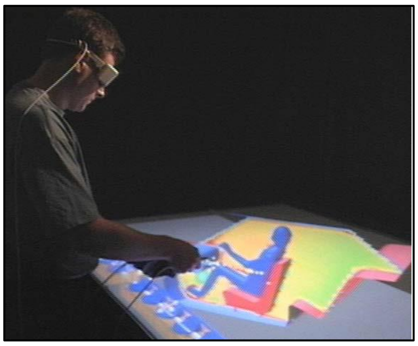


(c)

Figure 2-10: (a) The Responsive Workbench (b) Medical education and training and (c) Automotive car interior design (Fröhlich, 1997)

Ståhl et al. (2002) introduced, *The Pond*, a desk-based display system where several users can interact and search for data elements. *The Pond* desk was a large touch-sensitive plasma display placed in a frame (see Figure 2-11). Built into the frame were speakers to output sounds and music, as well as several RFID tag readers that were embedded into the carpet. These readers indicate position and state to the users. Ståhl et al. (2002) write, "… [t]he tags used in The Pond are passive. They make it possible to load and store information, but do not manipulate this information any further" (p. 73). The users can initiate queries by placing an RFID tag on the reader. This initiates the tag reader to identify the query, a keyword or phrase.

Figure 2-11: Collaboration table - The Pond desk (Ståhl et al., 2002)

The Pond desk was explicitly designed as a collaborative table allowing multiple users to work in small groups. To interact with the *Pond* table, the users stand around to perform various tasks either by tapping or stroking the touch-sensitive display surface.

Microsoft introduced *Microsoft Surface Computing* (now Microsoft PixelSense) in 2007. The table surface allowed for multiple users to sit around a table and interact directly with the screen (see Figure 2-12). The *Microsoft Surface* table can detect multiple fingers and hands, as well as identify physical objects, such as mobile phones, and recognise their position on the surface (Buxton, 2016).

Figure 2-12: Microsoft Surface (Riley, 2007)

It was also in 2007 that Apple introduced the iPhone (Buxton, 2016), and in the coming years, newer, better, faster and cheaper interactive technologies have been produced, such as the iPad.

In summary, Muller-Tomfelde and Fjeld (2012) describe the phases of large interactive technologies as follows: 1998 — from lab prototypes to real-world collaborative applications, 2001 — from single-touch to multi-touch and with tangibility and, 2009 — from projection to direct display technology (p. 81).

Figure 2-13 demonstrates current examples of multi-touch technologies. The first is a direct display, 55-inch (140 cm) 3M™ Multi-touch screen. This multi-touch table is LED backlit, ultra-slim and lightweight making it easy to mount into information kiosks and enclosure or as a table top (3M™, 2018). The second example shows the Promultis Uno Table Elite, a Backlit LED projected capacitive touchscreen technology which comes in a large range of sizes, from 48 inches (122 cm) to 84 inches (213 cm), allowing for multiple users (Promultis Multitouch Technology, 2017b).

Figure 2-13: 3M™ Multi-Touch Display (3M™, 2018) or the Promultis Uno Table Elite (Promultis Multitouch Technology, 2017a)

Interactive tabletop technology provides an unconstrained display orientation that allows the placement of physical objects on them, and offers a group interface providing users equal access (Muller-Tomfelde & Fjeld, 2012). The most current examples are shown to be used mainly as information kiosks, museums and galleries, at trade shows and in training areas.

An LSSDS has the capacity to synchronously support multiple users in one co-located space and, as a learning environment, provides collaborative interaction opportunities between the users and their computer. Mercier, Higgins, and Joyce-Gibbons (2016) state that the uptake of the use of the technology in the classroom has been limited and the possibilities of the technology has not been fully realised. These authors feel that the traditional teacher-centred classroom environment should be reconsidered, to become a classroom that includes collaborative interactive technologies such as the multi-touch table and multi-touch interactive whiteboards. However, it is not just the setup of the classroom that may need reconsideration, but the way the instruction is designed for these large collaborative interactive technologies may need to be reconsidered as well.

2.4.3 A background on Human-Computer Interaction

In 1981, Xerox announced a new office personal computer (PC), 8010 Star Information System. What was important about this PC system was that Xerox introduced the first generation of GUI (Graphical

User Interface) standards and guidelines (Canfield Smith, Irby, Kimball, Verplank, & Harslem, 1982). According to Ishii and Ullmer (1997, p. 2) it was the Xerox Star which set seven important HCI (Human-Computer Interaction) principles, *seeing and pointing* vs *remembering and typing* and What You See Is What You Get (WYSIWYG), the power of a mouse, windows, icons [to become Windows, Icons, Mouse, Pointer (WIMPs)], property sheets, and modeless interactions. These HCI principles were then adopted and published by Apple Macintosh, (Apple Computer Inc, 1987), and finally, with the Microsoft Windows 95 (Microsoft Press, 1995). For Apple, the idea of putting together these guidelines was, for application developers, both internal and external, to create applications that are consistent in terminology usage, appearance, and action sequence (Grudin, 2017; Shneiderman, Plaisant, Cohen, Jacobs, & Elmqvist, 2017). The notion of consistency being applied to standards and guidelines is something that needs to be considered when designing for LSSDS. Much of the early research in LSSDS technology has been primarily for research in the technology, and where each developed one application (Antle et al., 2011; Cuypers, Schneider, Taelman, Luyten, & Bekaert, 2008; McGivern, 2010). However, none were based on or produced by any standard or design principles. Therefore, it would be essential to consider the learners needs when designing for this new technology by including new standards and also design principles.

2.4.4 Affordances of Shared Systems

As a new interactive technology, an LSSDS provides a large surface where multiple learners can interact with the screen at the same time. When designing for this large surface, the learners should be able to instantly see the purpose of each element or icon—which of those are interactive, and those that are not (see Figure 2-14).

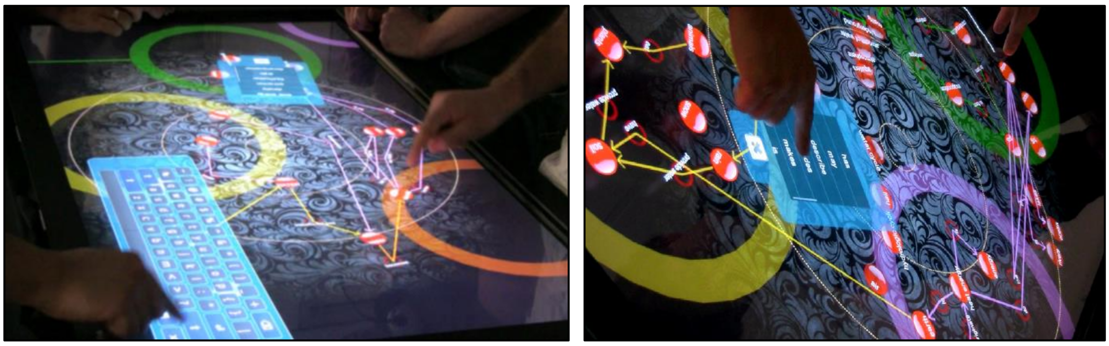
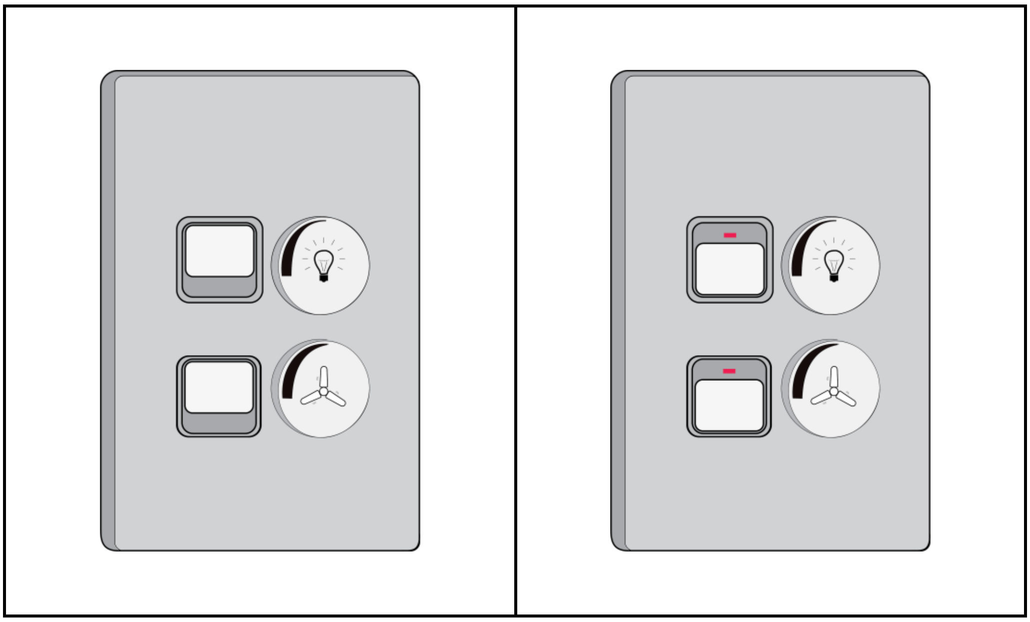


Figure 2-14: Example of the affordances on an NUI (Martinez, Kay, & Yacef, 2011)

Norman (1988) defines affordances as “the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used” (p.9). The following is an example of the perceived affordance of a standard Australian light and fan switch (see Figure 2-15). Image (a) is a representation of a light switch with a dimmer knob next to it. Under the light switch is the ceiling fan switch with a fan speed control knob next to it. The switches are designed to be pressed to turn on/off, and the control knobs turn left/right to regulate the brightness of the light and the speed of the fan. In image (a), both switches are off, the user is to press the bottom of the switch to switch them on. When pressing the switch an audio representation, a click, will indicate on or off. In image (b), both light switches are on, and the user is required to press near the red symbol to turn it off.



(a) Both switches in OFF state

(b) Both switches in ON state

Figure 2-15: An example of affordance and signifiers

An industrial designer has deliberately and intentionally included indicators, known as *signifiers*. These *signifiers* are something in the order of the little red line to indicate 'press here' to turn it off and are accompanied with a click sound. Other signifiers are the symbols on the revolving knobs to indicate bright or dull light and fast or slow fan. In this case, it can be considered that WYSIWYG.

Norman (2013) states, " … the term *signifier* is a mark or sound, any perceivable indicator that communicates appropriate behaviour to a person" (p. 14). The industrial designer must consider and adhere to the specifications and industry standards as set by the governing body before applying design principles to the design of a 'simple' light and fan switch. These specifications and standards would continuously be reviewed and updated to meet the needs of the end-user. These same considerations apply to the guidelines and HCI principles of large collaborative technologies, such as the LSSDS. Guidelines and design principles are necessary for a touch surface such as the user interface design, known as a 'natural user interface' (NUI). This is opposed to the earlier GUI guidelines discussed in section 2.4.3.

2.4.5 Touch, Gestures and the Natural User Interface

The LSSDS can provide a collaborative learning environment that offers a natural user interface (NUI) with *natural* being property to the product itself (Wigdor & Wixon, 2011). According to Wigdor and Wixon (2011), it is easy for a designer to revert to using the standards used in the past, such as the WIMP GUI. These standards were designed for the single user, mouse-based interaction. In its place, the new interactive interface required new examples of input actions and, therefore, has new affordances. The authors, Wigdor and Wixon (2011, p. 13), proposed some must-have principles when designing an NUI to ensure that both the novice and expert user feel that their user experience was an extension of their body. This was achieved through the design of an experience that was authentic to the medium and to build a user interface that considered the context, which included the correct metaphors, visual indications, feedback, and the input/output methods.

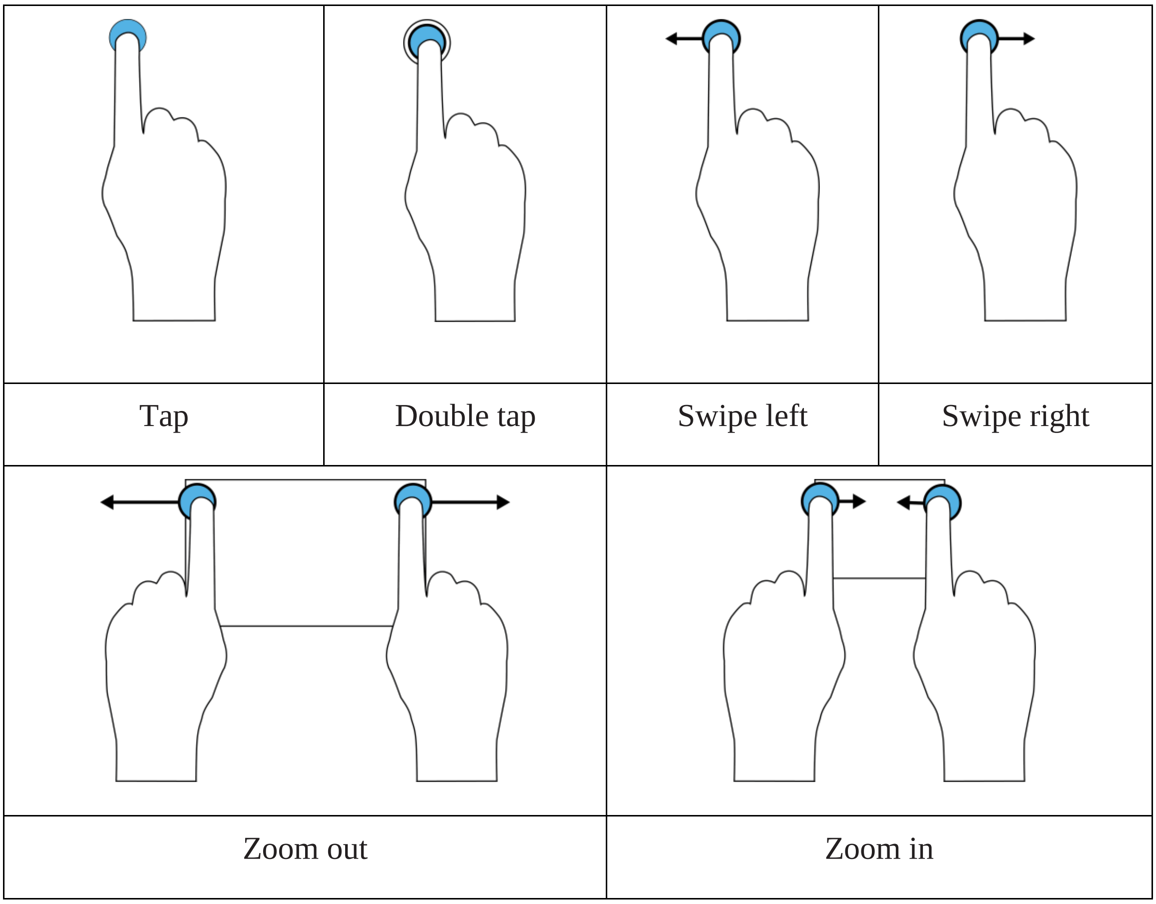


Figure 2-16: Hand gestures for the NUI

In summary, the LSSDS enables multiple users to interact in one co-located large shared digital space synchronously. The end-users do not need to have the technical know-how of a system. It is the instructional designer that needs to understand that, as a technology platform, there are many possibilities and affordances available to the end-user. When designing for a collaborative NUI, smart design principles will ensure areas that are touchable, by incorporating specific affordances and signifiers, and what is a just part of the aesthetics, the instructional package such as non-interactive visuals. Importantly, an instructional designer needs to have insight and a thorough understanding of collaborative learning theories when designing for a large interactive environment.

2.5 Collaborative Learning Theories

The following theories; *Sociocultural Theory*, *Activity Theory* and *Distributed Cognition Theory* are the three most pertinent to this research as they deal with social interaction and social environments.

2.5.1 Sociocultural Theory

In a constructivist model of learning, knowledge is not transferred but created and/or recreated by the learner, with the instructor as the facilitator (Belanger & Jordan, 2000). Social interactions demonstrate sound learning effects, and it is essential to understand the mechanisms for collaborative learning using *Sociocultural Theory* to explain how people relate to each other in an interactive social context. *Sociocultural Theory* explores the importance of the impact that society, for example, parents, teachers or mentors, makes to an individual's development.

Sociocultural learning theory began in the 1920s and 1930s, during postrevolutionary Russia, introduced by Vygotsky and a number of his collaborators, Luria and Leont'ev (John-Steiner & Mahn, 1996, p. 191; van der Veer & Valsiner, 1993, p. 39; Vygotsky, 1978, p. 1). Vygotsky theorised that learning occurs when individuals share information, and through this interaction, they construct an understanding together that could not be achieved alone (Eggen & Kauchak, 2007). Parents, teachers and older children play a key role in the learning of young children, as they provide the cognitive tools for development and support in language. Wertsch (1985) has studied Vygotsky's theoretical approach and states that three core themes form an interdependent framework. These are:

> (1) a reliance on a genetic or developmental method; (2) the claim that higher mental processes in the individual have their origin in social processes; and (3) the claim that mental processes can be understood only if we understand the tools and signs that mediate them. (pp. 14-15)

Wertsch's themes and Vygotsky's three points are not mutually exclusive; they are not individual processes, they all interrelate. To begin, some points of clarification. According to Wertsch (1985), terms translated directly from Russian - Vygotsky's mother language, was substituted for the original translation, and this resulted in some meaning being lost in translation, e.g. the word *genetic* and *mental*. Therefore, when using the word *genetic,* what Wertsch assumes Vygotsky is referring to, is its use relating to developmental processes, not to heredity or inherited abilities. Also, the word *mental,* discussed in the second point, refers to *higher mental processes* or *higher mental functioning*. Wertsch stated that each theme can only be understood by taking into account their interrelationships and that these approaches are not unique and are interdefined (Wertsch, p. 15).

To link back to Wertsch's three core themes: (1) Vygotsky's theory proposed that a child's developmental method, their cognitive or higher mental functioning, occurred in stages and that the child's attention, perception and memory became more complex and abstract over time. (2) Vygotsky believed that a child's higher mental functioning, learning and thinking, develops because of the interaction with the more knowledgeable people within their society — parents, teachers, peers, and these processes can only be understood through (3) the use of tools and signs — symbolic and psychological tools, physical tools and conceptual tools. *Symbolic and psychological tools* include — signs, symbols, texts, maps, works of art and especially the tool of language. *Physical tools* can include a pencil, pen or ruler or a technical object such as a calculator, a piece of software, computer, an LSSDS or an object that can be used in the garden, or out in the paddock. So, a physical tool can consist of any object/device to assist in carrying out a particular function, e.g. a hoe in the garden, a plough in the paddock. Finally, a *conceptual tool* can include something that is abstract, such as a scientific model, a diagram or a mathematical statement, a theory, or an object of art, literature and even virtual worlds (Kozulin, 1998; Woolfolk & Margetts, 2012).

It was the relationship between teaching, learning and development, and that of social interaction, which became the basis of Vygotsky's theoretical exploration (Eun, 2010). Vygotsky saw social interaction as being an important part in the development of cognition, known as the sociocultural principle, which begins long before formal school education. The sociocultural principle puts forward the approach that development relating to how children learn is 'interpersonal': beginning on a social level, externally, and then 'intrapersonal': moving to an individual level, internally. Vygotsky (1978) uses the following as an example: a child's development of pointing begins with the young child's gestural movement, not knowing why. The adult eventually realises this gesture as a pointing movement (interpersonal process), consequently giving it meaning it becomes a true gesture. Eventually, the child links this movement as a gesture becoming an intrapersonal process for the individual (p. 56).

Vygotsky (1978) states that in the process of internalisation, a number of transformations occur:

> *An operation that initially represents an external activity is reconstructed and begins to occur internally* … (pp. 56-57).
>
> *An interpersonal process is transformed into an intrapersonal one.* Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, *between* people (interpsychological), and then *inside* the child (intrapsychological). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relations between human individuals (p. 57).
>
> *The transformation of an interpersonal process into an intrapersonal one is the result of a long series of developmental events* … (p. 57).

Woolfolk and Margetts (2012) state, "Vygotsky proposed that we engage in higher levels of thinking in collaborative situations" (p. 95). Therefore, social interaction plays a vital role in a child's cognitive development that begins through an external social activity, which is then eventually, internalised. Much of Vygotsky's work relates to early last century, however, these same principles can be applied to present-day learning environments using current educational tools, such as LSSDS. When designing an interpersonal learning environment using LSSDS, several factors are critical. Promoting social activity and cooperation through careful considered task division and distribution among learners is essential so that learners collaborate effectively. Learners need to be guided into complementary activities, rather than competing in the same activity, in order to maximise communication and discussion. Similarly, the contributions of learners need to be managed so that one learner does not dominate, and that participation by all is encouraged. Effectively designed collaborative learning enables individuals to finally internalise the learning that first occurs in the social context.

LSSDS may create an interpersonal learning and development environment through two processes; social activity, such as group interaction, and task breakdown, where learning tasks have been divided and distributed among the learners. Each individual brings their own experiences and knowledge to the table. As they interact with the learning activity and discuss the tasks at hand, the knowledge gained will become internalised. The process of internalisation and transformation can be managed by careful design of the learning interaction when situated in the context of an LSSDS. For the learner, the activity on the LSSDS is interpersonal; it is the 'cultural development', or the social level, where the learners interact through discussion and collaboration with others (interpsychological). This is then internalised (intrapsychological) within the learner, becoming intrapersonal.

Vygotsky established that extensive learning begins long before a child commences school. “Any learning a child encounters in school always has a previous history” (Vygotsky, 1978, p. 84). Vygotsky’s main idea in social constructivist learning focused on knowledge constructed through learning development, that occurs collaboratively in a social context and begins with language. Learning and development are interrelated from the moment a child is born and starts with a baby’s cry; this is a way of communicating or asking for adult assistance (Vygotsky, 1978, p. 84).

Language plays a central role in the intellectual development of the child. It plays a critical role in the formation of a child’s mind as the primary form of communication. A child’s development language is ontogenesis, the transition from pre-linguistic, cooing, laughing or babbling, to linguistic communication, the development of words (Bruner, 1975, p. 1). From its earliest form, language is established in a social situation and connects to a child’s thinking, that through maturation and social experiences goes from being interpersonal to intrapersonal (Fox & Schirrmacher, 2011). Vygotsky believed that through higher mental functions such as social mediation, language plays an important developmental role that eventually helps a child in attaining their goals: “ ... children solve practical tasks with the help of their speech, as well as their eyes and hands” (Vygotsky, 1978, p. 26). Once there is an understanding of language, a child begins to question and develop their understanding of the outside world. Through this inquisitiveness or by imitation, a child will develop and learn, continually acquiring and adding new information and skills to an ever-growing large repository of knowledge. For example, as a child’s language develops they eventually get to the developmental level where they begin to be inquisitive about words and want to learn how to read. Parents may begin with picture word association, e.g. A is for apple and have a picture of an apple. An instructional method used to teach children how to read is the phonics approach. Phonics instruction teaches children to identify phoneme, the letter sound, and associate it with its grapheme, its letter shape. The next step is to connect and blend the phonemes; the independent letter sounds to the appropriate letter shapes, enabling the learner to read and spell words. This example demonstrates that the child’s language is continually developing, and the child is acquiring new knowledge and developing their schema.

Learning and development are interpersonal and dynamic; adult assistance is required to mediate and provide added guidance (Fox & Schirrmacher, 2011, p. 79). Vygotsky’s experimental work focused on young school-age children. The results of Vygotsky’s experiment found that children of the same age had different maturity levels, and their learning capabilities differed. The results also showed that, at times, adults or someone who is more knowledgeable, i.e. a parent, teacher or peer assistant, are required to mediate and provide guided learning to make up the shortfall. This is known as the Zone of Proximal Development (ZPD).

2.5.1.1 The Zone of Proximal Development

According to Vygotsky, at some point in a child's development, they will have a problem they are near solving, but it is just out of their reach of capability. While structures can be put in place to support the child, clues, reminders or even the teacher providing some sort of encouragement or assistance, some problems are just beyond the child's ability (Woolfolk & Margetts, 2012).

Vygotsky (1978) writes the zone of proximal development challenges:

> … the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers. (p. 86)

Therefore, unlike the learning environment where the individual's skills determine performance, it is how the individual makes use of the resources or tools in that situation that will strongly influence their learning performance.

There are two limits to the ZPD (see Figure 2-17). The lower limit, *what is known*, includes skills, tasks or abilities that a child is capable of achieving independently and requires no assistance, and the upper limit, *what is not known*, that refers to tasks that are within a child's reach with some degree of assistance (Fox & Schirrmacher, 2011, p. 79; Hill, 2006, p. 5; McLeod, 2014). The ZDP is the in-between area which is dynamic and changing; it is the area of maturation between the child's current level of independent functioning and what can be achieved with the assistance or intervention of others (Woolfolk & Margetts, 2012, p. 98).

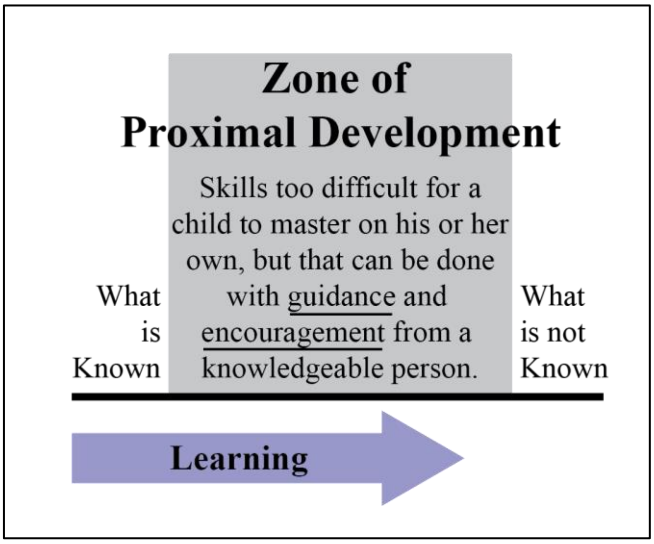


Figure 2-17: The Zone of Proximal Development (adapted from McLeod, 2014)

This intervention involves an adult, teacher or peer assistant, who supports and scaffolds the child to solve their problem, enabling them to achieve their goal and move to the next step.

Wood, Bruner, and Ross (1976) state:

> … [t]his scaffolding consists essentially of the adult “controlling” those elements of the task that are initially beyond the learner’s capacity, thus permitting him to concentrate upon and complete only those elements that are within his range of competence. (p. 90)

In the context of the LSSDS, a collaborative instructional designer could begin the collaborative instructional design by dividing up the task and distributing it among the users. Good design would also incorporate specific scaffolds, such as information, clues, prompts, reminders, and encouragement at the right time, to assist the child’s learning abilities. As knowledge improves the scaffolding is slowly removed.

Social interactions, due to patterns of dialogue and norms of behaviour, provide the scaffolding that enables the construction of knowledge and facilitates learning. Vygotsky’s studies primarily focused on children working in a classroom learning environment. However, according to Brown (1992, p. 191), the ZPD can include adults as well, with many levels of expertise, and with a variety of tools such as books, videos, wall displays, scientific equipment, and a computer environment to provide learning support. This includes a large scale shared digital workspace. The setup of such a learning environment can be considered to be an interpersonal representation of a thought process that also provides a social learning environment by providing social interaction. Through this social interaction, the learners create an intrapersonal learning experience through the use of their thought processes or the *“inner planes of verbal thought”* (Vygotsky, 1986, p. 252).

The structure of language and how we express concepts is integral to our thinking processes. Vygotsky (1986) states: “ … [t]he relationship between thought and word is a living process; thought is born through words. A word devoid of thought, is a dead thing” (p. 255). The ZPD provides the setting in which the social and the individual are brought together through speech and mediation (Daniels, 2001, pp. 8-9).

The LSSDS can be the mediation point; the peer assistant that is the ZPD (see Figure 2-18) which scaffolds and guides the learner by creating an interactive, collaborative learning environment. Learners are co-located around the table and the other people, providing another form of mediation in that this community is discussing, debating or critiquing the task at hand. The way the learning task is designed — divided and distributed among the learners — is another strategy used to scaffold learning. The division and distribution of tasks ensure that learners discuss concepts and interact verbally with each other. If the learning task is divided and distributed among group's members, the group problem solving would be more effective than just that of an individual (Hatano & Inagaki, 1991).

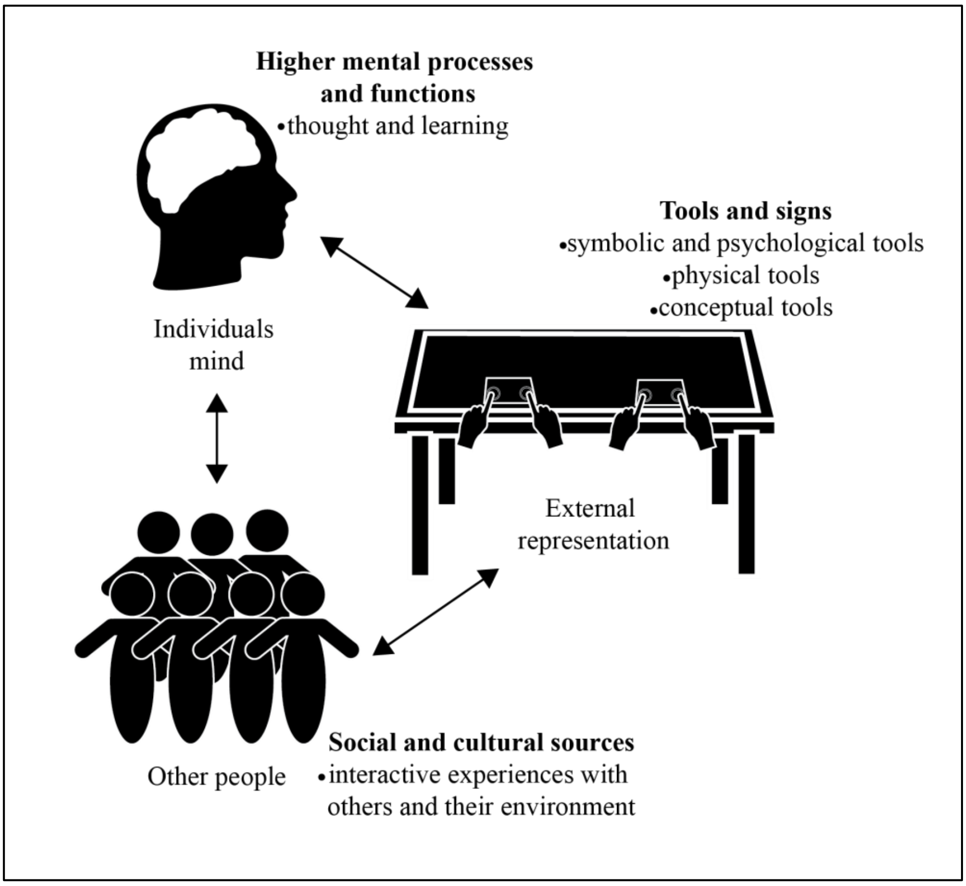


Figure 2-18: A perspective of Vygotsky's Sociocultural Theory

Tools such as an LSSDS, the way the learning application is designed, the language used by the community of learners, the other people, provides the scaffold in the learning processes, making the learners conscious thought first explicit and interpersonal, but then becomes implicit and intrapersonal.

2.5.2 Activity Theory

As a learning environment, the LSSDS is a tool where all the learners are in one co-located space, sharing the same screen interface and actively manipulating digital objects synchronously on the touch surface. To design a learning activity for the LSSDS, the instructional designer needs to have a theoretical understanding of *Activity Theory*.

During the latter part of the 1920s, Vygotsky's main focus was on the use of tools or instruments to control behaviour, known as an " … 'instrumental act'; a unit of activity mediated by signs" (Daniels, 2005, p. 33). Much of the learning research during this era was based on the behaviourist stimulus-response learning theory. In contrast, Vygotsky's research focused on "higher forms of human behaviour where the individual actively modifies the stimulus situation as a part of the process of responding to it" (Vygotsky, 1978, p. 14). It was the use of these signs, tools, instruments or artificial stimuli, that was said to be unique to human beings and considered to be the mediating point (Daniels, 2005, p. 33; Vygotsky, 1978, p. 39).

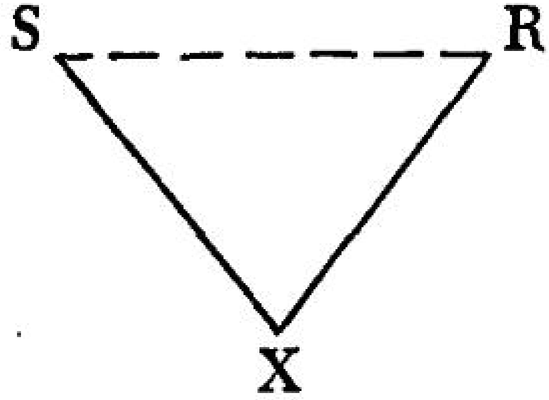


Figure 2-19: Vygotsky's structure of sign operations (Vygotsky, 1978, p. 40)

Vygotsky's research demonstrated that humans use language, as a form of communication, as well as other developed sign systems, for example, the use of notched sticks and knots, to stimulate and influence their own behaviour (Daniels, 2005, p. 33; Vygotsky, 1978, p. 39). Vygotsky wrote for every elementary form of behaviour; S for stimulus, presumes a direct reaction to the task, R for response, (S → R), but (X) creates a relation between S and R which demonstrated that an individual must be actively engaged to establish a link (see Figure 2-19). Therefore, X is the artefact which acts as the mediation that contributes to "… *natural memory …* " (Vygotsky, 1978, p. 38) as it derives from the "direct influence of external stimuli" (Vygotsky, 1978, p. 39). Through the use of mediation, humans demonstrate that they can extend their psychological functions, allowing them to organise and influence their behaviour.

According to Vygotsky (1997), the " … central fact about our psychology is the fact of mediation" (p. 138), and that higher forms of mental functioning are mediated by culturally derived artefacts, such as signs (Fernyhough, 2008). Vygotsky's sociocultural approach refers to human activities in a cultural context that are mediated by social processes and other symbol systems (John-Steiner & Mahn, 1996, p. 191). It is these social processes and semiotic mechanisms, symbol systems or psychological tools, such as language that mediates social and individual functioning that eventually leads to internalisation (Wertsch & Stone, 1986, pp. 163-164). These semiotic mechanisms provide the connection of the external with the internal and the social with the individual (Wertsch & Stone, 1986, p. 164).

Leont'ev, a student of Vygotsky, extended Vygotsky's framework, by analysing human activity into three defined areas: activity, action and operation. Nardi (1995) describes *Activity Theory* as being complex, whereby the unit of analysis; the activity, is dynamic and changes as conditions change, and where all levels move up or down. Turner and McEwan (2004, p. 425) write that Leont'ev's ideas should not be considered to be singular entities, but concentric layers, where: the *operations-conditions* level can be thought of as being the *how*, the *action-goal* level being the *what*, and the *activity-motive* level being the *why* (see Figure 2-20(a)). This was eventually depicted as a triadic interaction between the subject(s), which can consist of one or more people, and a group's object, its purpose, that is mediated by a tool or artefact (see Figure 2-20(b)). In brief, "the subject carries out the activity, the artefact is any tool or representation used in that activity (internal or external to the subject), and the object encompasses both the purpose of the activity and its product or output" (Turner & McEwan, 2004, p. 426).

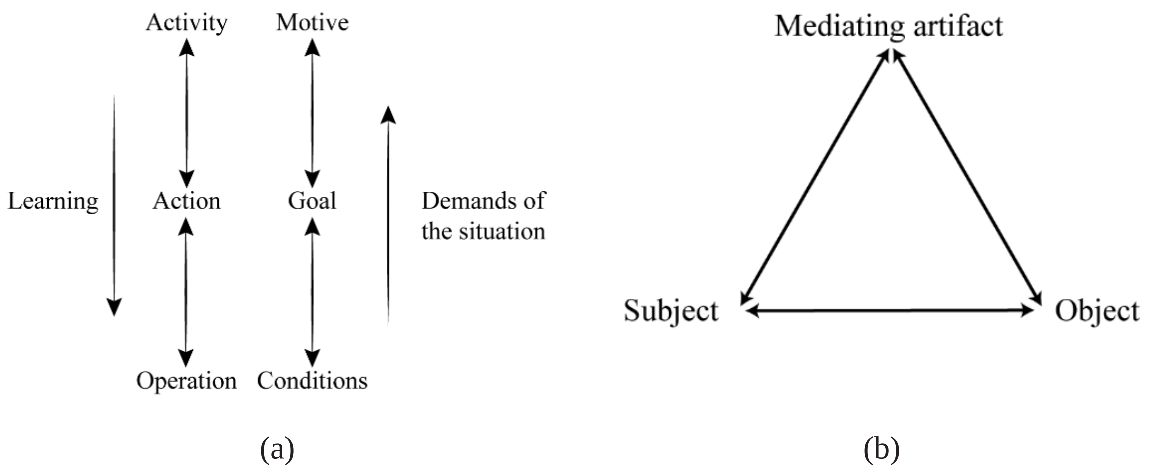
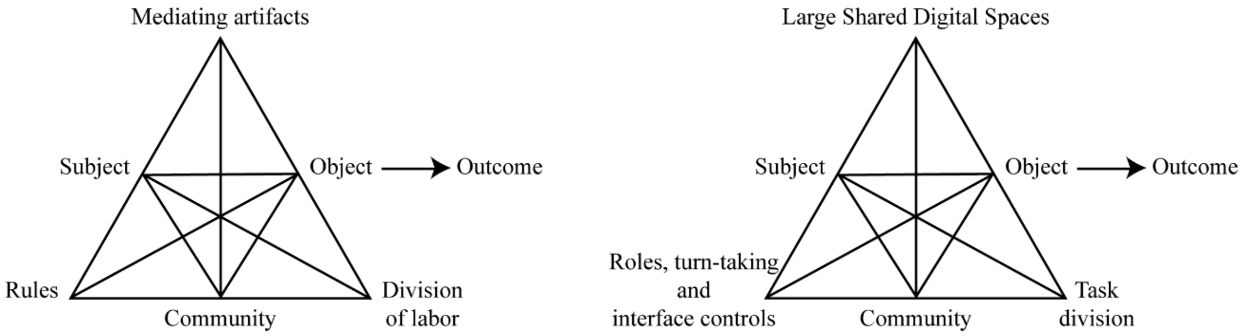


Figure 2-20: (a) Leont'ev's enhanced framework (Turner & McEwan, 2004, p. 425) (b) its common reformulation (Engeström, 2001, p. 134)

Leont'ev's theory was expanded even further in the 1980s by a Finnish academic, Yrjö Engeström (2001), who took the idea of *Activity Theory* out of the classroom and into the workplace. Engeström's extended version included extra elements such as *community*, other group activity stakeholders, and the *division of labour*, the horizontal and vertical divisions that have responsibility and power within the activity. Finally, there are the rules, formal and informal, or standards that govern the relationships between the subjects and the community (see Figure 2-21(a))(Turner & McEwan, 2004).

To further understand how co-located learners actively interact and learn in a social environment such as an LSSDS, there is a need to use a fine lens to examine and understand the whole activity (see Figure 2-21 (b)). Beginning with the apex of the triangle; the LSSDS becomes the mediating artefact; the object is the learning task that has been divided and distributed among the community. The subject/s are the individual members of the community. Each subject will be allocated a specific role and take turns in the learning activity. The design of the interface controls determines how each learner interacts with the activity and, finally, producing a learning outcome [the objective].



(a) Engeström's description of Activity Theory

(b) An LSSDS activity system based on Engeström's model

Figure 2-21: Two activity systems based on Activity Theory (adapted from Engeström, 2001, p. 136)

However, Engeström's concept can also be applied to a learning activity system (see Figure 2-21(b)), where the elements are interwoven and associated with each other either directly or indirectly. Nardi (1995) states that the *Activity Theory* framework is composed of internal and external elements and are considered to be *"fused, unified"*(p. 38). It is internal to people as it involves specific objects and goals, and at the same time, external to people, as it involves artefacts, other people, and specific settings. The collaborative learning environment begins with the LSSDS that becomes the mediating artefact. The *subject(s)* are the learners, the participants. The *object* is the purpose, the learning activity, which produces the learning *outcome*. The *community* is the stakeholders, the participants, who form the active group and, on a broader scale, the classroom becomes the concluding group of participants. The task division is a division of labour that is shared among participants and encourages shared discussion in the activity (object). The roles, turn-taking, and the interface controls govern the relationships between the *subjects* and the *community* who are actively participating in the activity; the *object*, also leads to group interaction which encourages conversation, and therefore produces the learning *outcome*.

According to Hatano and Inagaki (1991, p. 334), humans naturally seek to understand and are more likely to search for meaning when problem-solving in a group environment. A group will bring, per se, a *richer data base* to the table as " … no individual member has acquired or has access to all needed pieces of information, but every piece is owned by at least one member in the group" (Hatano & Inagaki, 1991, p. 335).

2.5.3 Distributed Cognition Theory

The theory of *Distributed Cognition* seeks to understand where and how individuals interact in their environment, through the use of tools, resources and materials, that brings together a body of knowledge in a social context (Hollan, Hutchins, & Kirsh, 2000). Nardi (1996) describes *Distributed Cognition* as a process that investigates the structure and organisation of cognitive systems — internally and externally in the head — and the changes these structures are subjected to through artefacts and the people working in collaborative groups (p. 78).

Hutchins (1995a, p. 176) argues that an established culture or a society as a group might have some cognitive properties that may operate differently at the individual and group levels. Roberts (1964), as cited in Hutchins (1995a, p. 177), suggests that: the cultural group can be seen as a more widely distributed memory regarding being a collective memory, which is more robust and has a much greater capability than that of an individual's memory. Wertsch (2008) describes collective memory as " … a representation of the past that is shared by members of a group" (p. 927). Hollan et al. (2000) state that *Distributed Cognition* concerns all of cognition, rather than a specific type of cognition and can be distinguished from other approaches, or in this case theories, by its commitment to two related principles.

The first principle relates to the boundaries of the *unit* of analysis for cognition. Hollan et al. (2000) state " … [a] process is not cognitive simply because it happens in a brain, nor is a process noncognitive simply because it happens in the interactions among many brains" (p. 175). This puts the context of *unit* in perspective, as Hollan et al. (2000) refers to two previous studies where Hutchins, see (Hutchins, 1995a) and (Hutchins, 1995b), analysed the bridge of a ship and an airline cockpit. In both these cases, Hutchins looked at each sociotechnical system, the bridge of the ship and the cockpit, as whole processes. *Distributed Cognition* differs from the traditional views of cognition, whose boundaries are those of individuals, such as cognitive architecture; the cognitive load with more individual views of cognition.

The second principle relates to the number of mechanisms, instruments or tools, necessary to take part in cognitive processes. In this case, *Distributed Cognition* looks at the big picture, all the processes involved in a system—which differs from traditional approach where manipulation of cognitive processes occurs in the head. In Hutchins (1995b) paper titled, "How a Cockpit Remembers Its Speeds", the author specified the unit of cognitive analysis necessary when pilots work and interact in a plane cockpit system, examining the internal processes, the manipulation of objects, and the traffic in representations among the pilots (Hollan et al., 2000; Wright, Fields, & Harrison, 2000).

What this example demonstrates is that individual memory on its own is insufficient to understand how this memory system, the *Distributed Cognition* approach, works.

The LSSDS is the cognitive tool, the external representation, that enhances “the cognitive powers of human beings during thinking, problem-solving and learning” (Jonassen & Reeves, 1996, p. 693). Figure 2-22 is similar to Figure 2-18, but with an added dotted exterior line representing the boundaries of cognition that consolidates the external representation, the LSSDS, where other people; all learners, can interact simultaneously through direct manipulation. The large size of the LSSDS makes it possible for multiple users to share and work on many activities, synchronously, in a face-to-face social learning environment. Each user will bring their views, knowledge and their mind to the shared workspace.

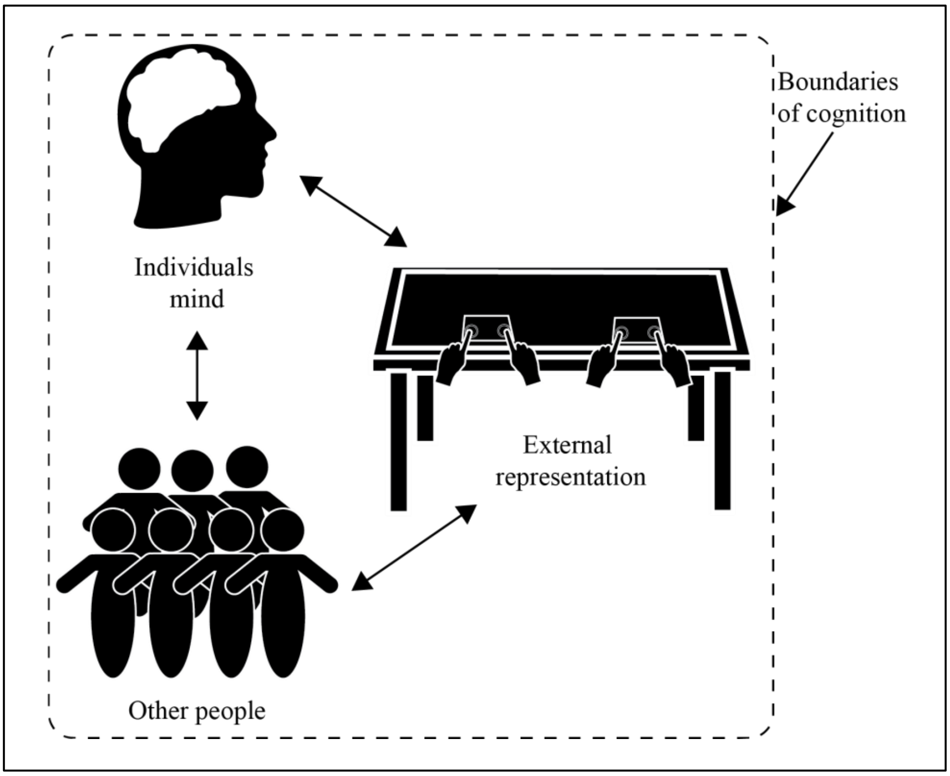


Figure 2-22: The boundaries of cognition in Distributed Cognition Theory

According to Harris (2009), “[d]istributed cognition suggests that capacities are distributed throughout the social and material conditions of the organization and that they are fluid rather than fixed” (p. 4). Rogers and Ellis (1994) state that the principal component of the functional system [also known as the cognitive system] is the analysis and compilation of the individuals and artefacts and how they interrelate with each other in a particular work environment. This analysis should focus on the way in which knowledge is transmitted between the learners and on how information is divided and sequenced through and across the artefact (Rogers & Ellis, 1994, p. 122). To facilitate collaborative learning in the same digital space [the work environment] would require an analysis of the learning activity, breaking it down into sub-components and then sequencing these sub-components between the learners. This creates a fluid workflow between the learners. To do this would require a well-designed learning application that would include new interface paradigms to support this workflow so that multiple users can interact synchronously in a large shared work space.

2.6 Lessons Learned from the Theoretical Background

Collaborative learning is a learning approach whereby a group of learners work together on a task, towards the same shared goal which could not be achieved individually. *Sociocultural Theory*, *Activity Theory* and *Distributed Cognition Theory* are heavily based on people working collaboratively, to accomplish something that could not be accomplished on their own.

Vygotsky's *Sociocultural Theory* is founded on the concept that learning takes place in a cultural context that is mediated by tools and other symbol systems (John-Steiner & Mahn, 1996). Vygotsky also claimed that human action, both social and on the individual planes, can only be understood through the use of mediation tools and signs. It is through culture and language where collaborative learning begins, through social interaction at home because of the influences of parents, siblings, family and friends and then at school with teachers, mentors and peers. Learning, of course, does not end there. This notion of learning through social interaction continues through life with the internal mental processes being challenged and updating continuously. The LSSDS and the purposely designed learning activity are the tools which can mediate learning. Bringing the group of learners around the LSSDS to work collaboratively is the social learning environment, or the community, where they discuss and share their knowledge.

Activity Theory has a similar idea to *Sociocultural Theory*, where there is a relationship between the learner, the mediating artefacts or tools and its underlying objective. *Activity Theory* extends *Sociocultural Theory* by looking at a learning or work environment, as a whole. Instead of the *individual entity* [the child], there is a *community* [e.g. the classroom], the group activity *stakeholders* [e.g. the students], the *division of labour* [e.g. the divided activities], and the horizontal and vertical divisions that have responsibility and power within the activity [e.g. the classification and distribution of the tasks]. The outcome is the *object* or the objective of the activity.

Activity Theory examines the learning environment, the LSSDS, which is considered to be the mediating artefact; the learning task is the object that has been divided and distributed among the community of learners. The community of learners consists of subjects; each subject is a learner within the community. Each subject is allocated a specific role and take their turn in the learning activity. The design of the activity, as well as the way the interface is designed, regulates how each learner interacts with the activity and concludes with meeting the learning goal/objective.

Distributed Cognition Theory has a different view when compared to the two previous theories. *Distributed Cognition Theory* is a framework that encompasses the cognition; the individual's mind, of an entire system that is distributed across a social group, other users, and external representations, such as artefacts and tools. The purpose of *Distributed Cognition Theory* is to contribute to system design and implementation for a collaborative or group setting where individuals contribute actions and activities to achieve a specific goal in one environment. *Distributed Cognition Theory* looks at the entire system, beginning with the design of the learning activity and how the activity is divided, sequenced and socially distributed among the learners, then with the technology, the LSSDS, to create a fluid workflow.

Classrooms are busy places that allow students to be collectively social. Studies have shown that collaborative interaction in classroom learning environments provides positive outcomes for students (Inkpen, Ho-Ching, Kuederle, Scott, & Shoemaker, 1999; Scott, Mandryk, & Inkpen, 2003). The LSSDS is the technology or the external representation that brings the learners together to form a community, and the design of the learning activity is what encourages the collaborative interaction that assists students to participate in shared decision making. To design collaborative learning materials for an LSSDS, where learners can actively collaborate there is a need to examine the current *Instructional Systems Design* (ISD) model.

2.7 Instructional Systems Design

The ISD model, originally designed in the 1940s, was developed to facilitate the production of high-quality instructional materials for the individual learner. While the instructional material developed using the ISD model might be delivered to large groups, the basic method of instruction assumed that learners worked as individuals to assimilate the content. With the advent of computers, ISD was widely adopted to assist in the production of complex and interactive multimedia educational packages. Educational multimedia environments were developed based on the ISD model, such as the CD-ROM single-player games like the *Carmen Sandiego* series that began during the 1980's with the game *Where in the World is Carmen Sandiego?* (Robinson & Schonborn, 1991), and more recently, online and network instructional packages such as *Mathletics* (3P_Learning, 2012) or *ABC Reading Eggs* (eLearning, 2012), were all developed based on the ISD model. These instructional packages were aimed at the individual learner using a single screen computer or on networked computers.

There are many models of ISD to assist instructional developers to design consistent and reliable learning materials for education and training programs (Andrews & Goodson, 1980; Dick, Carey, & Carey, 2009; Gagné, Wager, Golas, & Keller, 2005; Reiser & Dempsey, 2012; Schiffman, 2010). For example, Andrews and Goodson (1980) completed a comparative analysis of forty models of *Instructional Design*. To complete an analysis of all the ISD models available is beyond the scope of this research. Schiffman (2010) has also analysed and classified the ISD and produced a model that contains all the major elements that are the most widely used and is representative of the typical ISD model.

The following section will describe the ISD model in detail and critique it from a collaborative learning perspective. The ISD model is a series of methodological interdependent phases used to develop instruction to produce reliable learning and performance outcomes. These phases include the establishment of goals and the analysis of the learner, the design of objectives and selection of assessment strategies, media selection and instructional materials production, and if required, evaluation and revision (Chen, 2011; Gagné et al., 2005). In order to work with the traditional model (see Figure 2-23), the instructional design expert needs to understand the types of human capabilities: the individual learner's intellectual skills, attitudes and cognitive strategies, the skills requiring memorisation of information, and if previously learned information is required (Gagné et al., 2005, p. 10; Schiffman, 2010, pp. 197-198).

This current ISD model does not mention or include any factors to indicate the possibility of multiple learners. Therefore, there is an implicit assumption of an individual learner assimilating content.

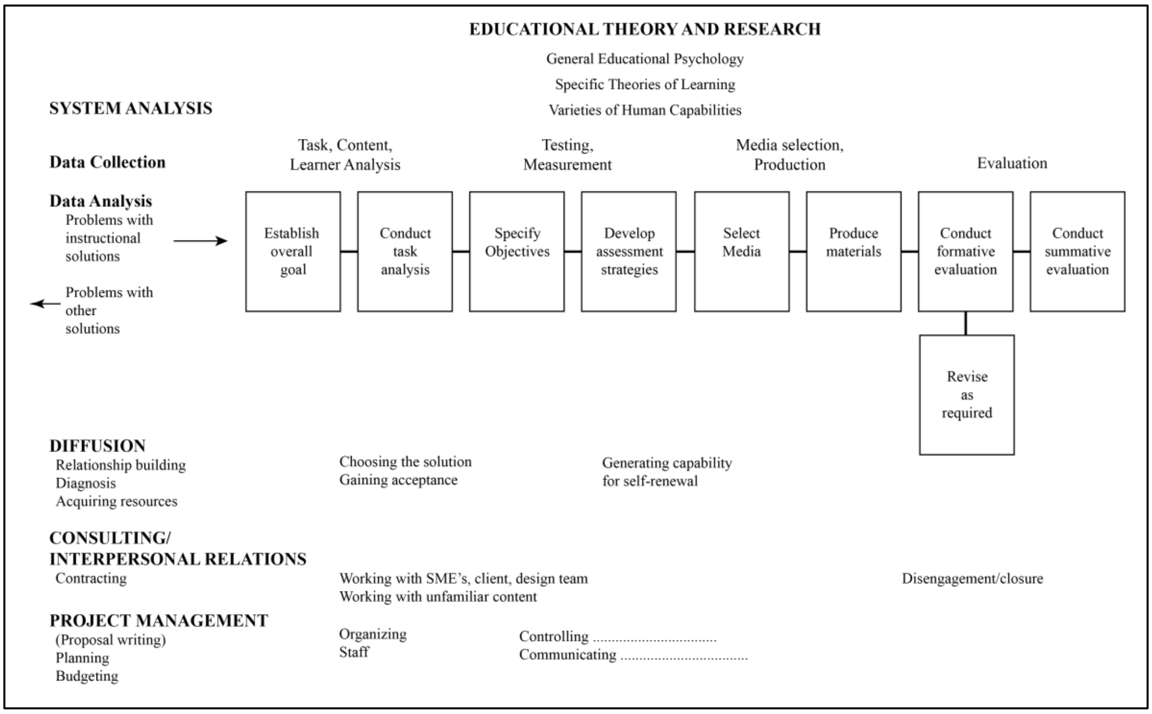


Figure 2-23: Traditional ISD Model (Schiffman, 2010, p. 196)

The Schiffman (2010, p. 196) ISD model has been described as a combination of theory and research. The following is an analysis of Schiffman's ISD model from the perspective of designing for collaborative learning applications that will begin with a discussion of the General Education Psychology, Specific Theories of Learning and Varieties of Human Capabilities. Following this analysis will be an evaluation of the underlying educational theories of the four phases: Task, Content, Learner Analysis; Testing Measurement; Media Selection and, finally, Production, and Evaluation. The remaining elements that are listed below with capitalised headings (DIFFUSION, CONSULTING/ INTERPERSONAL RELATIONS, AND PROJECT MANAGEMENT) will not be discussed as these topics relate mainly to the process of the production of the instructional materials, rather than to educational theory or design issues. These are not directly relevant to this research and therefore will not be the focus of the discussion. Schiffman (2010, p. 196) states that ISD is a "synthesis of theory and research" where there is a need to understand how humans relate to their learning environment, what stimulates them and how information is organised and relayed. There is an additional need to understand if the interrelationships within the learning system provide an efficient and effective means to produce the desired learning outcomes.

The following is a discussion of three sections of the traditional ISD model that are relevant to this research. The discussion will begin with a description of the ISD section, followed by a discussion of the theory or theories that apply to that ISD section, and will conclude with a critique from a collaborative learning perspective.

2.7.1 Underlying Theories of the Instructional Systems Design Model

The first section of analysis of the Schiffman (2010) ISD model begins with General Educational Psychological, then the Specific Theories of Learning and, finally, the Varieties of Human Capabilities of the Instructional Systems Design model (see Figure 2-24).

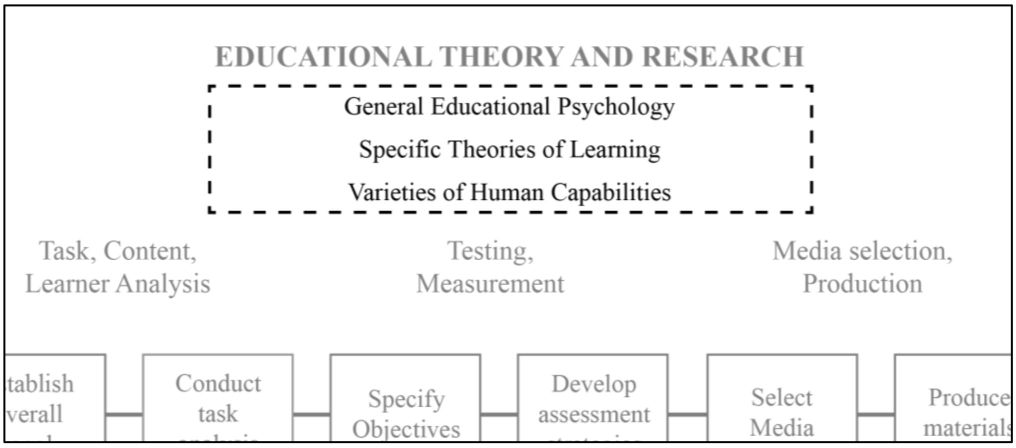


Figure 2-24: The underlying theories for the traditional ISD model (adapted from Schiffman, 2010, p. 196)

2.7.1.1 General Educational Psychology

Educational psychology is a relatively new field that has been developing for just over the last one hundred years, especially when compared to other disciplines like mathematics and astronomy (Alexander, Murphy, & Greene, 2012). Foundational theorists from the early 1900s who were important to educational psychology included William James, E. L. Thorndike and John Dewey.

According to Mayer (1992), the early theorists believed that the science of psychology could improve practice in the field of education. Three views of learning and instruction have developed over the course of the last century that have changed the way education is practised and researched. The first view, *Learning as Response Acquisition*, reigned over the first half of last century. Learning and instruction relate individual learning where the learners acquire their learning through repetitive practice and memorisation, which is based on the behaviourist principle of stimulus-response (Mayer, 1992, pp. 406-407). The second view, *Learning as Knowledge Acquisition*, developed during the 1950s and 1960s was a cognitive approach that is teacher-centred. The teacher dispensed the information, therefore, determining what is to be learnt, and imparts this information. The student's role is to process and absorb the information presented (Mayer, 1992, p. 407). Finally, there is *Learning as Knowledge Construction*, founded in the 1970s and 1980s. This is where the role of " … learner changed from that of a recipient of knowledge to that of a constructor of knowledge, an autonomous learner with metacognitive skills for controlling his or her cognitive processes during learning" (Mayer, 1992, p. 407). Where the learner changes from absorbing what is being taught to that of interpreting what is taught (Glaser & Resnick, 1989, p. 2). *Learning as Knowledge Construction* points towards Vygotsky's constructivist approach where students are active participants, learning and sharing information in a social environment, such as the LSSDS, and the teacher provides support.

Instructional Design Theory is a theory that provides explicit guidance on how to help people improve in learning and development (Reigeluth, 1999). According to Schiffman (2010), a designer should be aware of and have an understanding of the principles of human physical, emotional, social, and mental growth and development. The instructional designer should also look at the characteristics of learners and have an understanding of their socioeconomic status, IQ, sex differences, cognitive styles, creativity, and motivation, as these may affect learning.

Collaborative theories such as *Sociocultural Theory*, *Activity Theory* and *Distributed Cognition Theory* (see Section 2.5: Collaborative Learning Theories) are not shown in this section of general theories. These three theories are a more appropriate learning approach in a collaborative environment as they highlight an understanding that learning is more effective when there are other learners around. The traditional instructional approach does not apply to the constructivist perspective. Therefore, instructional design theories would need to " … place the learner's constructive mental activity at the heart of any instructional exchange, that treat instruction as an intervention in an ongoing knowledge construction process" (Glaser & Resnick, 1989, p. 2).

From a constructivist perspective, the instructional designer would need to look at learning from a social perspective. To do this, an instructional designer could look at specific theories such as *Sociocultural Theory*, *Activity Theory* and *Distributed Cognition Theory*. The first two theories highlight social learning environment where peers [the group] are interdependent on one another and where the use of tools, such as language, or instruments such as the LSSDS, control behaviour. The third theory, *Distributed Cognition Theory*, provides an approach where learners interact within both their social and physical environment and through the use of tools and/or technologies that extend their way of thinking.

2.7.1.2 Specific Theories of Learning

Schiffman (2010) states that an instructional designer needs to have a solid understanding of learning theories. These are divided into two categories, *descriptive* and *prescriptive* theories (Reigeluth, 1992). According to Reigeluth (1992),

> The field of instruction … has grown out of a behavioristic orientation which has focussed most efforts on prescriptions for memorizing information (association tasks) and applying skills (especially concept classification and procedure using). (p. 54)

Prescriptive learning theories, such as instructional design, provide instructional guidelines to achieve specific outcomes (Reigeluth, 1989; Ullrich, 2008). *Descriptive* learning theories relate to how learning occurs, using conceptual models to explain and predict learning results.

The Schiffman (2010) traditional ISD model, is a combination of *descriptive* and *prescriptive* learning theories. The traditional ISD model is presented in a prescriptive theory format — it provides the instructional designer with a series of steps or guidelines to create/develop instructional material, within these steps and guidelines there is a reference to individual learning theories. As previously discussed in Section 2.7.1.1, learning theories such as the behaviourist learning approach [*Learning as Response Acquisition*], as well as, the cognitive learning approach [*Learning as Knowledge Acquisition*], are two styles that are used in a traditional individual learning environment. The third and final approach, the constructivist approach [*Learning as Knowledge Construction*], is a theory that can be used to understand how to facilitate collaborative learning in the context of a LSSDS.

Prior to critiquing the ISD model from the perspective of designing collaborative learning applications for an LSSDS, it is necessary to contrast the fundamentals of how we learn as individuals and how information is acquired and stored in memory with collaborative learning approaches. Of course, there are other elements that are crucial to understanding the individual learner, concerning the characteristics of learning tasks, and how learning tasks are structured. Therefore, this discussion begins by outlining traditional views of Learning and Memory; defining what is learning and what is memory in the context of the traditional ISD model. A large part of instructional systems design involves determining what content to include, and for individual context, this involves a discussion of *Schema Theory*.

2.7.1.2.1 Learning and Memory

When the traditional ISD model was developed, individual learning was considered to be a process of the modification of behaviour that was the result of an individual's experience, training, activities and observations. Hilgard and Marquis' (1961/1968) wrote, "learning refers to a more or less permanent change in behaviour which occurs as a result of practice" (p. 2). This notion of learning still appears to be relevant today, with Anderson (2000) stating that "Learning is the process by which long-lasting changes occur in behavioural potential as a result of experience" (p. 4). More recently, Terry (2009) defines learning as " … a relatively permanent change in behavior, or behavioral repertoire that occurs as a result of experience" (p. 5).

Learning, if conceived as an individual and solitary activity, can be viewed as the result of the process by which long-lasting changes can occur due to behavioural potential and cognitive development that is the result of maturation and experience. From the perspective of individual learning and memory formation, the two approaches are inextricably linked: learning refers to the acquisition of knowledge, or certain behaviour, and memory relates to the retention and recall of this acquired knowledge and behaviour (Terry, 2009, p. 11). Anderson (2000) states that "Memory is the record of the experience that underlies learning" (p. 5). The creation of a memory record suggests that there is some form of mental change that takes place that is the result of a learning experience. Memory is an extraordinary phenomenon, where experiences modify and reorganise our brain. How we interact with the physical world: through our sensory experiences, our perceptions, our action provides us with an ebb and flow of information that is continually changing and determines whom we become (Thompson & Madigan, 2005). Ashcraft (1994) defines the term memory as, "the mental processes of acquiring and retaining information for later retrieval, and the mental storage system that enables these processes" (p. 11).

Terry (2009) points out that there is a relationship between the terms learning and memory, stating " … learning refers to acquiring knowledge or behavior, whereas memory refers to retaining and recalling the knowledge or behavior" (p. 11). Therefore, memory is a crucial part of learning and vice versa. The mental storage system for memory [our mind] is the place where "all the events, information, and knowledge of a lifetime are stored" (Ashcraft, 1994, p. 11).

One way to view the functionality of the mind is to compare it to a computer, in that it accepts input, stores and processes information and, when required, retrieves the necessary information (Coon, 2004; Pastorino & Doyle-Portillo, 2009). While there is a tendency to use this association; computer versus the human mind, there is a significant discrepancy: the human mind is capable of consciousness and awareness by focusing attention outwardly to the outside world, whereas a computer lacks in this ability (Pastorino & Doyle-Portillo, 2009).

If this view of the human mind versus the computer processing information is examined from the perspective of collaborative learning theory, what is evident is that it ignores the complex social and cultural dimensions of the learning activity. The standard ISD places focus on individual learning content, whereas in the collaborative context, the social and cultural dimensions should be considered more important. Therefore, when designing for collaboration, specific collaborative learning theories such as those discussed in Section 2.5 would influence how to better approach and encourage collaborative learning. For example, a point of consideration would be that these collaborative, social environments would influence the learning process as students bring prior knowledge, through interacting with their parents [family], teachers and peers.

2.7.1.2.2 Schema Theory

Reigeluth (1999, p. 12) stated that learning theories are descriptive as they describe how learning occurs using *Schema Theory* as an example. *Schema Theory* is considered descriptive as it proposed that knowledge is constantly accumulating and adapting when inconsistencies arise (Reigeluth, 1999; Rumelhart & Norman, 1976). The ISD model is focused on developing learning materials for the individual learner. The learner, when presented with newly developed instruction, would come with pre-existing schema, in the form of memories (Gagné et al., 2005).

Therefore, the instructional designer would contemplate that the individual learners come with their own knowledge and their own pre-existing schemata. When looking at designing for a collaborative learning group, the instructional designer would need to consider that when designing or planning for collaborative learning groups, elements such as discussion and interaction need to be included. The difficulty in designing for multiple learners working on one activity is student diversity, or student differences. Learners come with different skills, where some may be more advanced or work at varying levels. However, when developing for collaborative learning, the instructional designer needs to have strategies in ways that make the collaborative learning activity as social and interactive as possible, in order to assist and encourage discussion. When working individually, what may make sense to one learner may not make any sense to another, but when working in a group, one learner can assist the other. This, in turn, provides the weaker learner with the knowledge that is then internalised.

Schema Theory is closely associated with cognitive learning approaches for individual learners and individual theories of learning, to provide some indication of the type of content to present and the sequencing of this content. *Schema Theory* is a trace left by an event we experience, individualised and selected for remembering. Yu-hui et al. (1980, p. 61) describe *Schema Theory* as the need for one to connect new ideas and knowledge to those already known through past experiences and gain a new understanding. Meade and Cubey (2008, p. 3) support this by stating that “schemas are a form of thought that relates to cognitive structures”, like pieces of ideas or concepts which relate to how we learn how to think, and how we structure our thoughts.

Schemas are representations of patterns of interactive knowledge structures stored in memory. These representations are generic concepts that facilitate the use of this knowledge in certain ways and are considered to be a data structure stored in memory that gives it meaning (Rumelhart, 1980). Where the behaviourist learning approach relates to learning as a result of the stimulus-response acquisition, *Schema Theory* is related to the cognitive learning approach. There are three possible modes of learning in a schema-based system (Rumelhart, 1980; Rumelhart & Norman, 1976). The first is what Rumelhart and Norman (1976, p. 3) have termed '*accretion'*. This relates to "fact learning", adding new knowledge to what is already in existing memory. The second learning mode relates to the changes or the evolution that occurs to existing schemata and is what Rumelhart and Norman (1976) call '*tuning'*. The third mode of learning that Rumelhart and Norman (1976) conceived is where new concepts are formed; the creation of new schemata called '*restructuring'*. Restructuring can be patterned on existing schemata or can be generated from experience. Schemata acquisition can be seen to be an active and dynamic process, in that, it is continually being updated and constantly evolving.

Galotti (2008) describe Rumelhart and Ortony's (1977) view of schemata as the fundamental building blocks of cognition: packets of information. Rumelhart and Ortony (1977), at first, recognised four major features important to schemata that were:

> … powerful for representing knowledge in memory. These are: (1) schemata have variables; (2) schemata can be embedded, one within another; (3) schemata represent generic concepts which, taken all together, vary in their levels of abstraction; and (4) schemata represent knowledge, rather than definitions. (p. 101)

Then, in 1980, Rumelhart added two more general features of schemata:

(5) schemata are active processes. (6) schemata are recognition devices whose processing is aimed at the evaluation of their goodness of fit to the data being processed (p. 41).

By 1988, the first four features of schemata remained, whereas the final two features were revised and merged by Rumelhart and Norman (1988), who theorised that:

> … schemata should be envisioned as active processes in which each schema is a process evaluating its fit, binding its variables, and sending messages to other schemata that indicate its current estimate of how well it accounts for the current data. (p. 538)

The schema uses the same top-down and bottom-up approach to distinguish and evaluate how well it fits. Once schemata are activated, this process of interpretation, whether it is top-down or bottom-up, continually loops: evaluating, refining and discarding, to find the best overall fit which in the final interpretation becomes the best fit (Rumelhart, 1980, p. 43; Rumelhart & Norman, 1988).

As an example of schemata in the literacy domain, from a very early age, young learners are taught that the alphabet consists of letters; an alphabet schema. They also learn that these letters have sounds; a phonemic schema. By putting these letters and sounds together, the young learners can then decode written words to read texts, especially when decoding unfamiliar words when learning to read.

A collaborative learning environment provides a social setting which promotes social interaction. Learning begins when learners are interacting in a social setting through peer assistance and discussion. New knowledge forms as learners assist each other, therefore, acquiring the knowledge that is then internalised. So, when developing a new collaborative learning application, it becomes important for the instructional designer to devise and sequence the learning components that will encourage and facilitate social interaction, which finally promotes learning.

2.7.1.3 Varieties of Human Capabilities

When considering the application of learning principles to instruction, Gagné et al. (2005) believes that the instructional designer should begin by asking themselves the question, "What is to be learned?" (p. 60). To answer this question, the ISD expert should consider psychomotor skills and intellectual skills, attitudes and cognitive strategies, verbal communication and information skills and skills to enhance the memorisation of previously learned information (Gagné et al., 2005; Schiffman, 2010). Knowing these varieties of human capabilities ensures that the instructional designer meets the objectives of an instructional unit, or in the case of this research, instructional application.

However, from a collaborative learning perspective, not only is it essential to understand what the skills are that a learner requires, but the learner also needs to understand how to apply these skills in a collaborative sense. This means that techniques, such as collaborative learning strategies and skills (as discussed in section 2.2.1) also need to be considered. Section 2.2.1 discusses a variety of collaborative learning techniques (see Table 2-1 and Appendix R for full CoLTs list), with the overall basic principle underlying collaborative learning, being that the learners need to be taught and practice how to interact together and with the teacher.

Human cognitive architecture has been used to describe the concepts relating to individual human memory and cognition that are based on scientific methods and approaches using observation and empirical methods. Sweller, Ayres, and Kalyuga (2011) state that "[w]ithout knowledge of human cognitive processes, instructional design is blind" (p. v). Therefore, without an understanding of the specific frameworks or structures of human cognitive architecture, such as an understanding of the characteristics and complexity of the relationship between working memory and long-term memory, the success of the instructional design may most probably be hit-or-miss (Mayer, 2014).

The complexity of memory first became apparent in 1890, when William James (1890) described memory as a two-staged storage system: a primary and secondary storage that can be likened to short-term memory (STM) and long-term memory (LTM). Atkinson and Shiffrin (1968) used this same two-stage model of memory, STM and LTM, and extended this to include a temporary working memory (WM) and sensory memory (SM) as shown in Figure 2-25. This new memory structure demonstrates the progress of information that flowed through a system using a multi-modal model approach that consists of three memory stores: sensory memory, short-term memory [with working memory] and long-term memory. The flow and transfer of information between the three systems was a process where the selected information was copied from one store to the next.

The instructional designer needs to understand the way these memory structures work when designing for the individual learner.

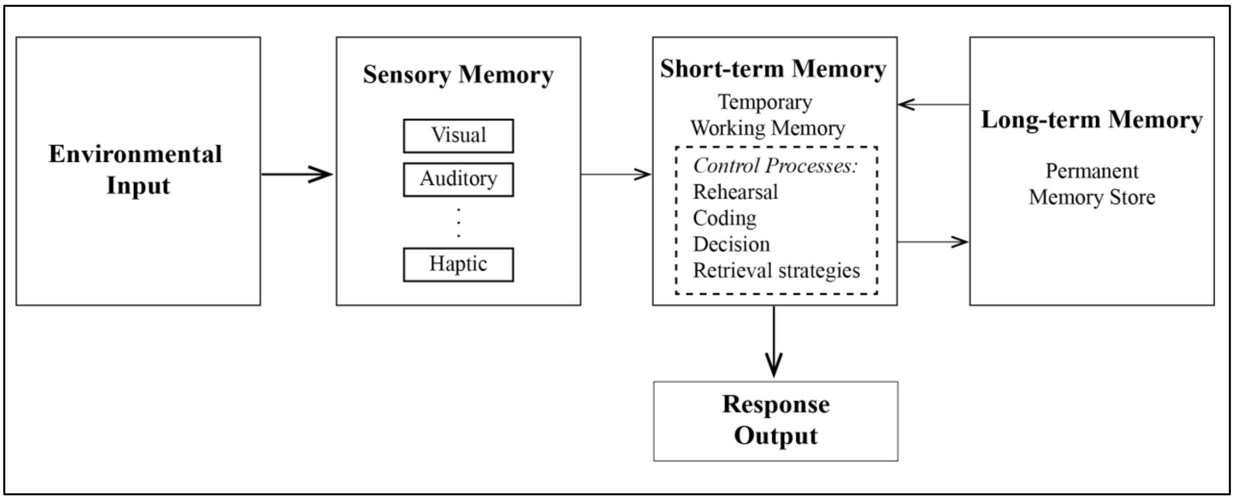


Figure 2-25: Information flow in the memory system (adapted from Atkinson & Shiffrin, 1971, p. 82)

When designing for an individual learner on a single user interface, such as a personal computer, how the information is presented on the screen may become an issue for the learner. Presenting too much information at once can create an essential overload, where the amount of information [the Environment Input] exceeds the learner's cognitive capacity. Cognitive capacity refers to the total amount of processing that can be supported by the SM and the learner's working memory [in STM] at any one time, with the goal that the information is eventually permanently stored in LTM (Mayer, 2014). Note: Mayer (2014) states that terminology, such as essential overload, is the same as cognitive processing, and essential cognitive processing is similar to intrinsic cognitive load.

The LSSDS provides a rich learning environment, as it can present the learning material, which prompts social interaction, in that it brings multiple learners together in one large environment. Therefore, the learning process here is not about the individual's learning process, and the limits of individual cognitive capacities to process information, but about a collaborative interactive and social learning process where the learners support each other in one space at the same time.

2.7.2 Major Instructional Systems Design Components

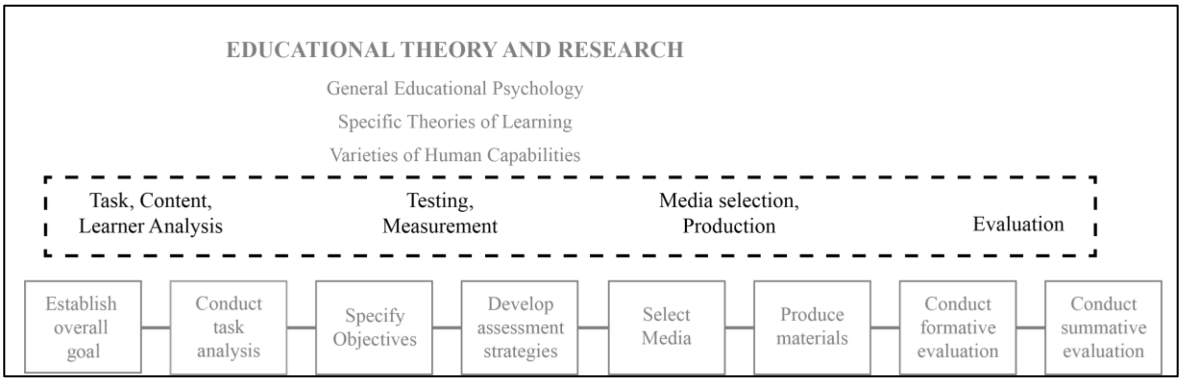


Figure 2-26: Major design components of the traditional ISD Model (adapted from Schiffman, 2010, p. 196)

2.7.2.1 Task, Content, and Learner Analysis

The second section of the Schiffman (2010) model relates to the type of data necessary to create instructional learning material for an individual. The Schiffman (2010) model of ISD begins with *Task, Content, and Learner Analysis.* Schiffman states that behavioural and cognitive orientations are considered challenging for the instructional designer (Schiffman, 2010). These approaches are geared towards a behaviourist approach—stimulus-response—or a cognitive approach where there is a focus on the individual's mental processes and are tailored towards individual learning theory approaches.

Task analysis is traditionally centred on a behaviourist approach beginning with establishing the needs and goals of the instructional problem, which provides the instructional designer with an initial focus (Morrison, Ross, & Kalman, 2013). Once these goals have been identified, the content should be categorised by decomposing the instructional problem into sub-goals, therefore identifying essential prerequisites. These sub-goals should then be arranged into a logical sequence for presenting the content (Jonassen, Tessmer, & Hannum, 1999; Morrison et al., 2013; Schiffman, 2010). Rogers, Sharp and Preece (2011) describe task analysis as "an umbrella term that covers techniques for investigating cognitive processes and physical actions, at a high level of abstraction and in minute detail." (p. 384). Rogers, Sharp and Preece (2011) point out that the information gathered from a task analysis may be used to design, improve and build new tasks. This approach may be problematic in the context of multiple learners who have different skill levels, who may progress at different rates, and who may be performing different task components.

With the ISD model being designed for the individual learner, the notion of designing learning tasks/content for multiple learners working collaboratively in one workspace requires the instructional designer to specifically establish the needs and goals of the instructional problem. There then needs to be an explicit focus on how the tasks are divided and how the content is distributed among many learners.

Schiffman (2010) discusses how the study of cognitive science has extended task analysis to include an analysis of the content by determining the importance and relationship of these individual concepts, in particular, how the material is presented to the learner. Schiffman (2010) writes that from a cognitive perspective an instructional designer would " … need to be aware of how students will process a particular body of content", and, " … how students prior learning (or lack thereof)—of both content-specific information and cognitive strategies—may affect their success with a particular instructional unit" (p. 198).

Content analysis is described as a method where an instructional designer would read and analyse the body of texts, images and symbolic matter to create learning material (Krippendorff, 2004, p. 3). Again, this approach may be problematic in the collaborative context. For example, different learners in the group may have significant differences in the structure and complexity of their schema and the rate at which they absorb and master the content presented.

Based on an understanding of *Schema Theory*, Task Analysis evaluates a content domain and determines the content goals. According to Jonassen, Tessmer and Hannum (1999, p. 8), a task analysis involves five specific functions: inventorying tasks, selecting tasks, decomposing tasks, sequencing tasks and task components and, finally, classifying learning outcomes. However, Jonassen et al. (1999) state that functions may be performed in different settings and may include only some or all of these functions. For inventorying tasks and their content, the process involves identifying and generating a list of the relevant tasks. Selecting tasks involves the ranking and prioritising of tasks to eliminate unnecessary instruction that is already known. Tasks are decomposed into subgoals to identify specific components of the task, its goals and objectives. These components are then laid out into a logical sequence for presenting the content (Schiffman, 2010) in order to facilitate learning.

Finally, Schiffman (2010), does not directly describe or discuss *learner analysis*, but hints of *learner analysis* are interwoven into the whole discussion. However, from the individual learning perspective of instructional design, the designer needs to understand *learner analysis*—the target audience when designing for the learner. *Learner analysis* has been broadly defined as an understanding of your target audience, referred to as "target population" by Dick et al. (2009, p. 92) or "learner populations" by Morrison et al. (2013, p. 50). Schwen (1973) provides a more definitive description of learner analysis, "as empirical methods or plans of analysis that, when combined with task analysis, produce specifications for maximally effective and efficient instruction" (p. 44).

Schiffman (2010) discusses *Task, Content,* and *Learner Analysis* from an individual learning perspective. However, when working and learning in a collaborative environment, how tasks are divided and the content distributed, plays an essential role in relation to the collaborative aspect or strategy of learning design. When working in a collaborative environment, the learners bring prior knowledge to the table. Therefore, the analysis of the collaborative task, the collaborative content and the learner/s becomes an essential factor. Instead of looking at *task analysis* from the individual learning theories perspective, such as the behaviourist approach, the instructional designer would need to look beyond these theories and look at the social aspect, using such theories as Vygotsky's *Sociocultural Theory*. *Sociocultural Theory* (see Section 2.5.1), is specific in that it looks at how society — in this case teachers and peers — can contribute to the learner's higher order functioning by sharing their knowledge and skills through the use of tools and symbols. The overall design process for learners working in a collaborative environment, such as the LSSDS, would need to consider collaborative learning theory. Therefore, an ISD that was designed based on individual learning theory would not be regarded as appropriate.

In presenting learning materials to the learner, the next step is to be aware of the learner's prior knowledge, as this will affect how the learner might process the material. Content analysis from a collaborative perspective is not only determining if the content of the task is suitable for group learning, but would also need further steps, such as how to structure the learning material for the collaborative group of learners. Another aspect that is important when working and learning in a collaborative environment is understanding how to apply the task and content in a team approach. Therefore, when working in groups, learner analysis becomes an essential part of the investigation, as learning moves from an individual aspect to a group aspect, where learners take cues from each other and bring in views from many learners. When a learner is working and learning on their own, they may face limitations based on the cognitive strategies they use to engage in the task. Learners working in a collaborative environment can take cues from other learners and may also provide cues to other learners, lifting these limitations.

2.7.2.1.1 Bloom's Taxonomy

In a similar way to how instructional design models have focused on the individual learner, taxonomies of instructional objectives have focused on hierarchies of learning tasks for individual learners. The concept of learning taxonomies was based on the idea that educators could design learning objectives that are hierarchical in organisation (Marzano & Kendall, 2007). A widely used example of this is Bloom's taxonomy. This concept, developed in 1956 by Bloom and a committee of college and university examiners, was intended to provide a classification of the goals of our educational system and general assistance to educators, such as teachers and professional specialists. This Taxonomy of Educational Objectives provides educators with skills in cognitive thinking in order to design effective classroom learning activities (Higgins et al., 2012, p. 1; Moore & Stanley, 2009, p. 2). Bloom's taxonomy was so innovative and created such an impact on how educators design educational objectives, that it remained unchanged for over fifty years and influenced many areas of teaching, learning and assessing. Anderson et al. (2001) updated the framework for Bloom's taxonomy in 2001. The original taxonomies in 1956 were nouns and in 2001, changed to become verbs and the order of the top two listings was reversed (see Figure 2-27). Bloom's Taxonomy of Educational Objectives will be the point of reference in this thesis as it is the original and underpinning theory behind Anderson et al. (2001).

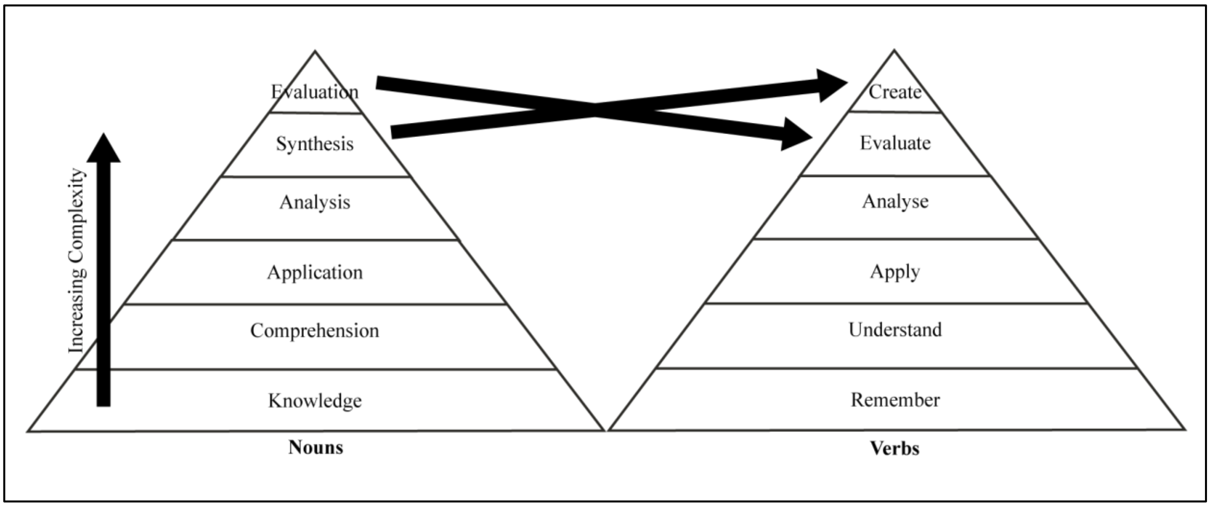


Figure 2-27: Bloom's Taxonomy Revised (adapted from Adams, 2015; Wilson, 2017)

Bloom's taxonomy was developed to provide educators with general assistance to classify learning objectives and goals in curriculum activities to cater for the needs of the individual learner. The aim was to ensure that instruction was not confined to the low levels of the taxonomy, knowledge and comprehension and that for more advanced learners, higher-level activities, such as synthesis and evaluation, were included.

To facilitate instructional design in collaborative learning environments such as LSSDS, a new multi-tiered taxonomy or taxonomies may need to be proposed when designing for a collaboration. These new taxonomies would need to provide a similar classification system like Bloom's, with consideration for the level of complexity, but relate to the complexity of collaborative activities —

for example, a suggested range level could be from cooperative to collaborative. The new taxonomies could be devised to complement Bloom's taxonomy and assist instructional designers when developing collaborative instructional strategies for collaborative environments.

2.7.2.1.2 Metacognition

Bloom's taxonomies set a precedent by providing a classification of goals for educators to design effective classroom learning activities for the individual learner. However, when multiple learners are working on a learning activity based on Bloom's taxonomies, in a collaborative learning domain such as the LSSDS, they bring and share their own experiences and knowledge.

When students do not think about or consider how they learn, learning can be taken for granted. But providing students with an opportunity to think about what they are learning is the beginning of the process of metacognition (Barkley et al., 2014). Metacognition was introduced by Flavell (1971) where he describes the process of memory development as — "a kind of 'meta-memory'" (p. 277). Metamemory refers to the metacognitive knowledge of memory and its relationship to memory functioning, difficulties, and strategies (Waters, Schneider, & Borkowski, 2009, pp. 55-56). Flavell (1976) then elaborated on the definition of metacognition as follows:

> "Metacognition" refers to one's knowledge concerning one's own cognitive processes and products or anything related to them, e.g., the learning-relevant properties of information or data. For example, I am engaging in metacognition (metamemory, metalearning, metaattention, metalanguage, or whatever) if I notice that I am having more trouble learning A than B; if it strikes me that I should double check C before accepting it as fact; … Metacognition refers, among other things, to the active monitoring and consequent regulation and orchestration of these processes in relation to the cognitive objects or data on which they bear, usually in the service of some concrete goal or objective. (p. 232)

Metacognition has been defined and conceptualised in many different ways: Merriam-Webster dictionary defines metacognition as "awareness or analysis of one's own learning or thinking processes" (Metacognition, n.d.). Eggen and Kauchak (2007) states, " … [m]etacognition is our awareness of and control over our cognitive processes" (p. 220), Wall and Higgins (2006) refer to metacognition as, " … learners knowledge of their own cognition" (p. 41). As a final example of metacognition, Hacker and Dunlosky (2003) state that it is, " … knowledge that people have about thought processes and individual monitoring and control of their own thoughts" (p. 73). To put it simply, metacognition is 'thinking about thinking' (Briñol & DeMarree, 2012; Gascoine, Higgins, &

Wall, 2017; Jacobs & Paris, 1987; Livingston, 2003; Peña-Ayala, 2015; Shaughnessy, Veenman, & Kennedy, 2008).

In day-to-day life, learners engage in metacognitive activities. Learners consciously, and even unconsciously, gain and take advantage of metacognitive knowledge by developing metacognitive skills to accomplish complex cognitive processes such as learning, decision-making and problem-solving (Livingston, 2003; Peña-Ayala, 2015). As an approach, metacognition refers to higher order thinking which affects how learners acquire, comprehend, retain and apply what they have learned, which influences learning efficiency, critical thinking, and problem-solving (Hartman, 1998). There is a range of collaborative skills and techniques which fall within the scope of metacognitive strategies, such as planning a group solution, dividing tasks and monitoring group progress.

Flavell (1979, p. 906) discusses the importance of the role of metacognition, which ranges from oral communication and oral comprehension to reading comprehension and writing, as well as areas such as memory, problem-solving, social cognition and self-instruction. There is also some suggestion that metacognition is making headways, in the areas of social learning theory as well as in education.

From a collaborative thinking perspective, where multiple students are working collaboratively, metacognition or metacognitive activity is a way in which multiple learners can bring and share their own experiences and knowledge to one LSSDS. However, this can only come about through a well-designed learning application that would gain the learner's attention and focus on thinking and encourage problem-solving. Social cognition is described by Fiske and Taylor (2016) as a study of how people make sense of other people and themselves, people thinking about people — and themselves. An instructional designer needs to understand how learners perceive each other, their behaviours and the way individuals think [thinking about thinking]. Moskowitz (2005) describes social cognition as, "the study of the mental processes involved in perceiving, attending to, remembering, thinking about, and making sense of the people in our social world" (p. 3).

According to Gourgey (1998, p. 82), metacognition would allow an individual learner to outline the nature of the learning task or problem. The learner would select a useful mental or physical representation to support the learning task, followed by choosing a suitable strategy. The next step is to allocate resources, such as time, to execute the learning task. To facilitate learning, the learner would use pre-existing knowledge, and then feedback, to ensure that the task is on track. Eventually, if need be, they would re-examine or update the task procedures or set recommendations for any future requirements.

In a collaborative environment, the learners would be encouraged to discuss and outline the task and come up with a solution as a group. From a collaborative perspective, when multiple learners are interacting collaboratively on an LSSDS, they are encouraged to verbally express their thoughts and ideas. Because they are working on a task in a group setting, these thoughts and ideas are affected by others, therefore, coming up with a group solution.

2.7.2.2 Testing and Measurement

In educational applications created for an individual learner, the evaluation of 'learning gains' is relatively straightforward and relates primarily to content and skill acquisition. Schiffman (2010) states that a large ISD team would include specialists that "may design the instruments and evaluation procedures" (p. 199). It can be assumed that the instructional design specialists in Schiffman's discussion pertain to accredited teachers or subject specialists. The instructional design specialists would need to have a background in education to be able to provide the team with appropriate means to plan and establish metrics to test and measure the learning outcomes, and to assess if an individual learner was meeting the learning objectives.

This current section of the model relates to the development of metrics necessary to test and measure an individual student's learning gains when working in an individual learning environment. From a collaborative perspective, it is difficult to determine how to assess student learning gains when working in a collaborative group.

What can be assessed is the specific aspects relating to multiple learners working together, how they coordinate their interactions and discuss the collaborative task. These features become important as they are considered to contribute to the group and the group's performance. In other words, to a certain extent, metacognitive processes, like planning and monitoring of progress, can be externalised in the form of a social process in collaborative learning environments.

2.7.2.3 Media selection and Production

Schiffman (2010) explains that when making media selection decisions, the instructional designer should focus on their knowledge of learning theory as well as the varieties of human capabilities. Schiffman (2010) discusses the types of media that should be included when designing instruction for the individual learner. The types of media covered include graphical images that are as realistic as possible to facilitate long-term memory, prior to presenting lots of verbal information. The video is another form of media that could be included to augment learning, as well as pictures, sounds and touch to facilitate retention in long-term memory. Schiffman (2010) states that when designing instructional material, it is beneficial for the instructional designer to understand the "…capabilities of all forms of media and technology"(p. 199), especially when having to deal with technical specialists employed or working on a project.

A great deal of the media selection used when designing for the individual learner is traditional, with the learner focusing their attention on the one screen of their personal computer, and the screen generally having only one orientation. Therefore, the way the content and interface elements such as icons and buttons are presented, is limited due to the nature and size of the screen. When developing a collaborative learning application for a collaborative environment, the interface layout requires special consideration as it is not just one learner to be considered, but many learners, and many hands standing around a flat interactive digital table. So, designing learning material and interface for multi-user systems, such as LSSDS, would need careful attention to the orientation of the learning materials as well as the interface controls to cater for users gathered around the large display. Particular attention to the division of the workspace, the arrangement of the collaborative learners—shoulder-to-shoulder or face-to-face—and how the task is divided and distributed among the learners, become essential. Also, the placement of shared media and interface elements, such as icons and pictures, become vital for two reasons: the first reason is to encourage collaborative discussion and the second relates to social activity and interactions between the learners. Sweller et al. (2011) write, "The ultimate aim of the theory is to use our knowledge of human cognition to provide instructional design principles" (p. vii).

This research involves the decomposition of tasks, working in a social collaborative environment on an LSSDS. Therefore, task decomposition, creating smaller divisions and assigning each learner a component of the task becomes an important feature as this encourages peer support and learning through social interaction and discussion (see Section 2.5). When assigning components in a selected activity, there is a need to understand the nature and structure of the learning task and role assignment. In the context of a simple phonics task; the task is broken down into several components that are then assigned to individual learners (see Figure 2-28). Figure 2-28 is an example of a previous research instrument (Butler, McGivern, Artmann, & Morgan, 2010) and is not the major contribution but has been integrated into the new research instrument.

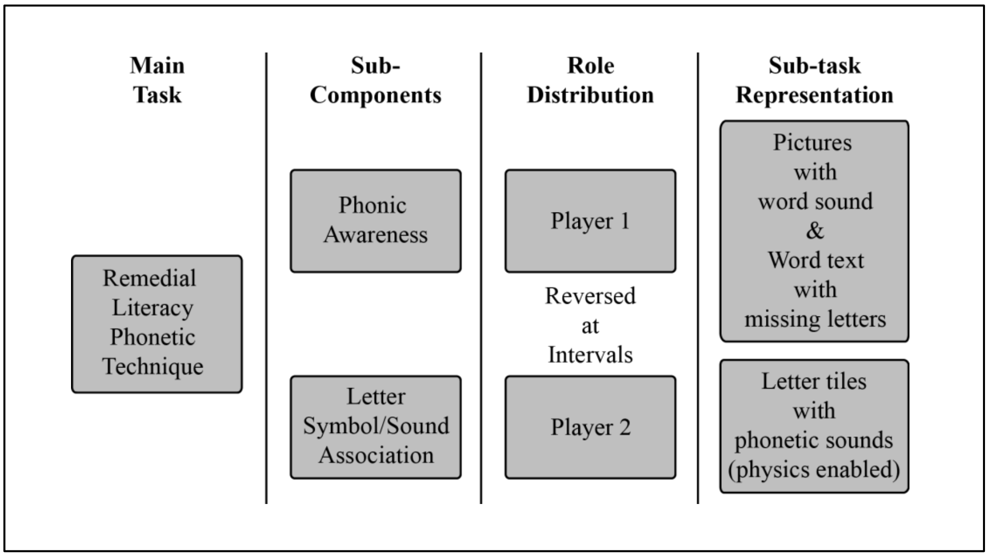


Figure 2-28: Task Decomposition for a Phonics Application (Butler et al., 2010)

This process ensures that each learner is aware of their specific role and provides the appropriate tool to complete the sub-task. The tasks and sub-tasks are arranged in such a way that the learners need to communicate with each other to complete the main task. A face-to-face situation provides a communication channel whereby learners can discuss the tasks at hand (Butler et al., 2010). The division and distribution of tasks between group members enforce group problem solving and would be more effective than just that of an individual (Hatano & Inagaki, 1991). Therefore, it may be considered that through interaction and communication, a learner may attain an understanding and knowledge that could not have been achieved on their own.

2.7.2.4 Evaluation

Evaluation is an essential component of the ISD process, to test if the learning environment produced and achieved the objectives identified in the design process. The systemic approach of ISD was originally based on the behaviourist approach that focused on observation, planning, measuring and evaluation of instruction by accentuating “reinforcement, feedback and practice” (McKenney & Reeves, 2012, p. 62). Schiffman (2010) considers that it is important for ISD, to not only understand the underlying theories of ISD but that it is also important that there is an understanding of both formative and summative evaluation, stating that: “ … on this rests the ability to assess the effectiveness of the entire ISD process” (p. 199).

The key factor of the ISD model is that it is an adaptable approach to instructional design that is used to design for the individual learner. However, evaluating the success of a collaborative learning system may differ when compared to a learning system designed for an individual learner. For an individual learner, the focus may be on the success of the system in promoting the retention of content, whereas the broader variety of skills gained in a collaborative learning environment must be considered. For example, the success of the system in facilitating discussion between learners might be a critical evaluation factor, as would the system's ability to ensure that all learners get a chance to participate.

2.7.3 Critiquing Specific Steps and Tasks of the Standard Individual Instructional Systems Design Model from a Collaborative Perspective

Within each of the major instructional systems design components are further individual steps (see Figure 2-29). The standard ISD model works well when designing learning environments for individual learners, on a single vertical interface where there is one user and one mouse device. When considering collaborative design, the traditional ISD model does not provide the necessary guidance on how to create and produce instructional materials if the learning activity is conceptualised as a collaborative learning activity.

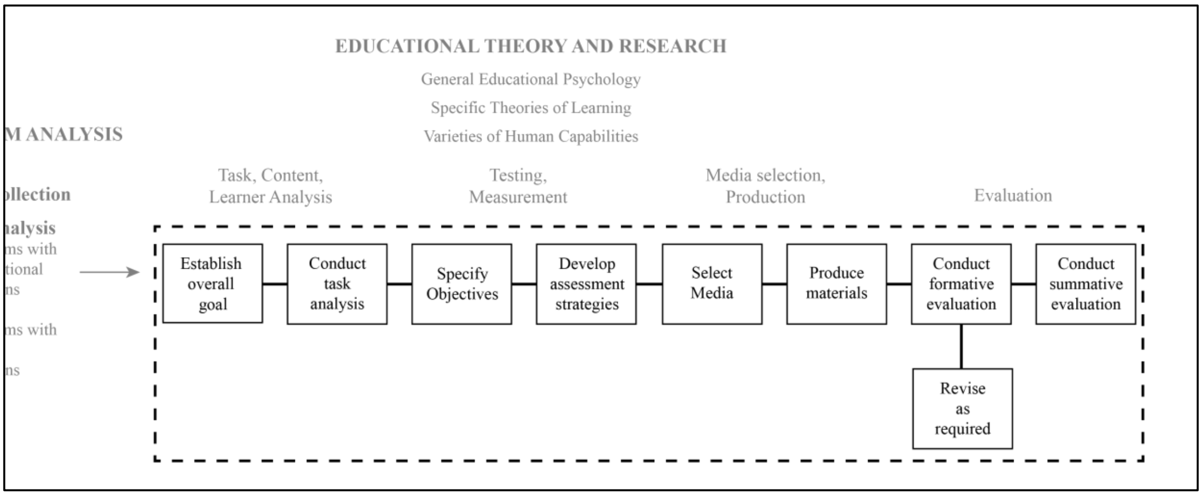


Figure 2-29: The individual steps within the traditional ISD Model (adapted from Schiffman, 2010, p. 196)

It is evident that *Establish overall goal* does not consider multiple learners. When establishing the overall goals, it is essential to look at this from a collaborative perspective. To devise the goals may mean that the instructional designer begins by looking at the nature of the learning task, the objective of the learning task, the communication aspect expected to occur in a task, and in what way multiple learners can contribute to the learning experience in a collaborative domain. Other aspects may mean that before *Conduct task analysis,* the instructional designer understands not only the characteristics of the learner, but multiple learners. This may influence the learning activity as the learners are not working towards their own goal, but towards the goal of the learning group.

Therefore, from the onset, the sequence of the steps in the current standard instructional systems design model, from a collaborative perspective, is not logical. In that, in following through the step-by-step process, subsequent steps may become disjointed or out of alignment and guide the instructional designer to the possibility of developing a collaborative learning application that is further from a collaborative task and collaboration.

The next two steps relate to *Specify Objectives* and *Develop assessment strategies* of the individual learner, who is working in an individual learning task. Bloom's Taxonomy is still highly regarded when setting up hierarchical learning objectives for the individual's learning task. However, when looking at this taxonomy, there is a possibility to set up new hierarchical collaborative learning objectives that will complement Bloom's Taxonomy. Designing instruction for a large horizontal screen such as an LSSDS, consideration of new ordered hierarchal collaborative instructional strategies and/or taxonomies must be contemplated. This order could be ranked from low to high-order cognitive learning skills. For example, multiple learners working in one space would be required to use specific skills such as coordination, where it is necessary to give and take directions. Another example could relate to a variety of specific collaborative interaction strategies where one user is assigned a particular role and task and then swap the role and task with the other learner. This swapping would encourage each learner to have an equal responsibility in the role and task. The methods the learners apply to the learning task, such as collaborative skills identification, and the practice that the learners employ to complete the task, mean collaborative interaction strategies are new skills to consider when working in an LSSDS. These are skills that do not need consideration when working in an individual learning environment, such as the standard computer. Therefore, this would give rise to the need for new types of assessment strategies, due to the collaborative nature and interdependencies of the divided and distributed learning tasks.

Select Media and *Produce Materials* are focused on individual design/learning theories for the standard computer and not for the LSSDS. The process of designing for multiple learners in one horizontal collaborative workspace requires more forethought and planning. Explicit design components need to be considered for the collaborative workspace, such as group composition—the group size, how the group will be arranged around the interactive learning space, the orientation of the screen—the division and arrangement of the divided learning tasks. Other necessary components relate to the functional elements that need to be applied to the large screen, such as the type of windows, the design of the icons, and the menus required.

Conduct formative evaluation and *Conduct summative evaluation* are two processes that occur at the end of the instructional process to assess the effectiveness of the entire ISD process (Schiffman, 2010). From a collaborative perspective, these two processes would also need to be included, but with a few exceptions—Formative evaluation from a collaborative perspective would consist of observations of the type of collaboration that occurred, such as what type of communication — what were the discussions between learners and did the group interact as planned. Summative evaluation in an individual learning environment would provide grades to the individual learner, but a summative collaborative assessment would be from a group perspective and demonstrate how the collaborative learners interact, discuss and complete the collaborative task.

Where a *formative* and *summative* evaluation is from the students perspective, one last step would need to be added to the collaborative design procedure. This would need to be in the form of a reflective process to assess the effectiveness of the instructional material, and the design process worked.

2.7.4 Summary of the Limitations of the standard Instructional Systems Design Model from a collaborative perspective

The standard ISD model does not cater for new collaborative learning environments where multiple learners work in a large shared digital space such as LSSDS. The following is a summary of the limitations from a collaborative perspective:

1. The current ISD model is focused on individual learning theories, when designing for collaboration specific collaborative/social theories should be considered.
2. The current ISD model is only focused on developing learning material for the individual learner, whereas, when working in a collaborative learning environment it is important to understand the characteristics of learners and the skills that may influence how the learners interact or conduct themselves during the learning activity.
3. The current ISD focuses on developing individual learning material for the individual learner. However, when working and learning in a large collaborative environment, how tasks are divided, and the content is distributed between the learners, plays an essential role.
4. The current ISD model is used to design instruction that is specifically for individual learners who are required to work through the learning activity on their own. When designing for collaboration; planning, teamwork and interpersonal skills are necessary aspects as learners are required to interact with others.
5. From the individual learners perspective, the current ISD model only needs to consider how the individual works and performs on their own learning task. When developing for a collaborative learning environment, how the collaborative learners work together, how they coordinate their interactions and discuss the collaborative task, also becomes important as these are considered to contribute to the group and the group’s performance.

6. When developing a learning application for a collaborative environment, the interface layout requires special consideration as it is not just one person to be considered, but many learners, and many hands standing around a flat interactive digital table. Designing materials and interfaces for multi-user systems, such as large shared digital spaces, needs careful attention to the orientation of the learning materials, as well as the interface controls, to cater for multiple users gathered around the one large display.

The whole instructional design process from a collaborative learning aspect would need to be reconsidered to include collaborative learning theories. Therefore, an instruction that was designed based on individual learning theory would not be regarded as appropriate.

2.8 The Need for a Collaborative Instructional Systems Design Approach

Consequently, there is a gap in the existing research in that there is no collaborative aspect to the existing ISD model. This gap can be addressed in the development of a *Collaborative Instructional Systems Design* model. Identifying goals and decomposing these goals into sub-goals relates more to the individual user. However, as this research is focused on the facilitation of collaborative learning in the context of LSSDS, the way the tasks are divided, and the content distributed amongst many users, becomes crucial. This will encourage group interaction and group discussion.

Other aspects are to understand learner analysis, the characteristics of multiple learners and how the interactive tasks will influence the learning activity. Regarding the collaborative system, skills such as planning, teamwork, communication and negotiation are considered and incorporated.

Current educational applications have focused primarily on the single user paradigm and its learning gains using the concept of traditional interfaces. The content designed for individual learners has relied on standard interface layouts and design templates. Whereas in an LSSDS, the presentation of the learning content and the design of the interface becomes crucial, as this is a learning environment that accommodates multiple users around one shared space. Therefore, particular attention to the orientation of the learning content, and the interface controls (such as icons, buttons and menus) to cater for multiple users gathered around the display, is necessary.

2.9 Summary

This chapter investigated and discussed three principal areas of concern and impact when designing learning applications for collaborative technologies such as an LSSDS. The literature review explored the research in context, beginning with collaborative learning, collaborative learning environments and the interactive learning environments enabled by these collaborative technologies. This was then followed by an exploration of the background of collaborative learning theories and how they have made an impact on collaborative groups of learners working on a task towards the same, shared goal. Finally, literature review explored the practical context of examining the current instructional systems design model and its impact when designing a learning application for the LSSDS.

This chapter concluded with findings that have established a need to research and develop a CISD model. These are as follows:

1. It is important to understand the characteristics of multiple learners and how they are influenced by the learning activity;
2. How the tasks are divided, and the content is distributed between the learners, plays an essential role;
3. Planning, teamwork and interpersonal skills are essential aspects that also need to be considered. These skills are important as they are considered to contribute to the group and the group’s performance;
4. The interface design and layout require special consideration as the LSSDS accommodates many users in one shared space.

These findings will influence the research questions and sub-questions, discussed in Chapter 3.

The current system for instructional design places many challenges for the designer when designing collaborative activities for LSSDS. A new CISD model will provide new guidelines to assist the instructional designer to develop collaborative learning applications for the new interactive technology; a large-scale shared digital space. This new CISD model will address the limitations of the current ISD model by providing a new conceptual model to facilitate collaborative learning in the context of LSSDS.

3 Methodology

3.1 Introduction

It has been determined that the current Instructional Systems Design (ISD) process is inadequate to design collaborative learning applications for shared face-to-face learning environments, such as the large-scale shared digital learning environment. Consequently, this chapter will outline the methods used to investigate this concern, in order to provide a design solution to the problem and to evaluate the proposed solution.

This chapter describes the methodology; the research design used to guide this research is divided into four sections. Section 3.2 provides a research overview and rationale to address the intention and justification for this research. Section 3.3 analyses the research problem by presenting the main research question and several sub-research questions. Section 3.4 presents the research approach using Design Science Research (DSR) to investigate the research questions and an explanation of why this method was selected. Finally, the research design framework is presented, which describes the process elements of DSR required for the experimental design, and the reasoning behind the two-stage approach.

3.2 Research Overview and Rationale

There have been many studies that have focused on how individuals learn, and the design practices of ISD (see Section 2.7). It is a system that is used to create learning materials focused on individual learners in classrooms and interactive learning applications. The ISD system also applies to the paradigm of solo learners working on a computer where the focus is on a "small display size and single point of input using a mouse or keyboard" (Morgan & Butler, 2009, p. 674). Studies have recently emerged (see Section 2.4.2: Large-Scale Shared Digital Spaces) in relation to Large-Scale Shared Digital Space (LSSDS) technologies. They regard the importance of the social aspect of these learning environments, with participants working collaboratively and how— through discussion—they can create a joint learning experience. The literature review (see Section 2.7: Instructional Systems Design) highlights a number of areas considered to be of critical concern, on the subject of instructional design for an LSSDS:

- to understand characteristics of multiple learners and how they are influenced by the learning activity;

- the division of tasks and the distribution of the content;
- to understand that planning and teamwork, and interpersonal skills such as communication and negotiation are important skills necessary when working in interactive, collaborative systems;
- the design, layout and affordances become important in order to accommodate many users in one shared space.

Current instructional designers are faced with a number of challenges when designing collaborative activities for an LSSDS. Selecting the correct research method to address these critical concerns, and answer the research questions, requires a systematic approach. Educational Design Research (EDR) was the first approach considered, but it was found that this approach was not suitable as EDR focused on evaluating learning applications, learning materials (artefacts) used in educational environments, as well as measuring learning outcomes. There is a need to take a step back and look at the Instructional Systems Design model. In doing so, a new systematic process is required to provide a series of guidelines to assist Instructional Designers to develop collaborative learning applications specifically for a LSSDS. Therefore, as the most appropriate methodology to assist in the development of a new artefact (and to answer the specific research questions - see Section 3.3: Research Questions), this research will adopt the DSR approach (see Section 3.5: Research Approach – Design Science Research).

Hevner and Chatterjee (2010), whose research is specific to this research method, have defined DSR as:

> … a research paradigm in which a designer answers questions relevant to human problems via the creation of innovative artifacts, thereby contributing new knowledge to the body of scientific evidence. The designed artifacts are both useful and fundamental in understanding that problem. (p. 5)

Where the ISD model was developed to cater for individual learners, the development of a new artefact, a CISD model, is intended to address these shortcomings by providing a new conceptual model. This new conceptual model will facilitate the design, construction, implementation and evaluation of interactive learning activities that accommodates multiple users face-to-face in a collaborative learning environment. An LSSDS is an example of this, encouraging user learning by working collaboratively as opposed to learning individually.

Therefore, based on the concerns raised within the Literature Review, a number of research questions have been structured to facilitate the development of this new CISD artefact.

3.3 Research Questions

The primary research question identified for this research is:

> P1. How can an instructional design model assist in the design of collaborative learning environments based on large-scale shared digital spaces?

In the literature review (see Section 2.7: Instructional Systems Design) it was identified that there are many styles of ISD models available to assist instructional designers to develop individual learning materials, however, these models are not appropriate for the design of collaborative learning in a collaborative learning environment on an LSSDS.

The main objective is to assist designers to plan collaborative learning applications for interactive learning environments such as the LSSDS. This begins with an investigation of the current practices of instructional strategies and related models, in order to understand how they work and how they are used. The new model investigates the types of collaborative learning environments for the LSSDS where multiple users can work in a co-located workspace.

In order to answer the primary research question, a number of secondary questions have been identified that must be investigated:

> S1. What are the educational affordances of large-scale shared digital spaces?

In designing for a specific learning environment, such as an LSSDS where there are multiple users, a number of challenges are presented. It is important to explore the educational affordances of this new digital space, to understand what this new learning space provides groups of learners who are interacting in the same shared space, as it differs from the old paradigms, i.e. the desktop computer. The educational affordances of this new technology provide a new shift in learning, as it encourages learners to communicate with each other and to explore the new interactive setting. This question aims to address the development of the new instructional design model based on a number of important aspects when designing for an LSSDS: (1) group composition and arrangement; (2) the incorporation of specific collaborative strategies to encourage user interaction; (3) the design of the shared workspace itself, for the large co-located workspace and application and finally; (4) the shared interface elements, which should encourage users to interact in order to facilitate effective collaborative learning interactions.

> S2. What educational issues need to be considered when designing a Collaborative Instructional Systems Design model for large-scale shared digital spaces?

The standard ISD model is centred around the paradigm of the individual learner, one computer, one space, one mouse etc., whereas, this research is focused on many users working collaboratively in one large co-located space.

A number of educational issues require consideration in order to design a genuinely collaborative instructional design model. A key aspect is the analysis of processes and instruction. With a collaborative focus at the centre of the analysis, it analyses the use of collaborative instructional strategies when designing a collaborative learning application. The design and implementation considerations may include:

- the specific design elements that need to be incorporated into the interactive workspace, such as the group (user) composition and arrangement of the shared problem space itself;
- the division of the tasks where the shared interface elements are placed; whether the learners are best placed face-to-face or shoulder-to-shoulder;
- the coordinated modes of interaction and activity incorporated into the collaborative workspace to maximise group learning and group discussion;
- and finally, evaluation – where learners are assessed as a collaborative group.

The output responses to the above research sub-questions will be the design of a new CISD model, which will be used to answer the following research sub-questions.

> S3. For a learning application designed using the Collaborative Instructional Systems Design model, what is the experience of the students and teachers in the classroom?

This question relates to the teachers and students response and reactions to a learning application design using the new CISD model. This will be achieved through the development of a collaborative application that will be presented to teachers and students. The students will interact with the application, and the teachers will be present in an observational capacity to provide assistance if required. Their reactions and responses will help verify the validity of the new CISD model and its output. In addition, a detailed analysis of the learning activity of students using a learning application design using the new model will be carried out in order to check if the collaborative learning interactions; designed into the application, are employed by the students.

> S4. How can a model influence the structure of learning tasks in an application in order to facilitate effective collaborative learning activity in a large-scale shared digital space?

New technologies such as an LSSDS require a new approach when designing and developing learning materials for groups of learners working synchronously and face-to-face in a collaborative environment. For a new CISD model to be effective, it is important to assess if the output of the model results in the types of collaborative learning activities for which it was designed. To answer this research sub-question, the CISD model itself and related resources (including examples of students using a learning application designed using the new model), will be presented to experts in instructional design to seek their feedback. It is important to understand the structure of collaborative learning activities designed into an application and recognise which activities encourage students to work cooperatively, and which activities encourage learners to work collaboratively.

> S5. How can a model guide the design of an interface on a shared digital space to facilitate effective collaborative learning activity?

The instructional designer is faced with many challenges when designing a collaborative workspace for learning groups. The literature review (see Section 2.7.2.3: Media Selection and Production) identifies a key design phase that was required when planning the interface for large interactive touch sensitive devices such as an LSSDS. The new design phase should take into consideration the characteristics of a group and the shared interface elements required to coordinate the group interactions and activities. Again, to help answer this research sub-question, the CISD model, related resources and examples of students using a learning application, will be presented to experts in instructional design.

> S6. What is the perception of Instructional Systems Designers of the utility of a collaborative design model?

This question has been designed to gain feedback and opinions of the CISD model from experts in ISD and educational learning. Instructional Systems Designers need to look at the new model to look at the sequence of each process, to assess the functionality of each process and if the scope of each process is considered manageable. In terms of the design processes, the CISD model should provide a solution for instructional designers when creating a collaborative application for multiple users in a co-located space.

The aim of these secondary questions is to establish the significance and quality of this research. Figure 3-1 provides an overview of the research design. Within each stage, the related secondary research questions are aligned. The first sub-questions, S1 relates to educational affordances of an LSSDS and is based on concerns and outcomes raised in the literature review and a detailed analysis of the literature. S2 relates to the design of the new CISD model and will primarily be based on the analysis of literature and a formal model design process. The next sub-question is in Stage One. Stage

One; S3, concerns an instantiation in the form of a learning application, resulting from the new CISD model. This instantiation has been developed to validate the model in its current state and will be presented to teachers and students. The feedback provided by teachers and students will be based on observational studies and interviews that will be looking at the learner's collaborative experience and self-perception, the interface experience and self-perception and any technological issues. Examining learning outcomes is beyond the scope of this research. Based on the outcomes of this phase, the model may need to be revised and updated. The final set of secondary sub-questions, Stage Two; S4, S5 and S6, refer to the analysis, by instructional design experts, of the latest and most up-to-date version of the CISD model. Experts will be presented with a video demonstration resulting from the previous study in order to observe, analyse and validate the functionality of the model.

The secondary questions have been ordered in such a way as to answer the primary research question and therefore, contribute to the body of knowledge. Questions S1, S2 and S3 have been designed to contribute to the design and refinement of the CISD model, including an instantiation in the form of a learning application and an observational study using teachers and students. Questions S4, S5 and S6 have been specifically designed to observe, analyse and validate the model based on expert opinion and analysis. In order to achieve the research outcomes, a specific study design of this research will be explained further in Section 3.5: Research Approach - Design Science Research.

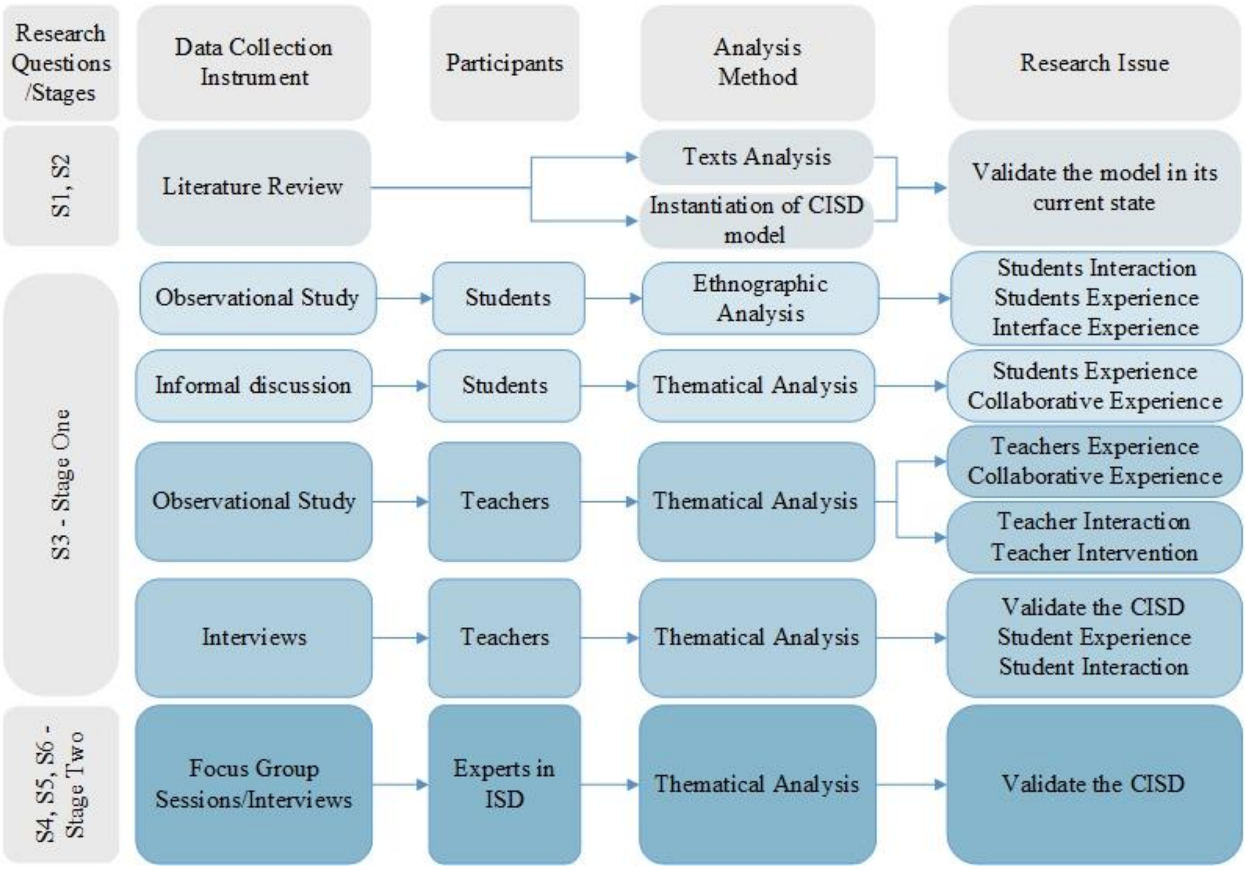


Figure 3-1: Overview of how the research questions relate to the experimental design.

3.4 Research Method

When selecting a research methodology, it is important to understand that methodology is a technique that is applied to the entire research framework and that this framework is used to “explore research questions and to create new knowledge” (Williamson & Johanson, 2013, p. 4). The research methodology selected for this research is the DSR approach (Hevner & Chatterjee, 2010; Hevner et al., 2004; Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007; Weber, 2013). LSSDS are new emergent technologies that allow for multiple users to work in one space. Therefore, to design specific collaborative learning applications for this new emergent technology, it was necessary to step back and consider a new collaborative instructional approach model, a CISD model. This new instructional design model, designed specifically for larger interactive technologies, will encourage face-to-face discussion/interactions between learners and should be considered for interactive, collaborative learning activities.

The foundations of DSR originated in Engineering and in the Computer Science discipline, in particular, Information Systems, where the focus was on the development of artefacts that would be considered to be useful to a particular community. For this research, it is proposed that the principles set out by DSR methodology can also be applied to the design, development, and evaluation of a new instructional model used in an educational context on a LSSDS.

It became evident during the literature review that there was a shortfall in the standard ISD model (see Section 2.7: Instructions Systems Design) where learning materials were designed for individual learners. A new collaborative instructional design model was required to assist in the design of collaborative learning materials in an LSSDS. To achieve this new instructional approach, a methodology such as DSR is required to assist in designing models and framework, and not for the design of artefacts for learning outcomes. The methodology of DSR is specific and well suited to this research as it aligns with the design, development, and evaluation of models and frameworks, or ‘artefacts’.

3.5 Research Approach – Design Science Research

The LSSDS has provided new research domains, particularly in the field of education. A unique feature of this large touch-sensitive device is that it provides a digital environment that allows multiple users to work synchronously and face-to-face with multiple simultaneous user inputs by touching the surface of the display. ISD is the current practice used when designing instructional material for individual learners. To facilitate collaborative learning and to assist in the design of learning applications for this new domain, it is proposed that a new instructional systems design model be developed to incorporate the innovative features of LSSDSs. The specific research methodology of DSR will be used to refine and validate the new model. Hevner and Chatterjee (2010, p. 5) have defined DSR in the following way: "… knowledge and understanding of a design problem and its solution are acquired in the building and application of an artefact". Therefore, DSR provides specific guidelines in order to develop and evaluate an artefact, or CISD model.

Two different scientific approaches can be used in research: one relates to *natural science,* and the other is the *science of the artificial [design science]*. Simon (1996) makes a distinction between *natural science* and *science of the artificial*. Natural science is a science that is based on a body of knowledge, such as physics, chemistry etc., which studies the physical and natural world; observing its characteristics and properties and how they behave and interact with each other (Simon, 1996, p. 1). In other words, natural science relates to natural objects and phenomena (Simon, 1996, p. 1). The term *artificial* is defined as something that is not natural or real, something that is man-made (Simon, 1996, p. 2). Simply put, the *science of the artificial* pertains to a body of knowledge relating to objects or artefacts that are based on the design of the artificial, man-made, that are intended to meet certain desired goals and phenomena (Simon, 1996, p. 3).

Design science attempts to produce useful man-made objects, known as artefacts (March & Smith, 1995; Simon, 1996; Weber, 2013). Therefore, for this research, DSR is the best methodological approach as there is a specific focus on the development of an artefact, a model, to suit a specific purpose, to assist in the development of learning applications for co-located workspaces such as the large-scale shared digital space. The authors, (Hevner et al., 2004, p. 77; Weber, 2013), have suggested that Information Technology (IT) artefacts produced in design research may include: Constructs, Models, Methods, and Instantiations. Based on the authors, Hevner et al. (2004) and Weber (2013). Table 3-1 presents a comparison and description of the four artefacts of DSR approach.

The existing research (see Section 2.7: Instructional Systems Design) identified a number of gaps in the existing ISD model where there were no specific collaborative aspect – analysis, instructional strategies and no specific collaborative application design aspects. Based on the four types of artefacts produced by DSR, as identified in Table 3-1, this research will adopt the third approach; Methods, to design a new artefact, the CISD model.

The standard ISD is also based on a series of step-by-step processes used to create instructional materials to produce reliable learning and performance outcomes. And so, the developed CISD model will incorporate the gaps identified to provide a means of developing instructional material that is consistent and effective, for multiple learners on an LSSDS.

	Authors and Description	
Artefacts in DSR	Hevner et al. (2004) DSR approach	Weber (2013) DSR approach
Constructs	Vocabulary and Symbols	Describes and represents events that occur in the work. For Example, *Classes of things*: businesses, *Sub-classes of things*: small businesses, *Properties of things*: level of profitability of businesses, *States of things*: a business is either liquid or bankrupt, *Events that occur*: sales, *Processes that things undergo*: orders, filling the order, and dispatch
Models	Abstractions and Representations	Conceptual object that comprises of constructs and associations among these constructs as a way to describe and represent some subset of real-world events. Constructs can be linked by an association and can have many meanings. For example: Database researchers will model a database system as 3 different levels that are made up of (a) an internal schema – data structures, file organisation held in physical storage, (b) a conceptual schema – the concept maps and their relationships, (c) an external schema – the user-level view. (Pakhira, 2012, p. 8)
Methods	Algorithms and Practices	A set of actions that is often ordered and is used to achieve an outcome (a product or service). A product is something tangible, something you can see and touch such as a 'prototype' system development method used to assist in the development of effective information systems. A service is something intangible; it is something that you cannot see or touch, such as the identification of an information systems strategy for an organisation. Researchers Comment: The CISD model is considered a method as it provides a series of ordered phases that produce a product.

Instantiations	Implemented and Prototype Systems	A concrete representation of an instance, a hardware/software system, produced by researchers, using some method to implement a construct or model.

Table 3-1: Comparison of the four forms of Design Science Research based on Hevner et al. (2004) and Weber (2013)

3.6 Research Design Framework

The formal DSR methodology framework proposed for this research is based on the research of authors from several disciplines(see Table 3-2), (Peffers et al., 2007). Peffers et al. (2007) identify six common activities that are shown in sequence.

The following is a summary of these common activities and, subsequently, is presented with a full description of how the six activities align with the DSR methodology for this research (see Figure 3-2):

- All authors agreed on Activity 1: Identify and define the research problem - defining the problem will assist in the development of the artefact and justify the value of the solution, and also agreed with Activity 3: Design and development, the artefact – the creation of the artefact.
- Two authors have stated Activity 2: Objectives of a solution: and Eekels and Roozenburg (1991) considers "relevance" and "requirements" significant to the objectives of the artefact in DSR and that is important and relevant to the problems.
- Activity 4: Demonstration has been identified by Nunamaker and Chen (1990) and Eekels and Roozenburg (1991) to prove that the idea, or the artefact, works.
- Most have agreed on Activity 5: Evaluation – Observe and measure how well the artefact works as the solution to the problem.
- Finally, Activity 6: Communication has been identified by Archer (1984) and Hevner et al. (2004) in order to promote the resulting knowledge, through scholarly research publications.

This summary provides a formal DSR methodology on which to base this research project.

Figure 3-2 shows each of the six processes (on the left of the figure). These six processes translate directly into six steps for addressing the defined research questions (shown on the right of the figure).

Common design process elements	Archer (1984)	Takeda, Veerkamp, and Yoshikawa (1990)	Eekels and Roozenburg (1991)	Nunamaker and Chen (1990)	Walls, Widmeyer, and Sawy (1992)	Cole et al. (2005) Rossi and Sein (2003)	Hevner et al. (2004).
Activity 1: Problem identification and motivation	Programming, data collection	Problem enumeration	Analysis	Construct a conceptual framework	Meta-requirements, kernel theories	Identify a need	Important and relevant problems
Activity 2: Objec-tives of a solution			Requirements				Implicit in "relevance".
Activity 3: Design and development	Analysis, synthesis, development	Suggestion, development	Synthesis, tentative design proposals	Develop a system architecture. Analyse and design the system, build the system.	Design method, meta-design	Build	Iterative search process, artefact
Activity 4: Demonstration			Simulation conditional prediction	Experiment, observe and evaluate the system			
Activity 5: Evaluation		Confirmatory evaluation	Evaluation, decision, definite design		Testable design process/product hypotheses	Evaluate	Evaluate
Activity 6: Communication	Communication						Communication

Table 3-2: A comparison of the Design and DS Processes from IS and Other Disciplines (Peffers et al., 2007, p. 53)

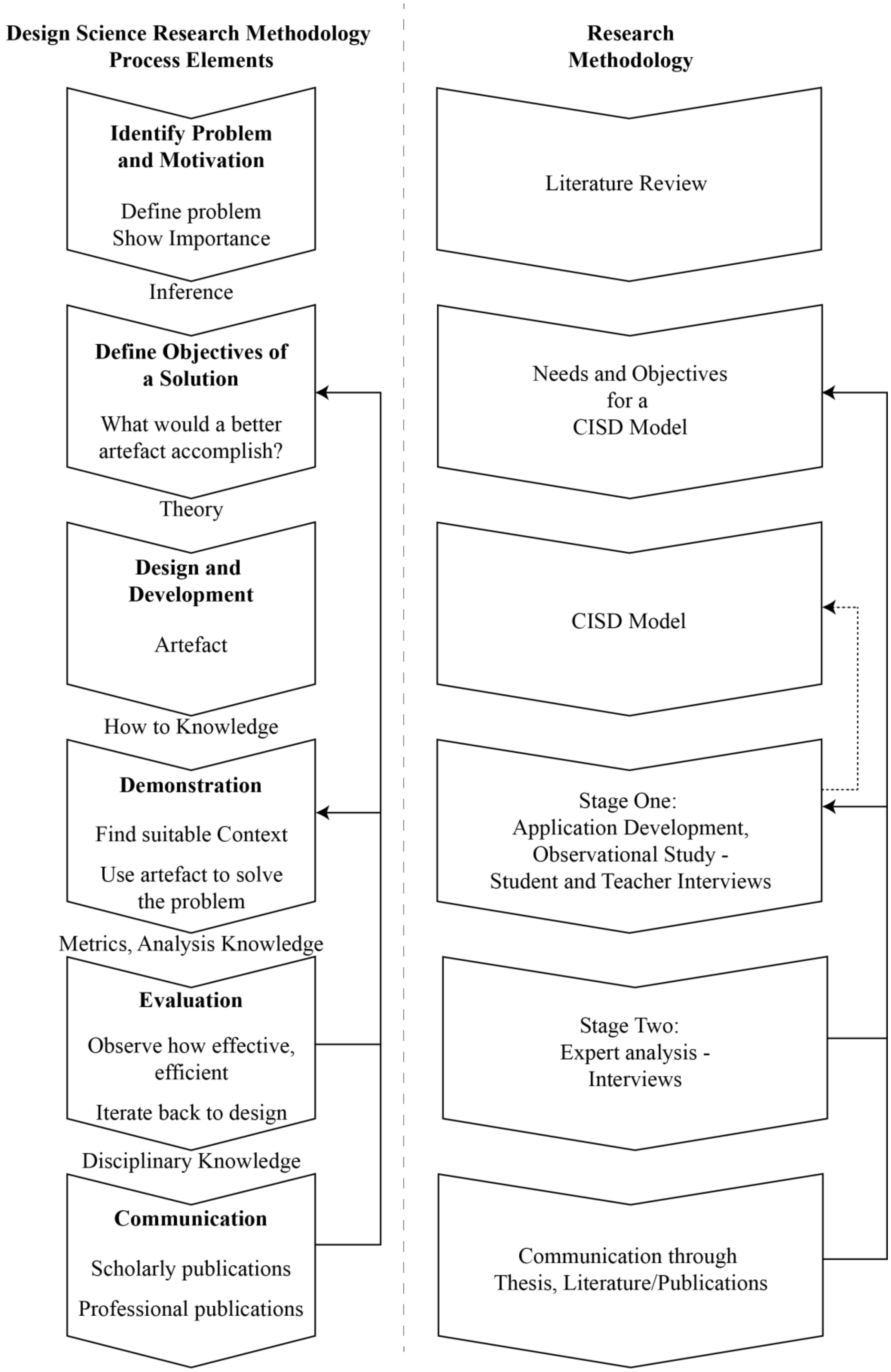


Figure 3-2: DSR Process Model adapted from Peffers et al. (2007, p. 54) and the Research Methodology applicable for this research

The six steps of this research project are as follows:

Activity 1: Problem identification and motivation - Literature Review

Activity 1 is based on the identification of the research problem and the need for a solution. The research began with the literature review. The literature review provided an in-depth analysis and evaluation of learning theories such as learning, memory and *Schema Theory,* and the principles of instructional design. This research also explored the features of a current ISD model. This ISD model has primarily been intended for the design of individual learning applications on traditional personal computer technologies. A number of problems were identified, as discussed in Section 3.2: Research Overview and Rationale. There is the problem in understanding multiple learner characteristics or collaborative design principles. For example, the division and distribution of tasks within the learning content/subject matter, particularly in relation to current learning theories and their practice. These all need to be taken into consideration.

In terms of the collaborative system, such as the LSSDS, specific skills such as planning, teamwork, communication and negotiating, will need to be incorporated into the learning activities.

The literature also identified that the current ISD model does not include a specific Design phase. When designing for large interactive learning environments, a design phase would be considered crucial, as it needs to accommodate many users in one shared space. The design phase would provide a step-by-step method to assist in the selection of specific design elements, layout, and affordances for the shared problem space.

Activity 2: Objectives of a solution – Needs and Objectives for a CISD Model.

Activity 2 is based on inference. In this case, it is feasible to infer that a new artefact in Instructional Design (ID) is required to address all the problems identified in Activity 1. The new artefact is the contribution to the body of knowledge and should support solutions to problems that have not been addressed until now.

Activity 3: Design and development – CISD Model

Activity 3 relates to the design and development of the artefact to support the above objectives. As identified in Section 3.4.1: Design Science Research approach and Weber (2013) identified four output-types of artefacts: Constructs, Models, Methods, and Instantiations. The output style identified for this research is Methods, which recognises a process of ordered actions to be used to achieve a particular product or service outcome. In order to acknowledge the objectives set out in Activity 1 and 2, it has been identified that a new model in ISD is required; a CISD model. This new CISD model will be developed to incorporate specific educational theories (sociocultural theories and collaborative learning theories), and collaborative technologies to assist in designing new collaborative learning activities for an LSSDS. The design of the new artefact will be covered in-depth throughout Chapter 4, and Chapter 5 and the design of the application will be covered in Chapter 6.

Activity 4: Demonstration - Stage One: Application Development, Observational Study – Student/Teacher Interviews.

On completion of the new artefact, or CISD model, a learning application will be developed in order to demonstrate that the new artefact is both functional and its architecture considered acceptable and worthwhile. The approach used for this learning application will be an observational study. The data collected during this observational study will focus on both qualitative and quantitative data.

Data collection in this phase will include observations of learner interactions, which will be video and audio taped. The data will be transcribed, summarised and analysed using a thematic approach. Observations and the response of the participants, non-verbal and verbal, may possibly assist in interpreting the findings using qualitative methods. Video data may also be analysed in a quantitative manner by comparing factors such as time on task and the duration of communication events between learners.

The demonstration of a learning application will refine, and possibly pinpoint which phase of the model works, and which doesn't and may iterate back to Activity 3 to be revised and updated.

Activity 5: Evaluation – Stage Two: Expert analysis - Interviews

Evaluation of the CISD artefact, Stage Two, will be offered to experts in the field of ID and university academics who will be invited to participate in a number of interviews. Stage Two is designed to gather information in the form of qualitative feedback and will take place via individual formal face-to-face interviews.

This is intended to evaluate and ascertain if the features of a new CISD model will assist in the design of collaborative learning environments and provide the solution to the objectives in Activity 2. Also, this will determine if this new model will meet the needs of instructional system designers and deliver practical guidance on the design of collaborative instruction using an LSSDS. The interviews will provide a richer explanation and exploration of the topic than general surveys. The use of ID experts and university academics will test the suitability of the proposed CISD and identify any problems that exist. A series of interview questions will be developed based on the research questions, in order to guide and focus the discussion. The interviews will be audiotaped, then transcribed, summarised and analysed using a thematic approach. The outcomes may recommend that the CISD suggest further revisions and iterate back to Activity 3 to try and improve on the artefact to make it more acceptable and worthwhile.

Activity 6: Communication – Communication through Thesis, Literature/Publications

The communication for this research will be relayed through scholarly research publications and is based on the common empirical research processes presented in research papers, such as problem identified/defined, literature review, a hypothesis development, data collection, its analysis, results, discussion and, finally, conclusion (Peffers et al., 2007, p. 56).

Table 3-3 summarises the methodology designed for this research as it relates directly to the primary and secondary research questions.

Primary Question				
P1. How can an instructional design model assist in the design of collaborative learning environments based on large-scale shared digital spaces?				
Secondary Questions				
Literature Review	S1. What are the educational affordances of large-scale shared digital spaces?		Answered in the literature review	
	S2. What educational issues need to be considered when designing a Collaborative Instructional Systems Design (CISD) model for large-scale shared digital spaces?			

Stage One	S3. For a learning application designed using the Collaborative Instructional Systems Design model, what is the experience of the students and teachers in the classroom?	Observation, Interviews, Subjects – Teacher and Students **Purpose:** Observe, analyse and validate the CISD, LSSDS Characteristics, Collaboration Learning activities Benefits	Instantiation of the model CISD – Artefact Product that is the result of the CISD. Observational study -Video/Audio recordings	Validate the model in its current state. Thematic Analysis, Categorise Issues Update the CISD. Survey data: -Collaborative experience self-perception -Interface experience self-perception Technology issues
Stage Two	S4. How can a model influence the structure of learning tasks in an application in order to facilitate effective collaborative learning activity in a large-scale shared digital space? S5. How can a model guide the design of an interface on a shared digital space to facilitate effective collaborative learning activity?	Interviews: Subject – Experts in ISD. Show compilation of a video demo resulting from Stage One. Purpose Observe, analyse and validate CISD, LSSDS	Interviews Interviewer Notes/Transcription of interviews	Observational data: Thematic Analysis -Categorise Issues -Re-categorise Thematic description and examples
	S6. What is the perception of Instructional Systems Designers of the utility of a collaborative design model?			

Table 3-3: The table above summarises the methodology designed for this research

The phonics learning application has been developed to test the validity and suitability of the CISD model for the LSSDS. Theoretically, it is easy to speculate how the participants will interact and collaborate on the LSSDS but until the participants have demonstrated group interaction and collaboration in the said work environment, can this be proven. Therefore, to test the validity and suitability of the CISD model this investigation has been divided into two phases, Stage One: Student/Teacher Observational Study and Stage Two: Expert Analysis.

3.6.1 Stage One: Student Observational Study

Stage One is a Student Observational Study where primary school students are required to interact on a LSSDS using a phonics literacy application with semi-structured interviews and discussion at the end of each session. The Stage One experiment consists of five pairs of primary school students who will participate in the phonics literacy gameplay to be conducted in a classroom environment. Each group of students will be required to play the interactive phonics literacy game on an LSSDS for twenty minutes; fifteen minutes of gameplay and a five-minute group discussion at the conclusion to gauge their experience. The teachers (members of the same primary school) are asked to observe how the students interact and collaborate in the learning activity and possibly assist the students with the learning activity if required. At the conclusion of all the student sessions, the teachers are asked to participate in a thirty-minute semi-structured interview to provide feedback on the students sessions.

All the students sessions, as well as the teachers interviews, will be audio and video recorded. On completion of Stage One, an information video will be created to demonstrate how the CISD model was used to assist in the design of the phonics learning application and how students interacted and collaborated on the LSSDS. This information video is pertinent to the next phase of analysis, Stage Two, the Expert Analysis.

3.6.2 Stage Two: Expert Analysis

Stage Two is an Expert Analysis, is designed to explore and gather data on the expert’s views and responses, using semi-structured interviews, to the new CISD model. The experts in this phase are Instructional Designers from various universities. The Instructional Design Experts will watch four videos of the students, from Stage One, interacting with the phonics learning application on an LSSDS and then participate in a semi-structured interview. These semi-structured interviews are selected to provide a rich, in-depth source of information that would not be obtained in a survey. Directly interviewing experts during this phase aims to test the suitability of the research artefact, the CISD model.

3.7 Development of the Research Instruments

3.7.1 Stage One: Student Observational Study

The students will play the phonics literacy application for fifteen minutes on the LSSDS. At the conclusion of each gameplay, the students will participate in a five-minute discussion to discuss their collaborative experience. For example: What did you have to do in the game? Was your friend able to help you in the game? How did playing on the table make you feel? The students questions (see Appendix A) have been designed to explore their collaborative involvement and experience with the phonics learning application on the LSSDS.

The teachers roles during these sessions are in an observational capacity and are only to intervene when necessary. At the end of all the student sessions, the teachers will participate in a thirty-minute semi-structured interview (see Appendix B). The semi-structured interview has been designed to gather the teachers opinions, in their own words, on their observations concerning many specific topics. Areas such as the interaction of the children, the design influence on the application, specific collaborative aspects of the application, the technology itself, and the LSSDS are explored, with suggestions for improvements, uses in the classroom and any other issues that need to be raised.

3.7.2 Stage Two: Expert Analysis

The Expert Analysis is a series of semi-structured interviews. These semi-structured interviews have been organised thematically using a combination of structured and unstructured interview techniques with both closed and open questions (see Appendix C). The interview begins with a general question about the experts Instructional Design experience. From there, the experts analysis has been divided into four main domains where experts are required to watch four short videos, 2-3 minutes each, of the students playing the phonics learning application on the LSSDS, maintaining the context of the themes. Each video demonstrates how the phases of the CISD model aligns with the design of the phonics learning application.

3.7.2.1 Video One: General Reaction to Technology and the Problem.

This video presents an overview of the technology, the LSSDS and an introduction to the problems of/when designing these collaborative workspaces. It looks at the issue of multiple people using the technology at one time; one of the problems identified was the need to design collaborative interactions so that people can use this technology simultaneously. The questions in this section explore the experts general reaction to the technology, which begins with questions regarding their experience on touchscreen technologies such as iPods, iPads and interactive whiteboards.

3.7.2.2 Video Two: The Need for a Collaborative Model and a look at the Overall Structure.

The video presents the steps of each process of the CISD model by demonstrating, with examples, how each phase of the CISD model aligns with the design process of the phonics literacy application and their related outputs. The question begins with the standard ISD model, and this is then followed by a comprehensive look at each phase of the new CISD model.

3.7.2.3 Video Three: The New Collaborative Taxonomies – Collaborative Instructional Strategies.

Video Three presents the experts with an overview of Bloom's Learning Taxonomy and discusses the three new taxonomies and how they complement Bloom's by focusing specifically on collaborative aspects.

3.7.2.4 Video Four: Connecting the Students Collaborating on the LSSDS to the CISD model.

This final video demonstrates the students playing the phonics learning application on the LSSDS and seeks the experts general overview/opinions on the usefulness of the CISD model in a real-world context.

3.8 Ethics Application

Any research with human participants requires observing specific policies and guidelines set out by the Monash University Human Research Ethics Committee (MUHREC). Since this research involves school-aged participants from a Catholic school, it also needed the approval of the Catholic Education Office Melbourne. Children and teachers in a classroom environment, as well as experts in Instructional Design, were essential to the collection of data. Prior to the recruitment of any participants and, in order to comply with the MUHREC policies and guidelines, a *low-risk application form* (see Appendix D) was completed. Other documents such as explanatory statements, consent forms and correspondence such as a letter to the school principal etc. were also submitted for approval. To adequately inform the specific groups of participants, it was necessary that the documentation was written in a language style to meet the needs of the different audiences. The documents written for the students, of various age groups, used clear language, whereas, the language style used for parents, teachers and experts in instructional design was of a higher, more academic level.

3.8.1 Ethics Issues

A great deal of consideration was taken to accommodate the complex sequence of steps in the data collection process and in preparing the many documents required for ethics approval. Yet, some amendments were required to meet the MUHREC policies and guidelines (see Appendix E). All the consent forms and explanatory statements required some minor corrections.

The consent forms, for all participants, required revision to update clauses relating to the length of time allowed for participants to withdraw after the completion of the data collection process. The *children and parental consent form* required an amendment to allow the video data to be shown to other people in order to ensure participant confidentiality from Stage One to Stage Two.

The *explanatory statements* required updating, especially concerning confidentiality and anonymity regarding the handling of the video data, how the results data would be communicated to the students, and how the participant's contact details were to be obtained.

The following documents (see Appendix D) have been approved by MUHREC.

3.8.2 Stage One: Student Observational Study

Stage One comprises of four Explanatory Statements - Child, Parent, Teacher, Principal, three Consent Forms - Child, Parent, Teacher, a letter to Principal and finally the approval letter from the Catholic Education Office.

As this phase of the research specifically involves working with children, it is a Victorian Government requirement: *Working with Children Act 2005*, that a check is completed (see Appendix F: Working with Children).

The application to conduct research in Catholic Schools, Catholic Education Office Melbourne Policy 2.8, can be found in Appendix G. The application to conduct research was approved by the Melbourne Catholic Education Office on 22nd December 2014, under the reference number, Project #2062 Morgan. A copy of the letter of approval can be found in Appendix H.

3.8.3 Stage Two: Expert Analysis

Stage Two consists of one Explanatory Statement and Consent Form for the Experts. The Ethics was approved by MUHREC on 12th December 2014, under the reference number, CF14/3310 - 2014001761. A copy of this ethics application approval can be found in Appendix D.

3.9 Limitations

There are several limitations concerning this research:

3.9.1 Stage One: Student Observational Study

For the purpose of testing the CISD model, one application has been developed. The dataset collected during this phase is small, with only a small number of students and teachers involved. The students learning outcomes are not included in this research as it is beyond the scope of this PhD.

3.9.2 Stage Two: Expert Analysis

The data set collected for Stage Two is small, but the data collected (semi-structured interviews) should provide a rich and invaluable source of information. This stage of analysis is not being used by the experts to design their own learning application due to time constraints but is primarily for their validation of the CISD model.

3.10 Summary

The chapter began with a research overview and the challenges faced by the current instructional designers when designing learning activities for an LSSDS. Based on these challenges, a number of research questions were presented and structured to introduce the focus of this research and to assist in finding a solution to the research problem; the contribution to knowledge. The DSR methodology was the framework selected for this research as it focused on the specific design of the artefact, a CISD model. This CISD model should lead to the future design of educational artefacts.

The first two activities of the chosen research methodology were undertaken and presented in Chapter 2. The following three chapters will detail the design of the CISD model for this study (Activities 3 and 4). Chapter 4 discusses the design and development process of the CISD model. Chapter 5 provides a detailed explanation of the CISD model including its theoretical foundations. Chapter 6 presents the development of a collaborative learning application based on the new CISD model. Consequently, this is then followed by two analysis chapters; Chapter 7 is the first stage of analysis focusing on the student/teacher observational study, analysis and results. Chapter 8 concentrates on the Stage Two analysis; the experimental results and analysis of the Experts. Finally, Chapter 9 is the Conclusion and Recommendations section, summing up the research and explicitly addressing the research questions, its contribution and any recommendations for future research.

4 Design Process of the Collaborative Model

4.1 Introduction

This chapter presents an overview and discussion of the method used to design the new Collaborative Instructional Systems Design (CISD) model. Chapter Two presented an analysis of literature in order to deliver detailed specifics with the aim of understanding the context of the research. This literature focused primarily on five main areas of literature; i) Collaborative Learning ii) Computer Supported Collaborative Learning iii) Interactive Technologies iv) Collaborative Learning Theories and v) Instructional Systems Design (ISD) Model. It is through this literature that gaps were identified in relation to the design of instructional learning materials, specifically relating to the collaborative learning domain.

The development of the new CISD model is based on the gaps identified in the Literature Review which relate to specific areas in Educational theory: Individual Learning, Sociocultural Theories, ISD and Learning Taxonomies and Interactive Technologies - collaborative learning. This chapter includes a summary of these theories, in particular, the current ISD system, and presents the limitations of ISD for instructional designers in collaborative learning domains such as a Large-Scale Shared Digital Space (LSSDS). This is followed by a comprehensive discussion of the Design Process – How did the CISD model come about? This new model will be specifically designed to assist instructional designers in planning instructional materials for collaborative learning domains, such as LSSDS interactive technologies.

4.2 Research Outline

To date, there has been no formal method based on educational theory that could be used to guide the design of learning applications for LSSDS. For example, there was no formal structure in place to assist the instructional designer to incorporate affordances for collaborative interactive surfaces. Touch-sensitive devices, such as LSSDS, provide new possibilities for this interactive learning environment. LSSDS is a “new educational technology” (Higgins et al., 2012, p. 1041), a tool that brings people together in an educational context, just as a boardroom table brings people together for meetings prompting discussions, ideas, and decisions. The LSSDS can be considered to be the sociocultural tool when integrated into a classroom environment, which goes one step further, not only through discussion but also by fostering group interaction and collaboration. With an aim to meet the needs of learners, a structured approach is required to accommodate multiple users to work synchronously in a face-to-face learning environment.

ISD was used to assist in the development of learning materials where learners were encouraged to work in a classroom environment. There, they would copy/receive their information from someone of authority such as a teacher, an instructor, or from a book or computer (de Jong & Pieters, 2006). Learners are now often encouraged to construct "their own knowledge in realistic situations, together with others instead of on their own" (de Jong & Pieters, 2006, p. 739). Up to now, instructional designers have relied on the ISD model (Schiffman, 2010) to develop instruction in order to produce reliable learning and performance outcomes. However, Instructional Designers face a number of challenges when designing for a group of people gathered around a large shared interactive display screen, such as; how to get users to interact and collaborate effectively (McGivern, Morgan, & Butler, 2012).

This research began with an analysis of the current standard view of ISD through the lens of collaboration. What began with *Task, Content, Learner Analysis, Testing, Measurement, Media Selection, Production,* and *Evaluation* will be revised and the sequence altered to assist instructional designers develop collaborative learning applications.

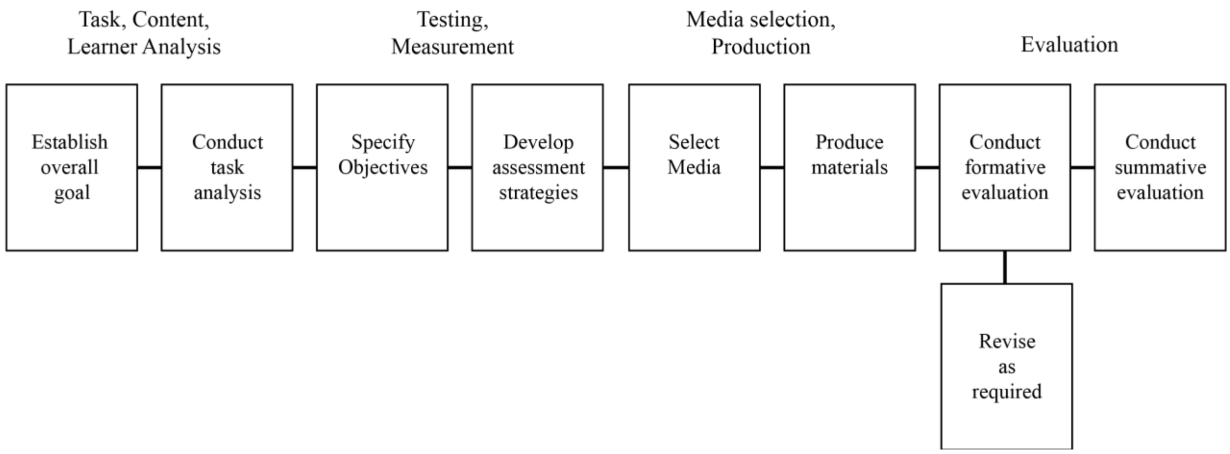


Figure 4-1: Instructional Systems Design view (adapted from Schiffman, 2010, p. 196)

These standard ISD stages include the establishment of goals and the analysis of the learner, the design of objectives and selection of assessment strategies, media selection and instructional materials production, and the evaluation and revision as required (Chen, 2011; Gagné et al., 2005). Schiffman (2010, p. 196) states that ISD is a "synthesis of theory and research" where there is a need to understand how humans relate to their learning environment, as in, what stimulates them, how information is organised and relayed, and whether the interrelationships within the learning system provide an efficient and effective means to produce the desired learning outcomes.

The background of ISD was previously discussed in the introduction (see Section 2.7, para. 1). The ISD model has been around for over 70 years and was originally devised to facilitate the production of learning materials to be delivered to large groups and where learners were required to study and work on their own. The ISD expert needs to understand the different types of human capabilities: the learner's intellectual skills, attitudes and cognitive strategies, the skills requiring memorisation of information, and if previously learned information is required (Gagné et al., 2005, p. 10; Schiffman, 2010, pp. 197-198). In terms of creating instruction and learning processes, there are four main areas: Task Content and Learner Analysis; Testing and Measurement; Media selection and Production; and Evaluation.

Research has shown that Instructional Design or ISD is very much related to asynchronous learning, weighted towards the individual learner and individual learning. Therefore, to address the shortcomings in the current ISD model, a new proposed CISD model has been designed to support synchronous learning situations and provide collaborative, face-to-face learning environments.

4.3 Design Process

A number of steps were taken in the creation of the CISD model. As Dick et al. (2009) continuous improvement cycle demonstrates (see Figure 4-2), each phase and sub-phase went through a rigorous, circular improvement process of development.

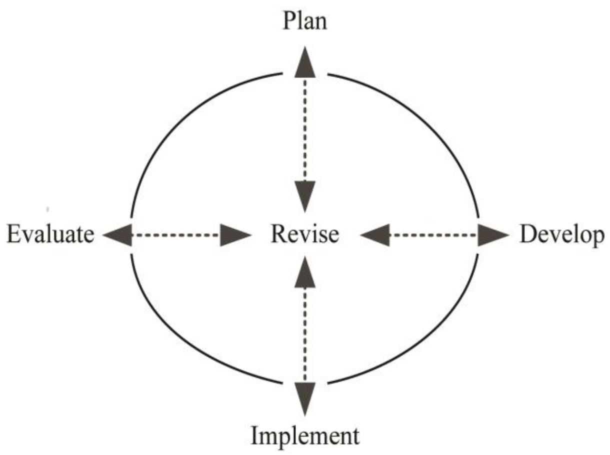


Figure 4-2: Continuous Improvement Cycle (adapted from Dick et al., 2009, p. 5)

The rationale began with reviewing the original ISD model. Ideas and thought processes would be diarised in a notebook, or drawn on the whiteboard (see Figure 4-7) to be critiqued and reviewed. Once each phase and sub-phase was developed, the ideas would then be applied to the CISD model.

4.3.1 Step 1: The Initial Process

A number of theoretical approaches, such as sociocultural theories, collaborative learning, and ISD, were taken into consideration when designing the new CISD model. Figure 4-3 was the initial plan and provided a rudimentary starting point. In regard to identifying missing collaborative and interactive characteristics, the initial plan began with an analysis of the standard Instructional Systems Design model. A number of questions relating to collaborative and interactive design were used as constant reminders. For example: “What collaborative characteristics are required to create a CISD model?”; “What are the interactive characteristics required?” and “Which collaborative elements are required/missing?”

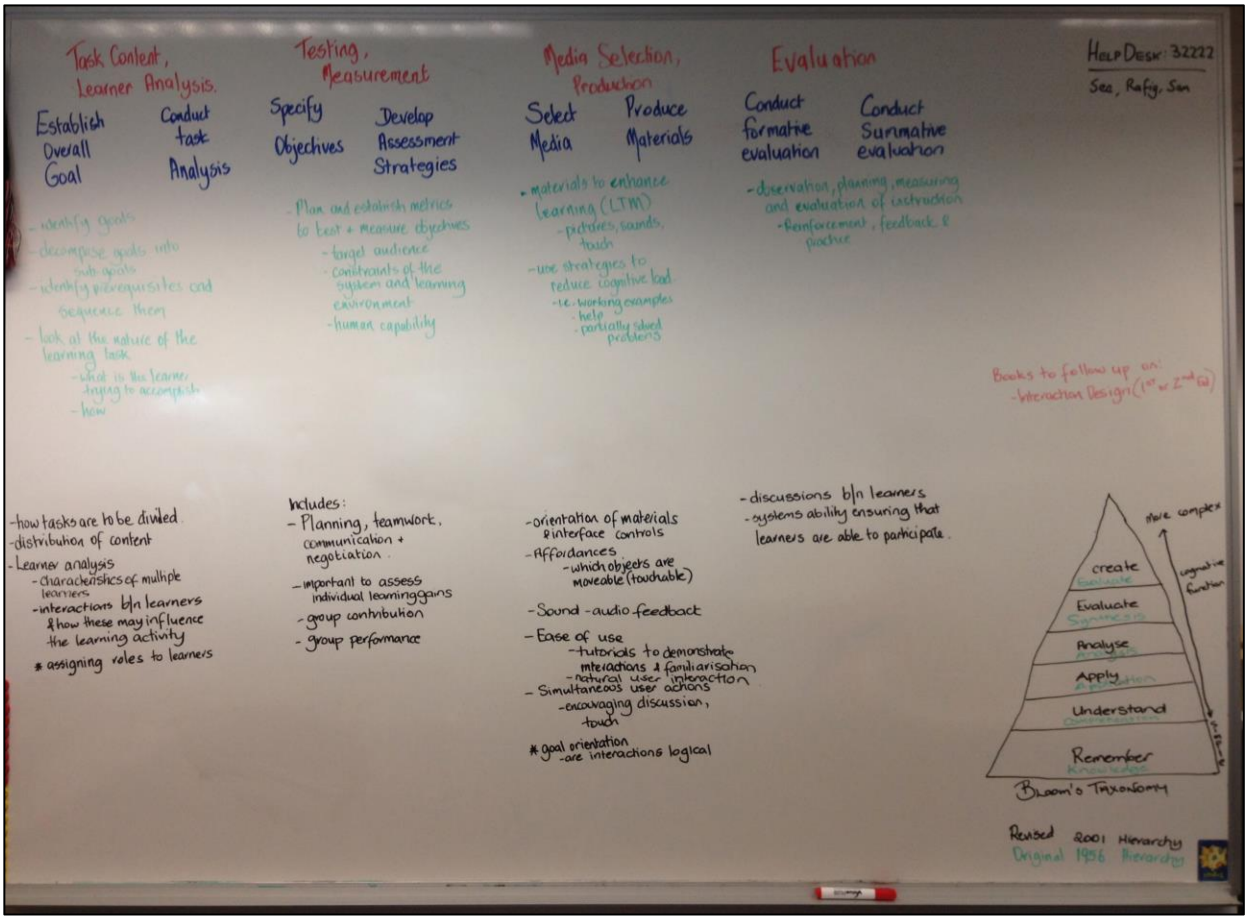


Figure 4-3: The Initial Plan - 1st August 2012

From within the literature review, elements, ideas, and concepts were gradually added to this basic model (see Figure 4-4).

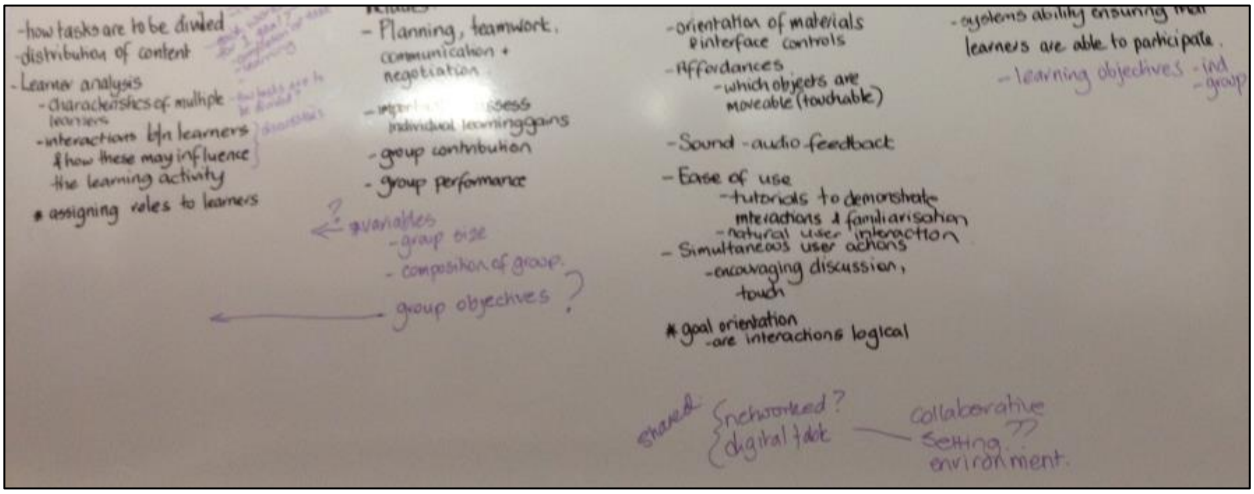


Figure 4-4: The growing model 7th August 2012

This initial process motivated the development of the first conceptual model of the new CISD Model; using a mind map tool MindMaple Pro (see Figure 4-5). However, this first model had a significant flaw; while there was now a focus on group instructional elements, other elements belonging to individual instructional design also existed.

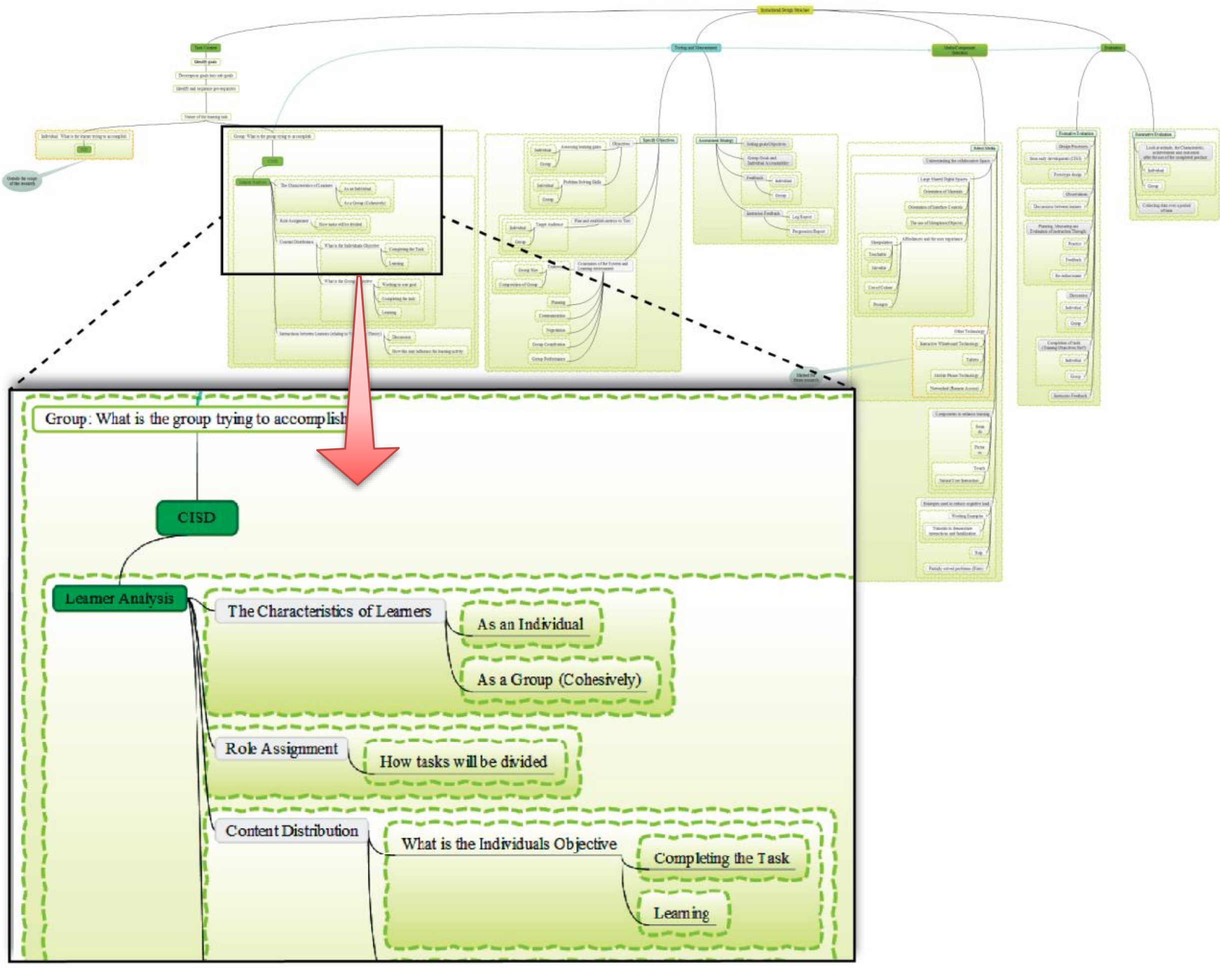


Figure 4-5: The first model 14th August 2012

This issue was resolved by introducing a decision checklist (see Figure 4-6); a series of questions which would determine if the instructional task/s are appropriately associated with the collaborative characteristics in a collaborative learning approach.

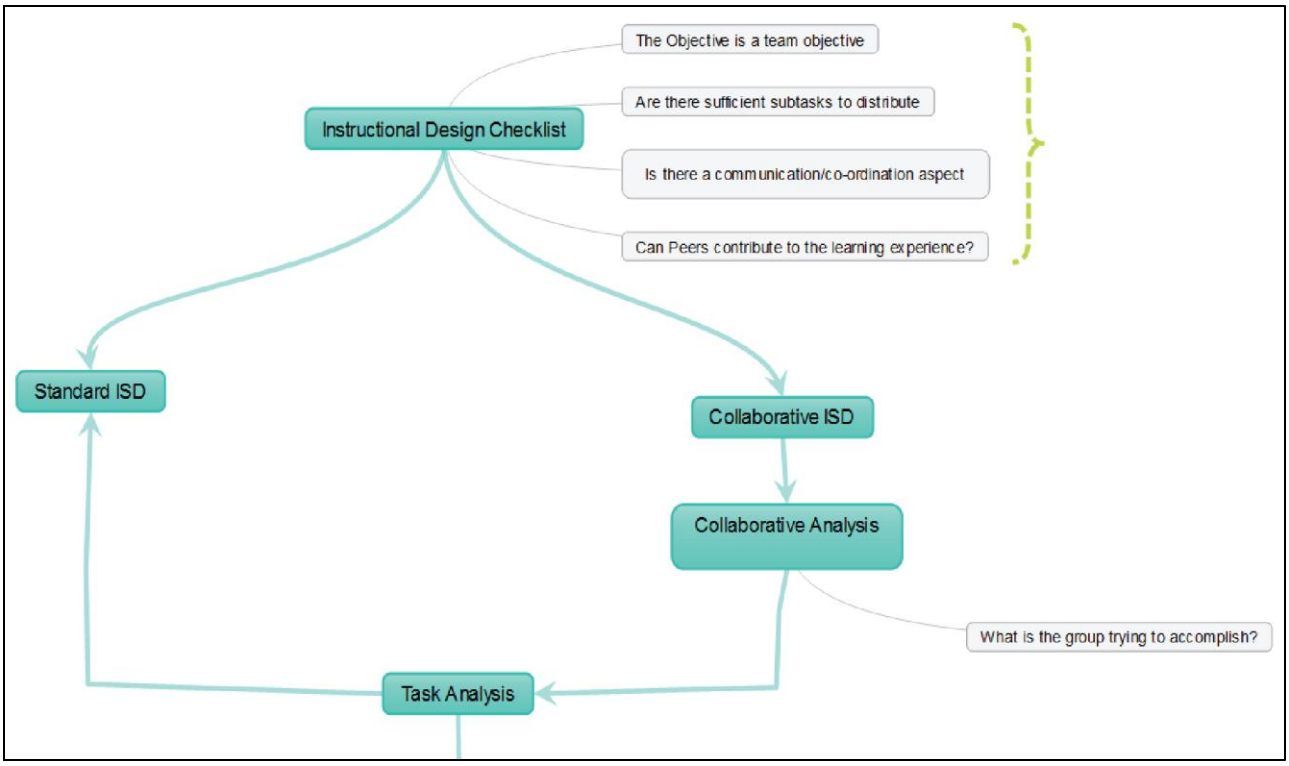


Figure 4-6: Inserting the Instructional Design Checklist - 16th August 2012

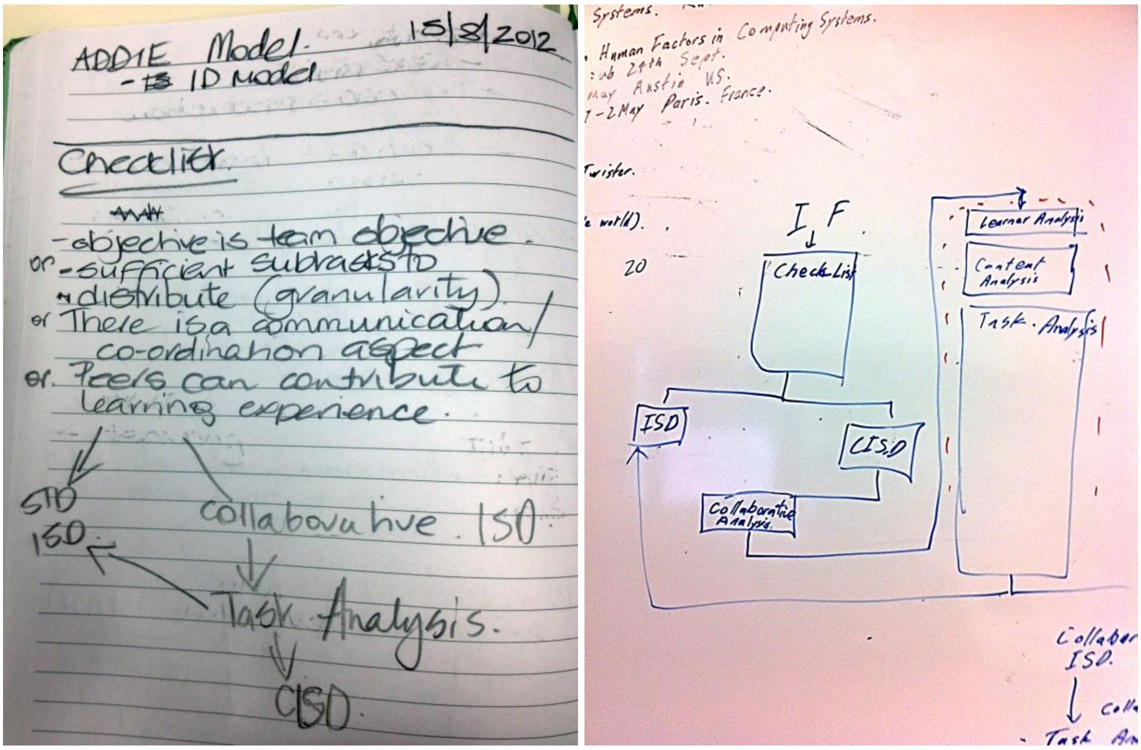


Figure 4-7: Thought processes – Diary and on a whiteboard 21st August 2012

As part of the weekly discussion meetings, progressive print versions of the CISD model (see Figure 4-8) were produced and used in the review process.

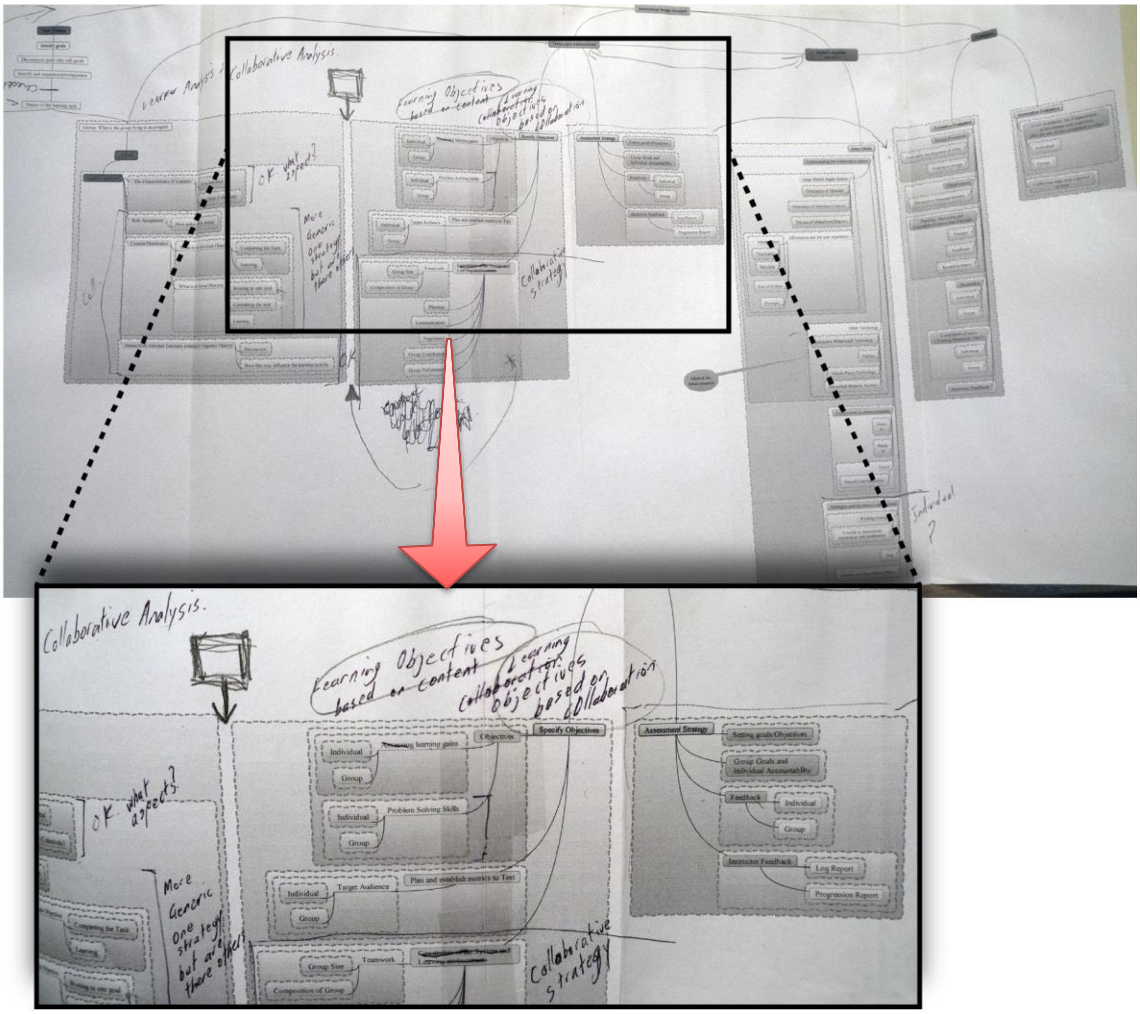


Figure 4-8: First Draft of the CISD Model in Microsoft Visio

The mind map tool used to develop the initial versions of the new CISD was no longer feasible. The new CISD model was expanding and new collaborative phases were beginning to emerge. To accommodate the growing model, it was decided to transfer to Microsoft Visio 2010 (see Figure 4-9) as it could accommodate the newly emerging collaborative phases.

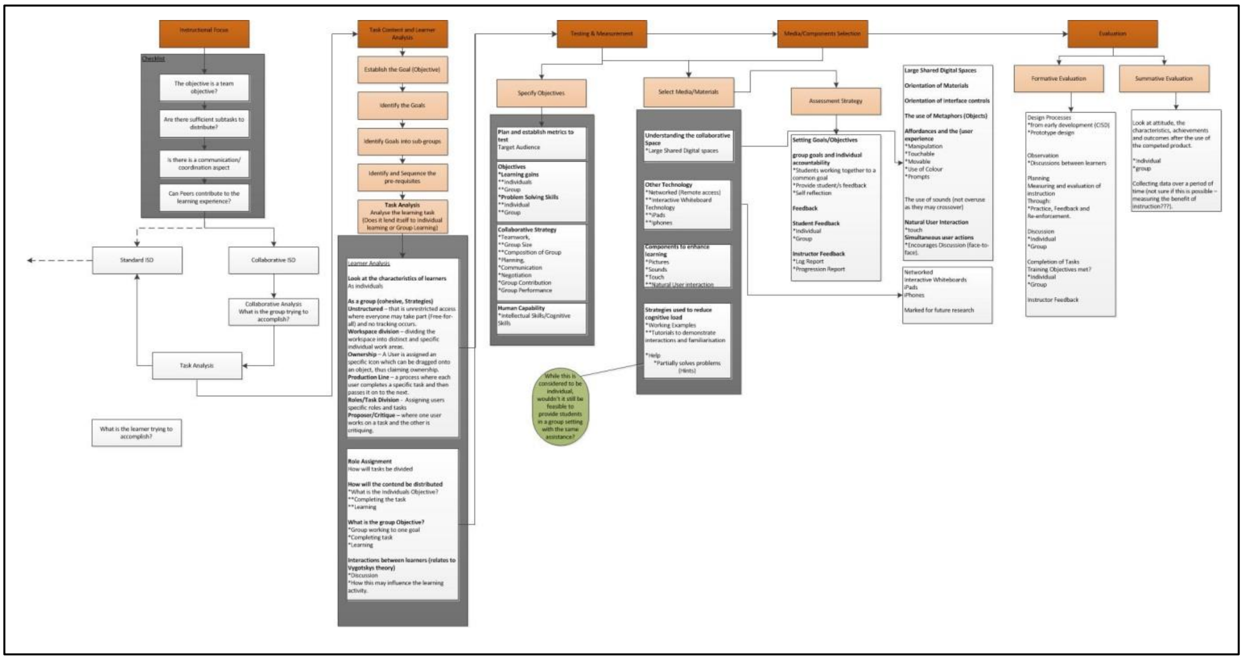


Figure 4-9: CISD Model as at 22nd August 2012

Instructional Focus became the first phase and it is within this phase that a new decision checklist resides. The decision checklist consists of a number of questions used to analyse whether the *Instructional Focus* meets the collaborative criteria. If the criteria are met, the next phase, which at this point is *Task Content and Learner Analysis*, is initiated. If the criteria are not met, then the standard ISD approach is recommended. Throughout this time, the remaining phases are still based on the standard ISD model and comprise of: *Task, Content and Learner Analysis*, *Testing & Measurement*, *Media/Components Selection* and, finally, *Evaluation*. These phase headings, however, began to evolve. *Task, Content and Learner Analysis* became *Learner Analysis, and Collaborative Analysis* became *Collaborative Analysis*. Within *Collaborative Analysis*, three sub-phases were developed: *Learner Analysis, Content Analysis* and *Collaborative Task Analysis*. These sub-phases are influenced by theoretical areas such as Sociocultural Learning Theory.

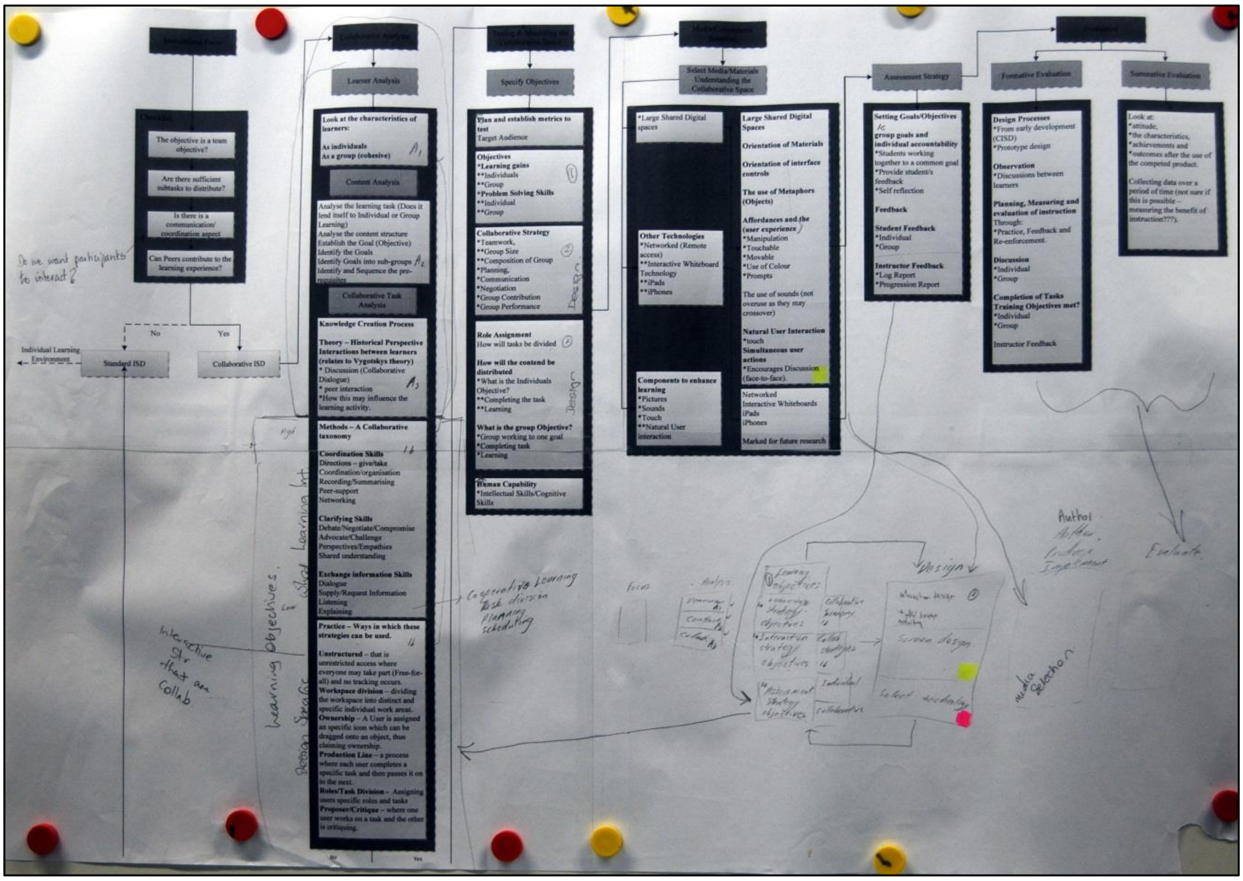


Figure 4-10: CISD model as at 25th August 2012

A revised version of the CISD model would be presented in the weekly supervision meeting for feedback. Each new phase was reviewed rigorously through discussions, while notes were made on the paper copy of the model (see Figure 4-10). Once completed, each new phase would be updated and concatenated with its previous phase. A flow between phases of the model was established involving specific outputs of each phase that acted as inputs for the following phase. At this stage, the CISD model was beginning to consolidate.

4.3.2 Step 2: Consolidation Process

The consolidation process progressively unified each phase within the CISD model. At the weekly meeting, a revised model would be presented prompting further critique and review by the supervisors, thus strengthening this collaborative instructional model. During the consolidation process, the third phase of the model, *Learning Objectives*, was discussed and revised to include three sub-phases; *Learning Strategy Objectives, Integration Strategy Objectives* and *Assessment Strategy Objectives* (see Figure 4-11). The *Learning Objectives* phase is innovative in that it is influenced by Bloom's Taxonomy of Learning Objectives.

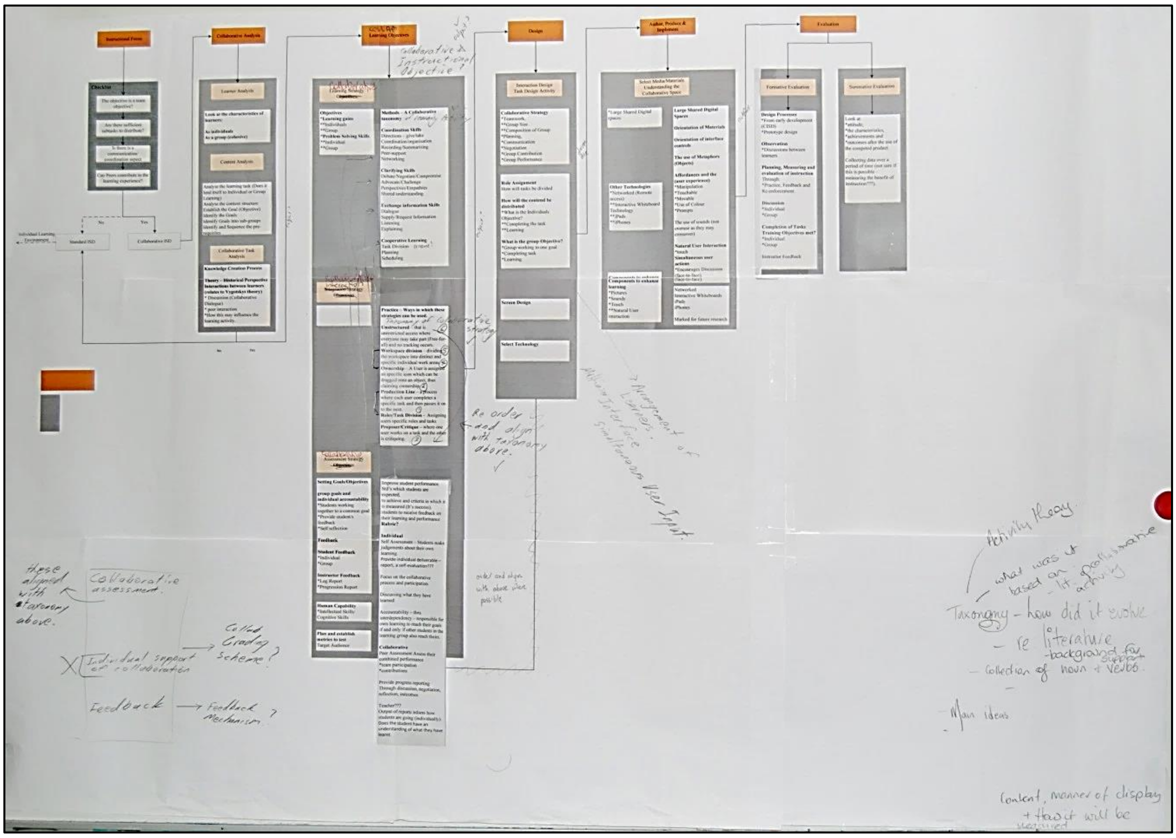


Figure 4-11: CISD model as at 6th September 2012

The naming of this phase soon changed to Collaborative Instructional Objectives. The three sub-phases and two taxonomies were developed into Collaborative Learning Strategies (Methods), Collaborative Interaction Strategies (Practices) and Collaborative Assessment Strategies (see Figure 4-12).

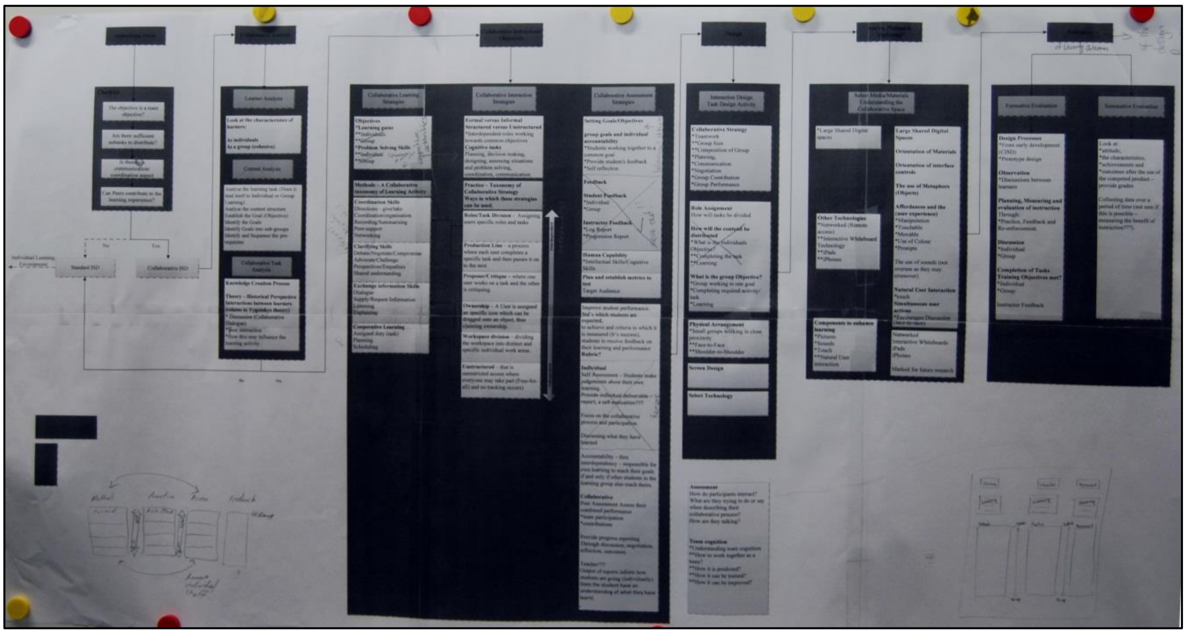


Figure 4-12: CISD model as at 18th September 2012

The third taxonomy, *Assessment*, changed to *Indicators*, which was the final taxonomy added (see Figure 4-13). In keeping with Bloom's Taxonomy, these three taxonomies were hierarchical and placed in order from high cognitive benefit (collaborative) to low-cognitive benefit (co-operative). The remaining phases: *Design*, the *Author, Produce and Implement* phase, and finally, the *Evaluation of Learning Outcomes and Design Outcomes*, were all examined and refined.

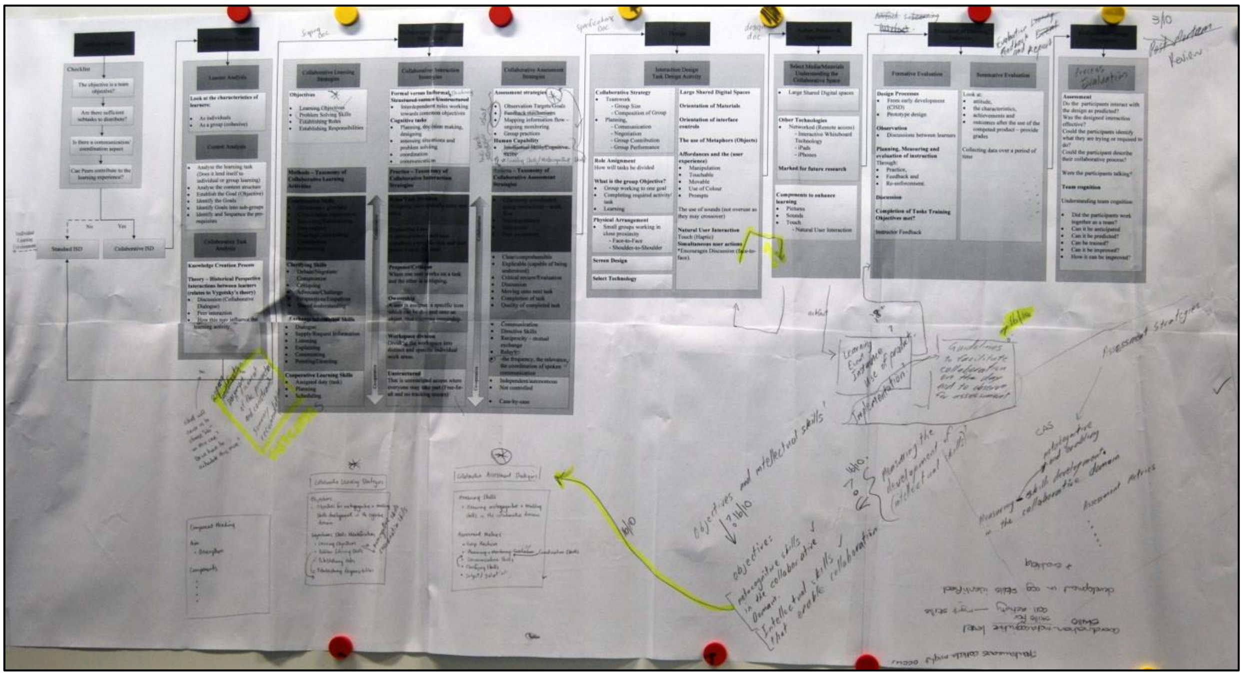


Figure 4-13: Development and inclusion of the Design Phase – 3rd October 2012

4.3.3 Step 3: Refinement Process

During this final process, each phase was reviewed, improved, modified, and refined. The fourth phase titled *Design* incorporated a number of elements relating to collaborative workspaces such as the selection and analysis of the technology to be used, the group (users) composition, the shared problem space itself, the shared interface elements, and the coordinated modes of interactions and activities. A central quad arrow was added representing an interrelationship between all four collaborative design components. Within these components, there is no one element more important than the others. All four components are interdependent (see Figure 4-14).

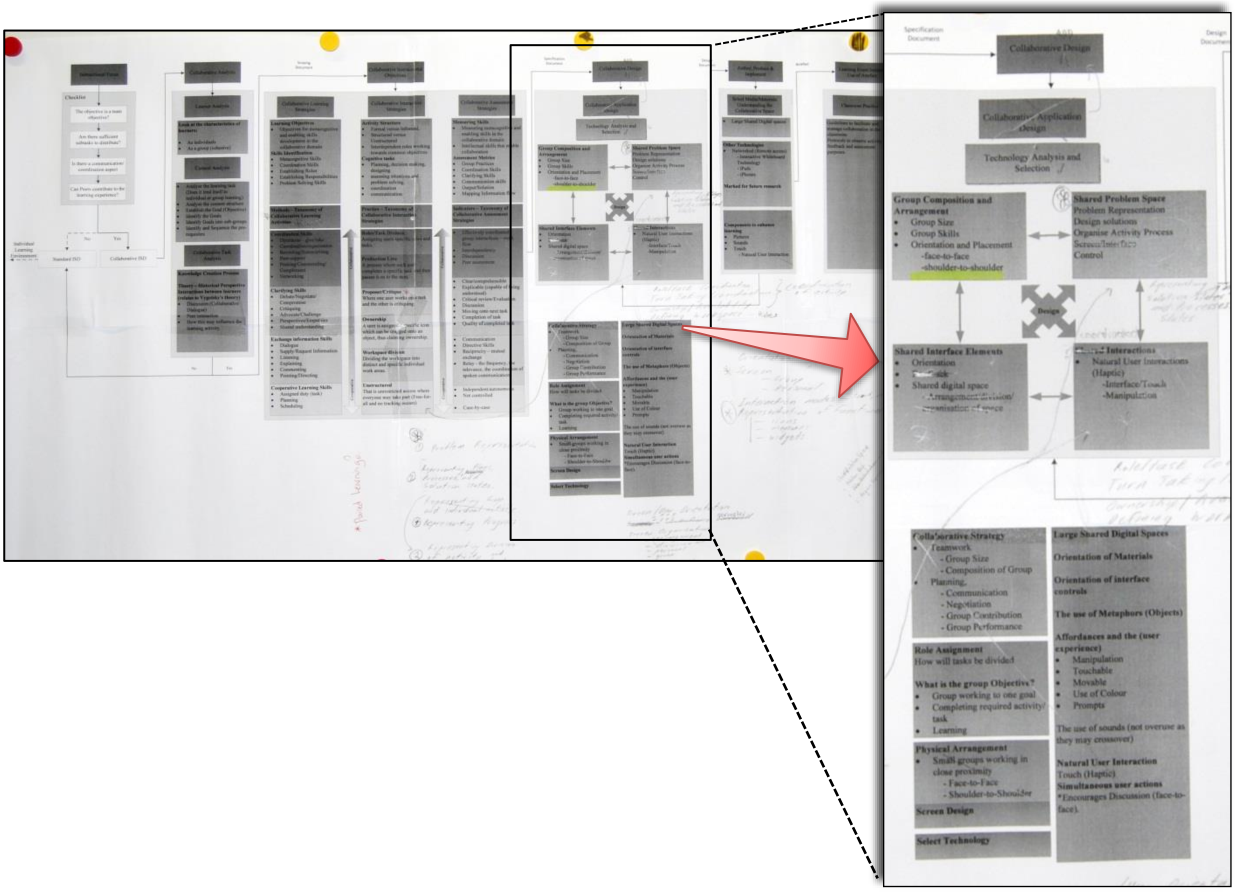


Figure 4-14: Refining the CISD - Design Phase – 24th October 2012

The remaining four phases: Author, Produce and Implement, Learning Event Instance and the Evaluation of the Learning Outcomes and lastly, Evaluation of Design Outcomes, were also reviewed and refined (see Figure 4-15).

The fifth phase, *Author, Produce and Implement* was updated to become *Development/Release and Implementation* and relates primarily to the Technology platform, the Systems Development Life Cycle, and the Authoring Platform of the *System Design Phase*. Following this phase is Phase Six; *Learning Event Instance Use of the Artefact*, which concatenates *Development/Release (Implementation)* to the final two phases - *Evaluation of Learning Outcomes* and *Evaluation of Design Outcomes*. *Learning Event Instance Use of Artefact* was added to provide guidelines for collaboration within the platform and tie it in, by providing protocols and/or procedures in order to assist with assessing the *Evaluation of Learning Outcomes*. This phase has remained similar to *Design Outcomes* in that assessment is still considered to be Formative and Summative. However, evaluation in this case, is more related to how the students interact collaboratively, through observation, through discussion and through how effectively the task/s were completed as a group. A new and final phase was added that relates to the *Evaluation of Design Outcomes*. This phase includes a Confirmative Analysis and Reflection. These components have been included in order to test the actual design of the instructional package by providing the designer with feedback on the effectiveness of the instructional package itself.

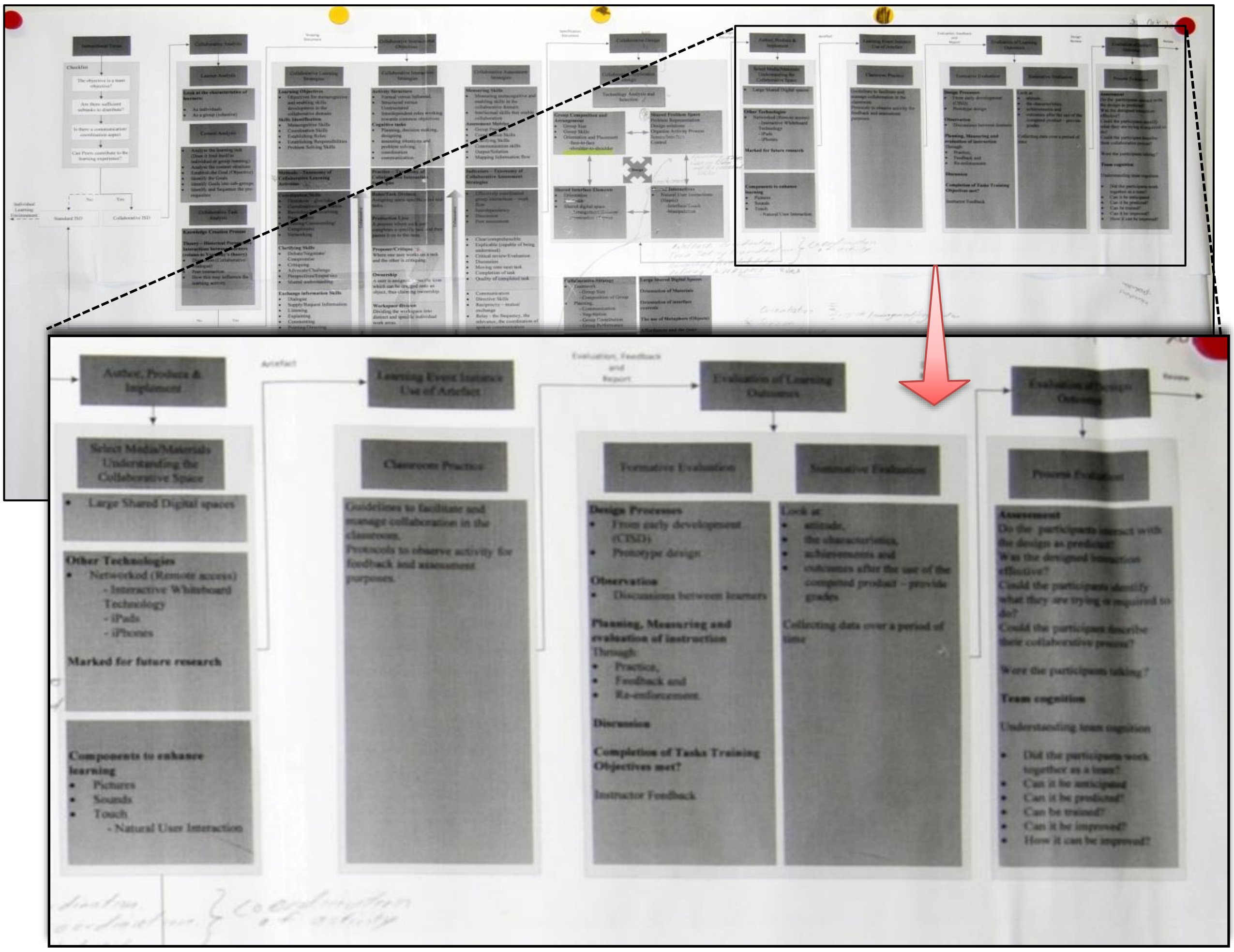


Figure 4-15: Refining the remaining phases of the CISD – 24th October 2012

4.4 Summary

This chapter described a number of concepts and ideas that were incorporated into the design process of the new CISD model. The objective of the new CISD model is to provide instructional designers with support, guiding them through a series of phases and sub-phases and assist in identifying collaborative opportunities through the analysis of learners, the content and the collaborative task. After an exhaustive design process, the final sequence of phases developed for the new model included *Instructional Focus; Collaborative Analysis; Collaborative Instructional Strategies; Collaborative Application Design; Development, Release and Implementation; Learning Event Instance Use of Artefact and Evaluation of Learning Outcomes;* and *Evaluation of Design Outcomes*. Overall, the CISD model has been designed to provide a foundation, or conceptual model, to accommodate the design, development, implementation, and evaluation of collaborative and interactive learning activities on LSSDS. A detailed description of the new CISD model and the related taxonomies is covered in Chapter 5.

5 The Collaborative Instructional Systems Design Model

5.1 Introduction

Large-Scale Shared Digital Spaces (LSSDS) are unique learning environments where more than one user can interact and collaborate in the same workspace. To assist and meet the challenges of designing collaborative learning applications and collaborative activities, a specific design process, a Collaborative Instructional Systems Design (CISD) model, is required. This chapter provides a description of each individual phase of this new instructional design model and the expected outputs for each phase.

The previous chapter, Chapter Four: Design Process of the Collaborative model, provided a comprehensive description of the design process of the new model. This chapter provides an in-depth description of the new CISD model which incorporates theoretical foundations based on the explored literature. The literature from which the model was derived includes Collaborative Learning, Collaborative Learning Environments, the Sociocultural Theory of Learning, Distributed Cognition Theory, and Instructional Systems Design.

The new CISD model is based on Vygotsky's philosophy of sociocultural learning (see Section 2.5.1: Sociocultural Theory). Sociocultural Theory was conceived on the idea that learning occurs when individuals in a culture or society, such as parents, teachers and older children, share information. These societal interactions provide the mediation tools and signs, enabling the construction knowledge and understanding that could not be achieved alone. The technology of LSSDS provides a forum where these social learning interactions and supporting digital content can take place, in a controlled learning environment. Distributed Cognition Theory (see Section 2.5.3: Distributed Cognition Theory) extends Vygotsky's philosophy whereby individuals interact in their environment, through the use of tools, resources and materials and brings together a body of knowledge in a social context. It is important to understand how individuals, and the resources that they make use of in their environment, form a shared cognitive system. The new CISD model is designed so that as information flows through parts of the system and is transformed, learning occurs and is internalised by the individuals.

5.2 The Collaborative Components

The outcome of the design process, established in Chapter 4, is the CISD model. A summary of the proposed CISD model is shown in Figure 5-1, with the corresponding standard Instructional Systems Design (ISD) model inset. The CISD model has been summarised in this manner due to the intricate level of detail and complexity of the full model and provides a quick guide to the phases and major features for Instructional Designers.

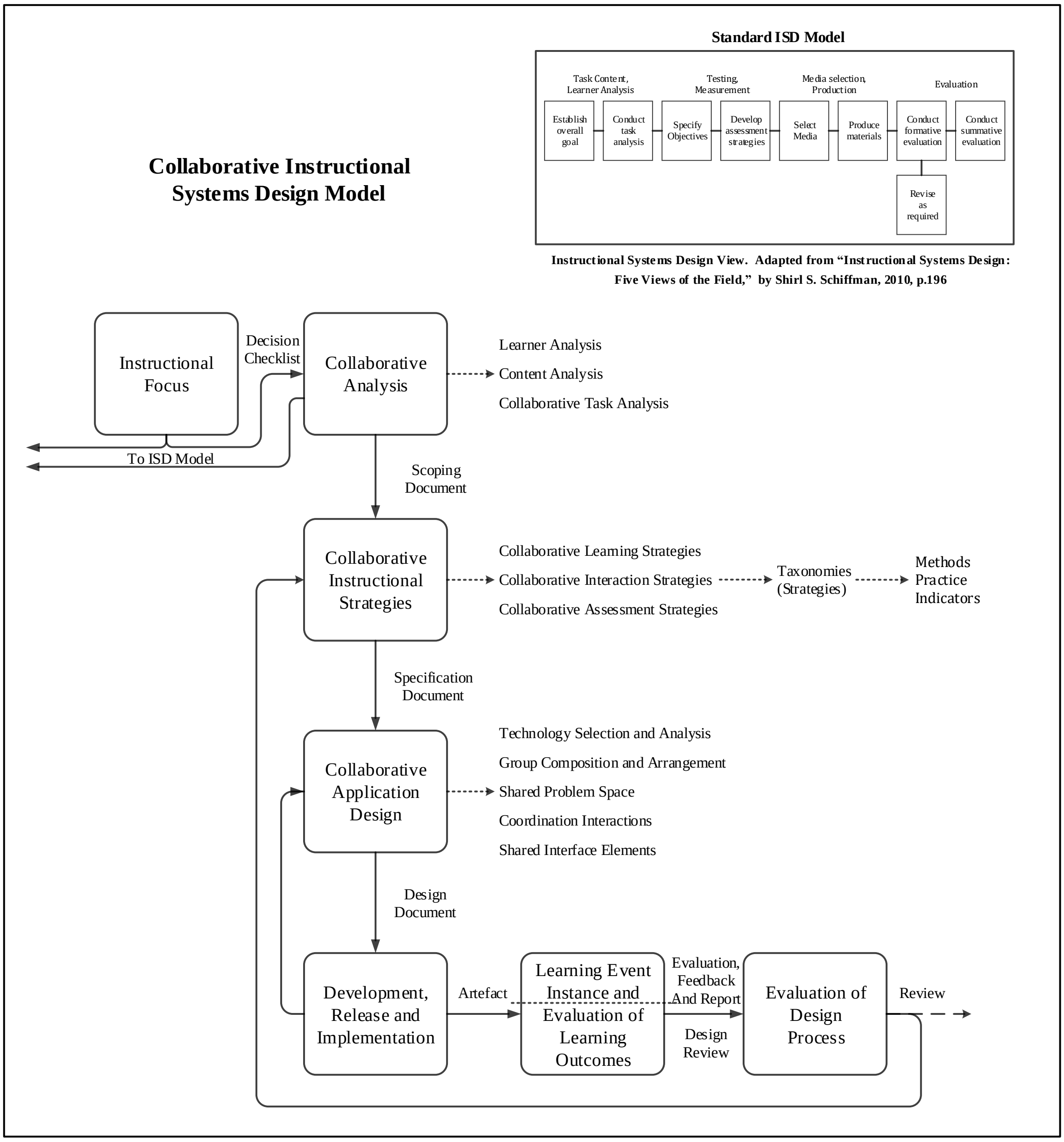


Figure 5-1: The new Collaborative Instructional Systems Design Model

The CISD model is comparable to a flowchart. It consists of a sequence of seven main phases that are interconnected, with lines and arrows indicating a progressive order. Within each phase, there is flexibility via dotted arrows, which point to sub-phases. On the completion of each phase is an output, in the form of a document or report, to assist the designer with the subsequent phase. The return arrows indicate that iteration is possible, in that if the instructional package requires an update or has a problem, the Instructional Designer can go back to reconsider and/or update the design.

A summary of the CISD process begins with Phase One; *Instructional Focus*. This phase includes a series of questions in the form of a checklist to identify and determine if the desired learning application is suitable for collaboration. If ‘No’, the arrow exits out toward the standard ISD model and, if ‘Yes’, the CISD continues toward Phase Two; *Collaborative Analysis*. Collaborative Analysis considers the characteristics of the learners, the content, and the collaborative tasks. On completion of the *Collaborative Analysis*, the output is a Scoping Document, and the Instruction Designer then considers the types of Phase Three; *Collaborative Instructional Strategies* that will be required. Within this phase, there are three interdependent instructional domains and their related multi-tiered taxonomies. These three areas centre on Collaborative Learning Strategies, Collaborative Interaction Strategies, and Collaborative Assessment Strategies. An arrow indicates the connection and associated taxonomy. The output of the *Collaborative Instructional Strategies* is a Specification Document. *Collaborative Application Design* is the fourth phase of the model. Within *Collaborative Application Design* are five components, each with their unique, explicit features that act as a guide, where its output is a Design Document. Phase Five; *Development, Release and Implementation* concentrates on the development of the software. It is at this point that if any necessary design modifications are required, the arrow points or iterates back to the previous phase, *Collaborative Application Design*. The learning artefact is the result of the completion of this phase. From here there is Phase Six; *Learning Event Instance Use of Artefact and Evaluation of Learning Outcomes,* where the application is taken into the classroom and placed in the learning environment, the LSSDS. Phase Six produces two outputs. The first occurs in *Learning Event Instance Use of Artefact*, which produces an Evaluation and Feedback report that focuses on the use of the artefact. This is then followed by the *Evaluation of the Learning Outcomes,* where the instructional designer prepares a Design Review report. Finally, Phase Seven is the reflective process, *Evaluation of Design Outcomes*, which looks back at the entire process to report on what or where the phases worked and where improvements may be required. If all has worked well, the collaborative design process exits, otherwise, there is an arrow that points back to *Collaborative Instructional Strategies* to refine the process.

A more comprehensive, phase by phase description of the CISD model is discussed below. While moving through the CISD model, a small thumbnail highlights the phase reference point. This thumbnail is a compact graphic representation of Figure 5-1 that provides a step-by-step guide through the design process with a description of each phase and any expected outputs.

It should be noted that in designing the CISD model, the first four phases have been created explicitly with collaboration in mind. The final three phases have been included as they are important to the instructional design process and are essential when developing learning applications/materials. These, however, are not the focus of this research.

5.3 Instructional Focus

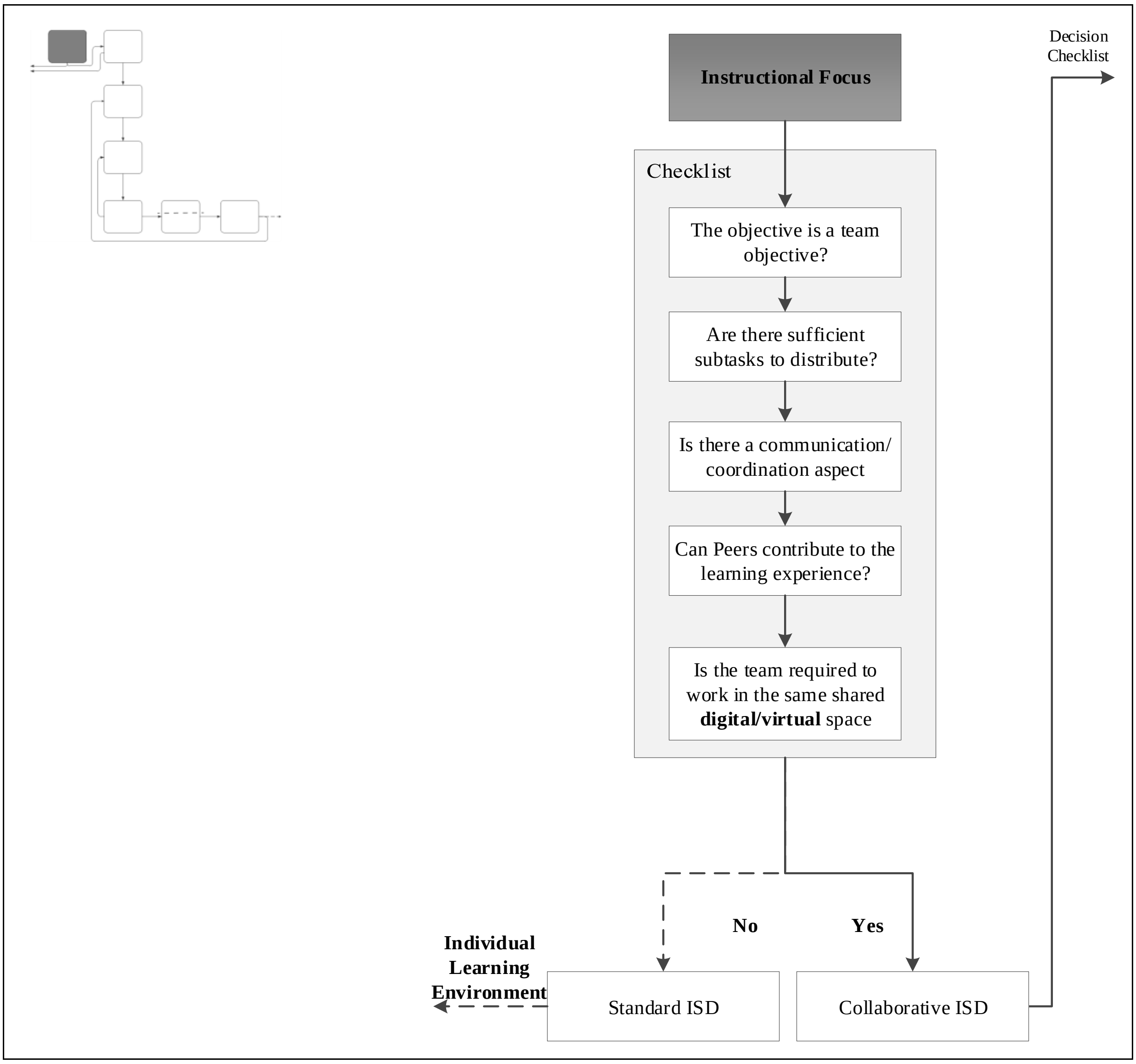


Figure 5-2: Phase One - Instructional Focus

The CISD process begins with *Instructional Focus* (see Figure 5-2). *Instructional Focus* is used to identify and determine if the learning task is appropriate for a collaborative learning approach.

Section 2.5.3: Distributed Cognition Theory examines how a group can be regarded as a cognitive system, both in computational or calculated dependencies and, in social organisation. Hutchins (1995a) alleged that cognitive properties within culture or society might function differently at the individual level than at a group level. Therefore, it is important to establish if the *instructional focus* of a new learning task relates to a group culture, a collaborative process, or if it relates a learning event for an individual.

5.3.1 Instructional Focus Expected Output

A decision checklist (see Figure 5-3 and Appendix K: *Instructional Focus* – Decision Checklist for larger copy), in the form of a series of Yes-No questions, is used to evaluate whether the instructional task/s are suitably aligned with collaborative aspects so as to warrant a collaborative learning approach. The Yes-No questions in the decision checklist assess collaborative activities. This should provide the instructional designer with the answers to whether the *instructional focus* has the appropriate collaborative features and scope to warrant a CISD treatment. If the criteria 'Yes-No' questions indicate a CISD focus, then Phase Two; *Collaborative Analysis* is initialised.

Instructional Focus Decision Checklist		
Instruction Type:		
	Yes	**No**
Is the objective a team objective?	☐	☐
What are the team objectives?		
Are there sufficient subtasks to distribute?	☐	☐
Describe the subtasks?		
Is there a communication/coordination aspect?	☐	☐
Describe possible communication/coordination aspects?		
Can Peers contribute to the learning experience?	☐	☐
Is the team required to work in the same shared digital/virtual space?	☐	☐
Recommendation to continue?	☐	☐
Notes:		

Figure 5-3: The Checklist to determine if a collaborative application is feasible.

If the CISD criteria are not met, then it is recommended that the standard ISD approach be implemented, i.e. an individual learning environment.

5.4 Collaborative Analysis

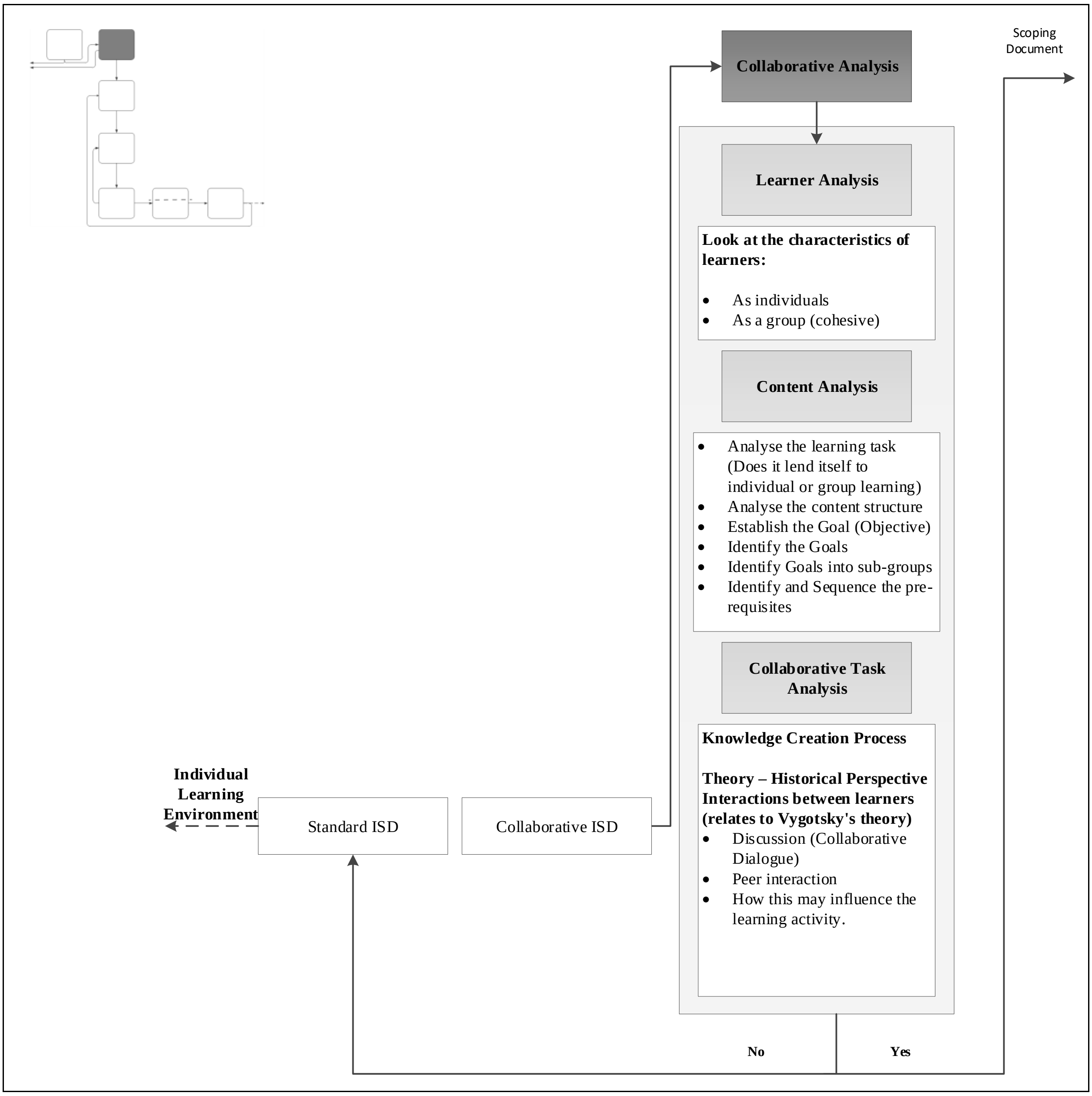


Figure 5-4: Phase Two - Collaborative Analysis

The traditional ISD model grouped Task, Content and Learner analysis as one phase, with a basic heading. When designing the new CISD model, these three elements were united to become the more detailed *Collaborative Analysis* (see Section 4.3.1). Within *Collaborative Analysis* there are three sub-phases:

- *Learner Analysis* - all-inclusive analysis examining the nature of the learner/s,
- *Content Analysis* - the nature of the content and, finally,
- *Collaborative Task Analysis* - the nature of the collaborative learning activity in a social context and any influential theoretical underpinnings.

The instructional designer needs to know the characteristics of the learners and know the nature of the content prior to working out what collaborative tasks might be appropriate. The expected outcome of this process is a scoping document. *Collaborative Analysis* provides a deeper level of analysis in several sub-sections as described below.

5.4.1 Learner Analysis

Many factors need to be considered to understand the nature and characteristics of the learners – as individuals and then as a cohesive group. When conducting a learner analysis, it is important to understand the characteristics of the intended audience, the individual learner, and their demographics. The audience demographics should include components critical to the achievement of the specific training objectives, such as the age of the learner, their gender, education, and motivation. Other characteristics may be social, ethnicity, cognitive abilities (such as learners with disabilities), and whether they are adult learners. Therefore, when considering the design of a collaborative learning environment, it is not only important to identify the individual learners characteristics, as mentioned above, but to also understand characteristics of multiple learners, and the ability to share of information and tasks in a collaborative group environment.

5.4.2 Content Analysis

Content Analysis is a five-step process of analysis and documentation that defines the suitability, goals and objectives from a collaborative perspective (see Section 2.7.2.1**:** Task, Content, and Learner Analysis).

The steps in this process include

- Analyse the learning task: analyse the content of the learning task and divide it into themes to determine if the learning task lends itself to individual or group learning.
- Analyse the content structure: classify the nature of the content and any sub-components.
- Identify and prioritise the goals and establish the learning objectives.
- Break down these goals into sub-groups.
- Identify and sequence tasks.

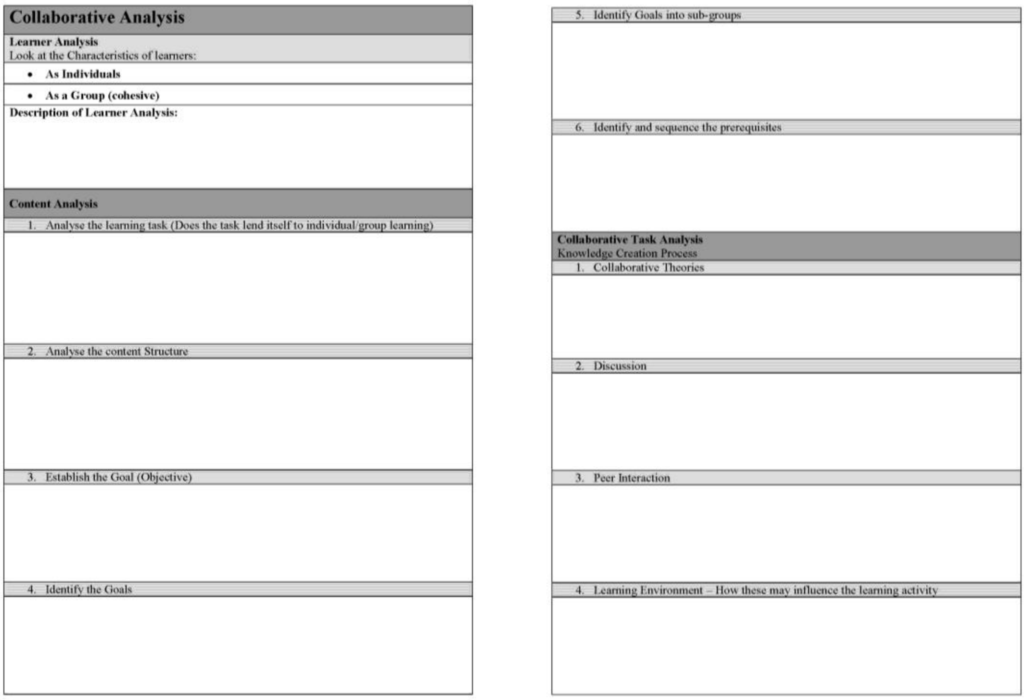
The purpose of this analysis is to prepare for the creation of the new collaborative learning material (see 2.7.2.1, para. 5).

5.4.4 Collaborative Task Analysis

This analysis assesses the knowledge creation process and, in relation to Vygotsky's Sociocultural Theory, looks at the sharing of information through discussions with peers and interactions between learners. The aim here is to get a general indication of the possible nature or the types of collaborative learning activity that might be possible given a detailed understanding of the learners, the learning objectives and the content involved.

5.4.5 Collaborative Task Analysis Expected Output

This process results in a Scoping Document which describes the characteristics of the learner, a breakdown of the content, and the nature of the learning tasks required. The aim is to assess the learning situation, and whether it lends itself to a collaborative learning approach, and to identify the collaborative learning goals. The output of this process is a scoping document (see Figure 5-5 and Appendix L: Collaborative Analysis – Scoping Document for the larger version).



Collaborative Analysis

Learner Analysis
Look at the Characteristics of learners:

- **As Individuals**
- **As a Group (cohesive)**

Description of Learner Analysis:

Content Analysis

1. Analyse the learning task (Does the task lend itself to individual/group learning)
2. Analyse the content Structure
3. Establish the Goal (Objective)
4. Identify the Goals
5. Identify Goals into sub-groups
6. Identify and sequence the prerequisites

Collaborative Task Analysis
Knowledge Creation Process

1. Collaborative Theories
2. Discussion
3. Peer Interaction
4. Learning Environment – How these may influence the learning activity

Figure 5-5: Scoping Document

The conclusion of this phase may still recommend the implementation of the standard ISD. Otherwise, the instructional analysis moves onto the next phase, Phase Three - *Collaborative Instructional Strategies*.

5.5 Collaborative Instructional Strategies

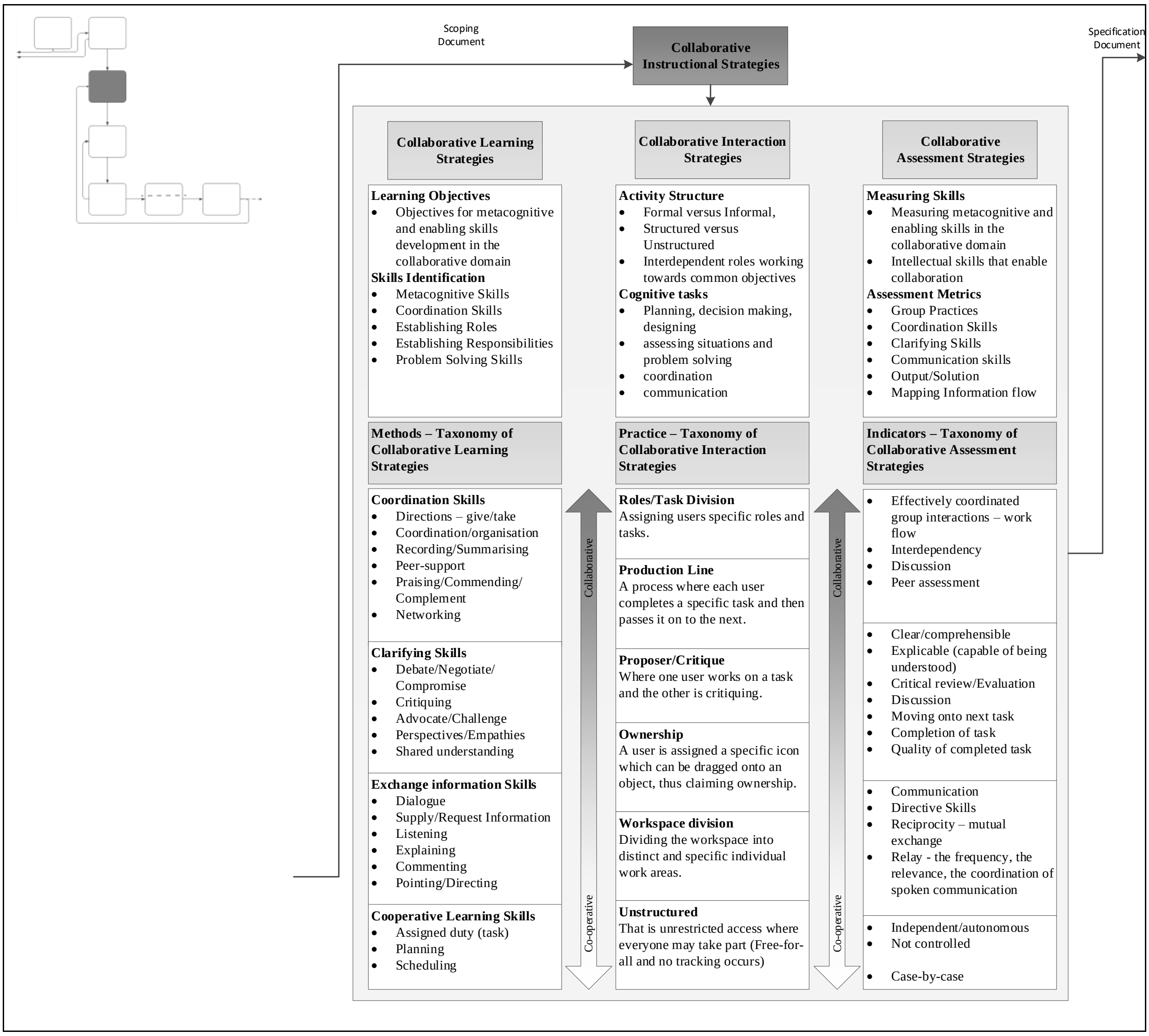


Figure 5-6: Phase Three - Collaborative Instructional Strategies

Collaborative Instructional Strategies proposes three domains or sub-phases and their related taxonomies, to provide a systematic and methodological plan to assist in the development of collaborative instructional environments (see Figure 5-6). For the instructional designer, it is important to understand the collaborative learning objectives, the interaction strategies, and assessment strategies.

The overall nature and purpose of the *Collaborative Learning Strategies* involves two main components, the Learning Objectives and Skills Identification (see Figure 5-7)

Figure 5-7: Collaborative Learning Strategies

Collaborative Learning Strategies is a detailed analysis of learning objectives and skills identification. Learners bring their own experiences and understanding into the classroom (Zaraté, 2013). It is, therefore, essential to identify the individuals metacognitive and enabling skills in order to facilitate group learning, interaction, and participation. Once these skills have been identified, the learning group dynamics, such as *Coordination Skills*, their roles, and responsibilities, can then be realised. These strategies assist group problem-solving, decision-making, and self-monitoring skills. Learners discussing their ideas amongst peers should result in the identification of many possible solutions and provide workable strategies to complete their task.

Metacognitive skills were selected for this research, as many of the collaborative learning skills mentioned, such as those in *Coordination Skills*, are in the metacognitive domain and are expected of learners when working collaboratively in an LSSDS. Metacognition was a term originally defined by Flavell (1979, p. 906) as a “cognitive phenomena”, which involves an arrangement of communication, comprehension, and areas relating to memory, problem-solving and social cognition. Efklides (2008) extended Flavell’s description by stating that metacognition is a “multifaceted phenomenon” that includes facets such as metacognitive knowledge, metacognitive experiences and metacognitive skills. In general, metacognitive knowledge relates to self-knowledge—what we already know—and cognitive processes such as memory, language, and the awareness of knowledge. It is these abilities/skills which help learners become more knowing and responsible for their own cognition/thought processes (Efklides, 2008, p. 278; Martin, Kragler, Quatroche, Hargreaves, & Bauserman, 2015, p. 192). Metacognitive experiences relate to motivation or self-processes and are a combination of the relationship between the learner and the task, bringing together past knowledge and experiences. This includes the learners thought processes in undertaking the task of working towards a deeper and thorough understanding of the task goal and objectives (Efklides, 2001, 2009). Efklides (2008) described metacognitive skills as the deliberate use of cognitive strategies by the learner, such as rehearsal and/or elaboration to regulate the process of cognition. Veenman (1999) states that metacognitive skills relate to, "procedural knowledge that is required for the actual regulation of, and control over one's learning activities. Task orientation, planning, monitoring, and checking are some examples of skills that can be acquired and executed implicitly", and through analysis of protocols such as thinking aloud (p. 510).

The overall nature and purpose of the *Collaborative Interaction Strategies* section refer to the detailed analysis of the Activity Structure and Cognitive Tasks (Figure 5-8).

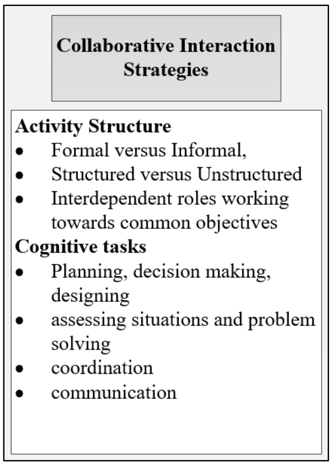


Figure 5-8: Collaborative Interaction Strategies

Collaborative Interaction Strategies is concerned with how the interactive activity and the cognitive tasks are organised. When incorporating interaction strategies into learning activities, the instructional designer needs to consider several activity structures and tasks. These activity structures could be of a formal/structured or informal/unstructured type, with learners working together on a shared task, or with learners working interdependently towards common goals. For example, formal interactive activities are structured by assigning users to specific roles and tasks, whereas informal activities are more liberal, giving users free-for-all access to all roles and tasks.

The overall nature and purpose of the *Collaborative Interaction Strategies* section considers Measuring Skills and Assessment Metrics (see Figure 5-9).

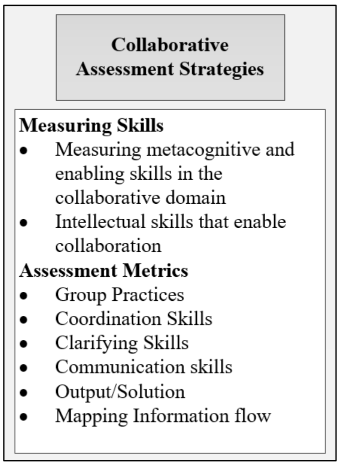


Figure 5-9: Collaborative Assessment Strategies

Collaborative Assessment Strategies is centred on measuring skills and assessment metrics. These should be observed in learner behaviour if the collaborative learning strategy is successfully implemented. To-date, in traditional teaching methods, there is an abundance of literature that focuses on testing and assessing individuals. To assess and measure particular skills in a collaborative context, such as metacognitive and intellectual skills, a variety of components are required. These structures are grouped and ranked from low-level assessment strategies to higher and more complex assessment strategies.

These strategies are observable and should assist teachers in identifying these types of behaviours and assess the quality of the collaborative interaction. The instructional designer will also need to include assessment metrics such as group practices, which measures how the group work and support each other when working together.

To put the three strategies into practice, supporting taxonomies have been developed that list and categorise specific skills, tasks, and behaviours. These give the instructional designer a list of possible approaches, although this may be extended if needed for specific learning contexts. These new taxonomies aim to complement Bloom’s existing multi-tiered taxonomy for individual learners (see Figure 5-10). The supporting taxonomies are intended to present distinct levels of collaborative instructional complexities from a low level to a high level of cognitive impact. Low-level activities are likely to be cooperative rather than collaborative, with learners working independently. This means they are less likely to engage in activities that produce collaborative learning benefits. High-level activities require the learners to actively engage with each other and, therefore, are more likely to result in collaborative learning benefits. The three new taxonomies are also aligned as closely as possible horizontally so that there is a logical flow between the *Learning Strategies* targeted, the *Interaction Strategies* used and finally, with the *Assessment Strategies* that may be utilised to evaluate the quality of the collaborative learning interactions.

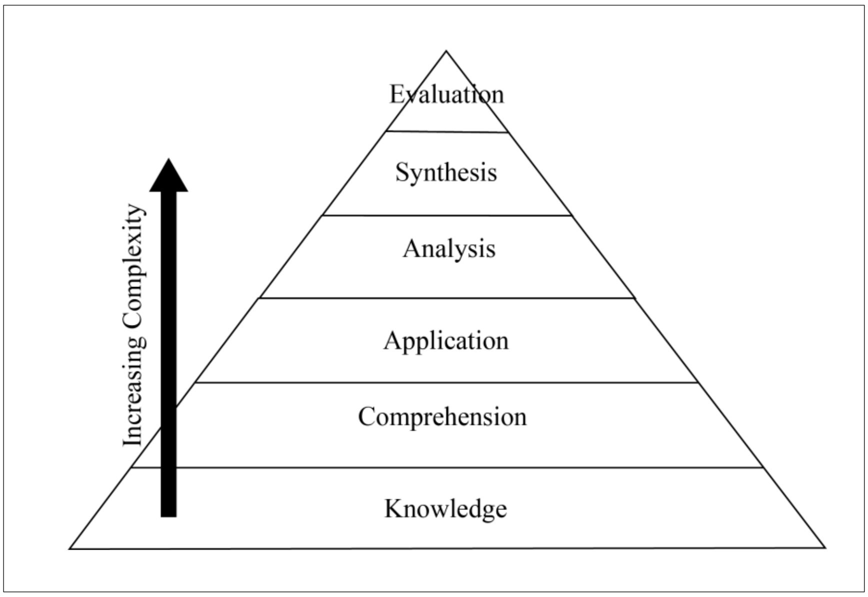


Figure 5-10: Bloom's Taxonomy (adapted from Adams, 2015)

Bloom's Taxonomy is represented as a hierarchy pyramid, "ranging from lower-order skills that require less cognitive processing to higher-order skills that require deeper learning and a greater degree of cognitive processing" (Adams, 2015, p. 152).

Figure 5-11 is a representation of the three new taxonomies. These three new collaborative taxonomies are inverted and have been arranged analogously, ranging from a low level of cooperative complexity to a high level of collaborative complexity. The purpose of this is to encourage the instructional designer to focus on and include the higher level collaborative taxonomies. The co-operative level activities are the lowest in complexity and complexity increases when moving up the model. The upper collaborative- level activities are the most complex, requiring the learners to have a deeper and richer understanding of all the events.

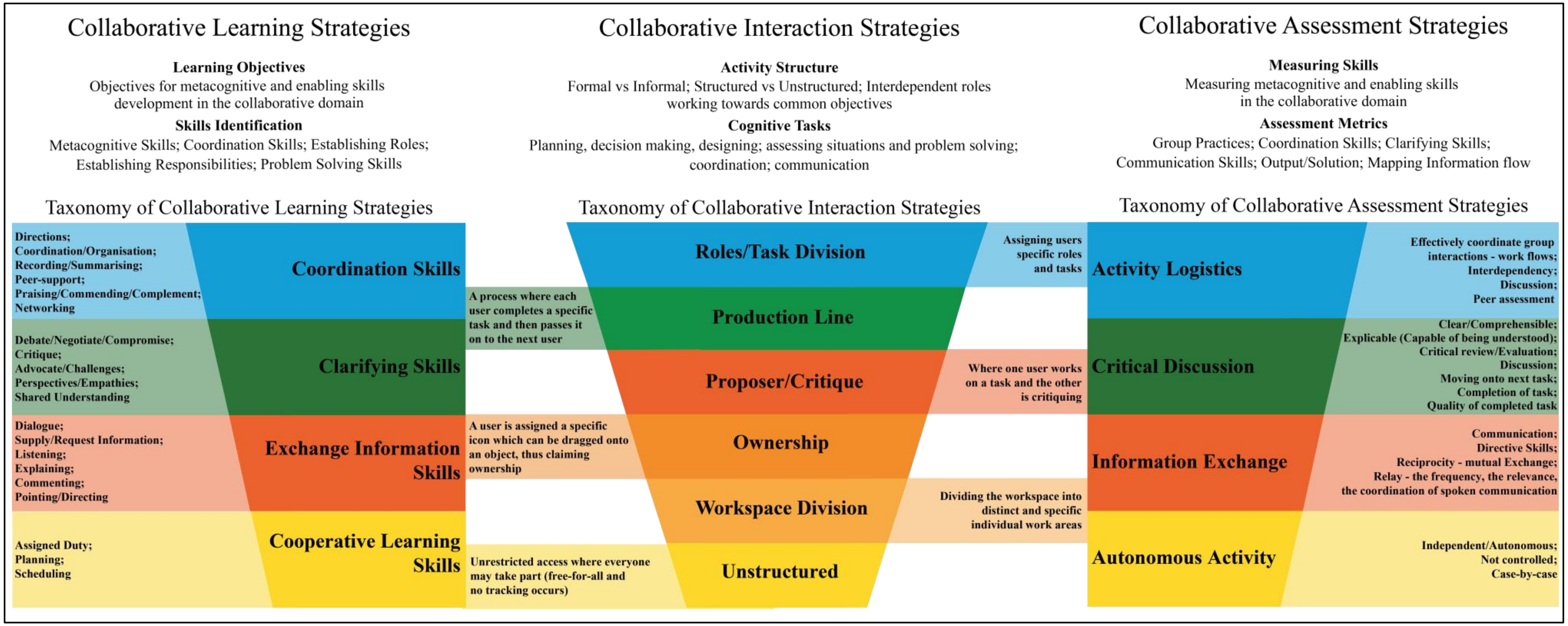


Figure 5-11: The Three New Taxonomies in Collaborative Instructional Strategies

5.5.1 Collaborative Learning Strategies

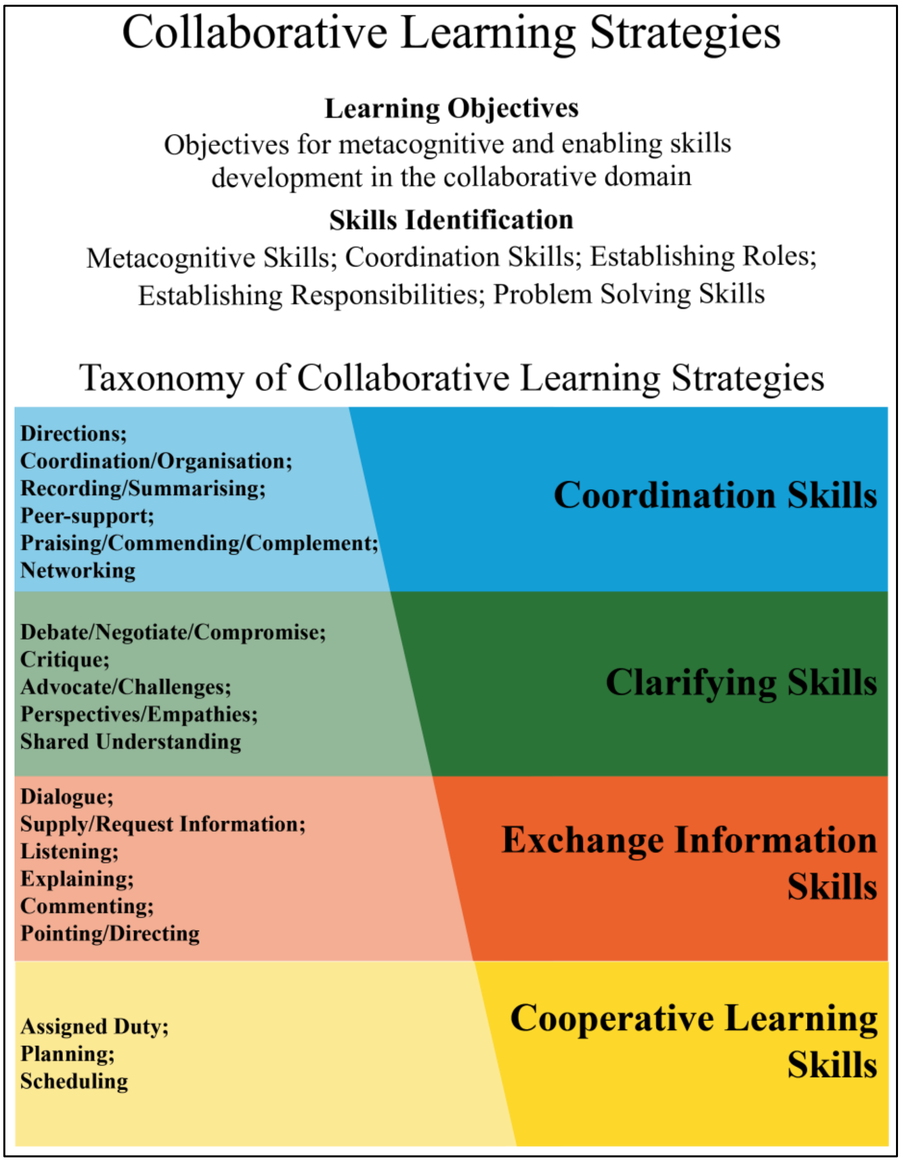


Figure 5-12: Taxonomy of Collaborative Learning Strategies

The Taxonomy in *Collaborative Learning Strategies* identifies learning strategies that have a high cognitive benefit, such as Coordination and Peer Support skills, and then ranks other collaborative learning activities in descending order of cognitive benefit. The lower end of the scale relates to cooperative activities such as working individually on related tasks-cooperative learning. As noted previously, *Cooperative Learning Skills* are where learners are working together in small groups towards their own individual goals and are the least collaborative of the four methods. Cooperative learning is, however, an important starting point, in that; learners acquire social skills and the practice of working together. Incorporating skills such as task assignment [Assigned Duty], Planning, and Scheduling and participation activities into learning tasks, provides students with the grounding on how to begin working together.

The ability to exchange information requires specifically refined skills. *Exchange Information Skills* is more engaging as learners are required to demonstrate interpersonal communication skills. This is an ongoing process of the sharing of information via a message transaction that is either verbal or non-verbal and requires the sending and receiving of information between two or more people (West & Turner, 2010, p. 10; Wood et al., 1976, p. 17). Verbal skills include dialogue – the supply and request of information, listening, explaining, and commenting. Non-verbal skills rely on body language such as pointing, directing and facial expressions.

In an ideal world, for a learning group to communicate effectively, some structures such as logic, order and predictability are required. In the real world, this is not always the case. When learners are working collaboratively, there may be unresolved problems that lead to poor quality or incomplete tasks. To overcome these issues, learners require specific clarification skills to ensure that two-way communication is occurring, with the aim of understanding the task at hand. Specific *Clarifying Skills* such as debate/negotiation/compromise, critiquing, advocating/challenging provide perspective and, empathies encourages ideas, argument, discussion, reasoning and finally, clarification may improve the shared understanding of the group (Cragan, Wright, & Kasch, 2008).

The final classification in the Taxonomy of Collaborative Learning Strategies is *Coordination Skills*. "Teachers know that it is much easier to incorporate active/collaborative learning tasks if students have already acquired appropriate skills from participation in effective group work in other classes" (Barkley, 2010, p. 41). Therefore, a group may be required to accomplish all the previous skills in order to attain *Coordination Skills*. In this model, *Coordination Skills* is the highest level of cognition, in that users are required to demonstrate a number of skills, such as to give and/or take directions, be able to record or summarise what they have learnt, as well as providing peer support. Finally, as a group, learners should be able to debrief via a collaborative reflection in order to discuss their thinking processes, actions and ability to listen to peers in the organised community (Kim & Lee, 2002).

5.5.2 Collaborative Interaction Strategies

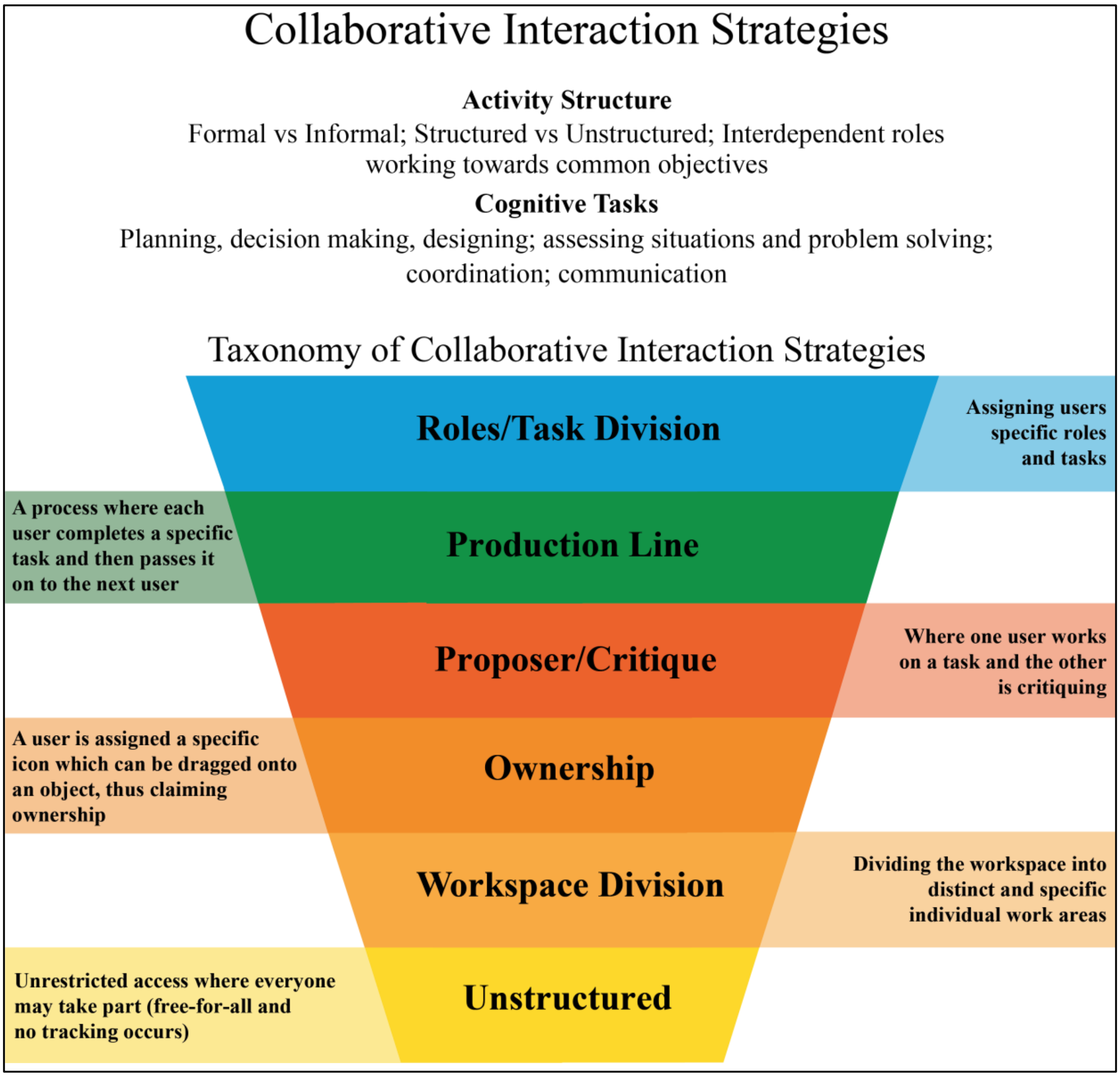


Figure 5-13: Collaborative Interaction Strategies

The Taxonomy of Collaborative Interaction Strategies is used to encourage and motivate learning activities. It ranges from highly organised collaborative processes, where users are assigned specific roles and tasks [*Roles/Task Division*] to lower cooperative processes that are *Unstructured*. Due to the multiple inputs available in LSSDS environments, without structures users have unrestricted access in a free-for-all where each learner is provided with no guidance as to the appropriate form of activity. A highly organised collaborative process would be a learning activity that is decomposed into basic components, and these components can be assigned to individual learners (Butler et al., 2010). An example of a formal learning task, demonstrated on an LSSDS, involved a remedial phonics application (McGivern, Butler, & Morgan, 2011) which identified and divided a task into sub-components and then distributed these amongst players. The anatomy learning application demonstration shown on the Sectra Table (Sectra, 2017) and the children interacting on the Hatch WePlaySmart multi-touch table (Hatch, 2017a), as shown in Figure 1-1, are two current examples of applications developed for the LSSDS. Both applications offer two distinct types of interaction strategies.

The anatomy study on the Sectra Table is targeted towards an older audience who are encouraged to interact and explore visual representations of the human body. The product is described as encouraging group discussions and collaboration, which is essential for team-based learning. The learning application uses a formal learning approach, beginning with the teacher and a group of students situated around the table discussing and interacting with the learning task. The control of the task is transferrable from one person to another, thus encouraging group discussion and teamwork. Based on the description and the video supplied, it can be presumed that the Interaction activities for this instructional application relate to two specific areas in *Ownership* and *Proposer/Critique*. *Ownership* – because the control of the task is transferrable from one person to another, and *Proposer/Critique* – as it is assumed a group discussion would involve verbal and social interactions.

WePlaySmart (Hatch, 2017a) is an LSSDS that allows up to four children to play simultaneously. The gameplay for the WePlaySmart interactive table is aimed at preschool learners and is described by Hatch to be a cooperative learning environment that teaches young learners positive behaviour and teamwork. The games are described to encourage learner development through collaboration. Children's conversations are recorded and saved during play then allowing teachers to listen and evaluate the recordings (Hatch, 2017a). Children learn through collaborative play and are encouraged to problem-solve, take turns, follow instructions and be team players. Given this scenario, the age of the target audience, and the Taxonomies of Interaction Strategies for these products would be considered to take place in the lower level of the interaction strategies table. The learning activities appear to be organised in a way that would encourage children to explore on their own in *Unstructured* free-for-all activities, and other activities provide specific Workspaces that have been divided to inspire the exploration of their work area.

The above examples are by no means an exhaustive list of possible activities. However, the three examples display how learning activities can be arranged and coordinated. In one instance, a highly structured activity focuses on *Roles/Task Division*, and two other examples demonstrate how different activities can relate to other interaction strategies.

5.5.3 Collaborative Assessment Strategies

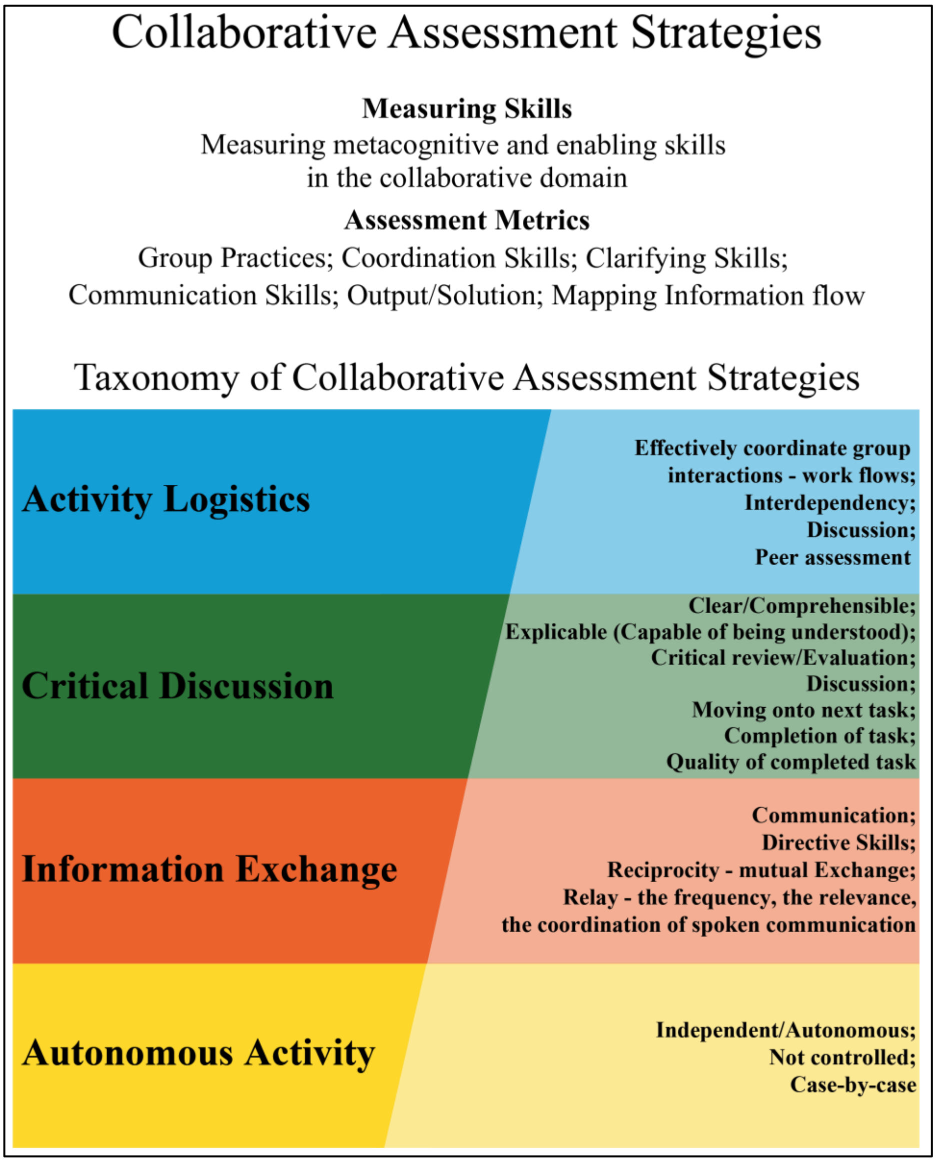


Figure 5-14: Taxonomy of Collaborative Assessment Strategies

The Taxonomy of Collaborative Assessment Strategies is an observable hierarchical classification type that is directly related to the strategies selected from the previous two taxonomies. This taxonomy is used to assess the progress of the learner by observing the way the learners interact with one another. As discussed in the previous two taxonomies, this taxonomy ranges from low-level cognitive complexity, *Autonomous Activity*, increasing to a high level of cognitive complexities, *Activity Logistics*.

Autonomous Activity is considered to be more of a cooperative behaviour where learners work independently, and the way they interact and react to a learning situation is expressed spontaneously and case-by-case. *Information Exchange* relates to how the learners pass information from one to another, and what methods are used to relay the information. This can be verbal (speech act), or non-verbal (facial expression, or gesture such as pointing).

Critical Discussion has been defined by van Eemeren and Grootendorst (1984) as

> … a discussion between a protagonist and an antagonist of a particular standpoint in respect of an expressed opinion, the purpose of the discussion being to establish whether the protagonist's standpoint is defensible against the critical reactions of the antagonist. (p. 17)

Critical Discussion is the next step up from *Information Exchange,* where learners situated around the LSSDS will be expected and encouraged to clearly express their opinions and review and evaluate a learning situation. At the conclusion of expressing their point of view, are the learners able to move on to complete the task/s, or will they need to come to some agreement and compromise?

Finally, *Activity Logistics* relates to a way in which the learner or learners respond to each other in the 'learning activity observable behaviours' so that can be easily identified and measured. The expected activity logistics anticipated within this higher complexity level begins with peer-assessment. Learners assess each other on and during the learning activity. This requires discussion and planning, where the learners are required to work interdependently, thus coordinating and harmonising the way they work together. Being able to observe these behaviours will provide some assessment of the quality of the learning in collaborative terms, rather than just in individual learning gains.

5.5.4 Collaborative Instructional Strategies Expected Output

The expected output from this phase is a Specification Document that describes the Objectives of the learning strategies, the structure of the interaction strategies, and the assessment skills required for the learning task. The example provided (see Figure 5-15) is not definitive and will need to be adapted appropriately for each developing project. A larger version of Figure 5-15 is shown in Appendix M.

Collaborative Instructional Strategies Form		
Subject:		
Collaborative Learning Strategies	**Collaborative Interaction Strategies**	**Collaborative Assessment Strategies**
Learning Objectives	Activity Structure	Measuring Skills
Objectives: • for metacognitive and enabling skills development in the collaborative domain	Activity: • Identify the activity structure and tasks • Formal versus Informal • Structured versus Unstructured • Interdependent roles working towards common objectives	Measuring: • Metacognitive and enabling skills in the collaborative domain. • Intellectual skills that enable collaboration
Describe Learning Objectives	**Describe Activity Structure**	**Describe Skills to Measure**
Skills Identification	**Cognitive Tasks**	**Assessment Metrics**
☐ Metacognitive Skills	☐ Planning, Decision making, design	☐ Group Practices
☐ Coordination Skills	☐ Assessing situations and problem solving	☐ Coordination Skills
☐ Establishing Roles	☐ Coordination	☐ Clarifying Skills
☐ Establishing Responsibilities	☐ Communication	☐ Communication Skills
☐ Problem Solving Skills		☐ Output/Solution
		☐ Mapping Information Flow
Notes:		

TAXONOMIES		
METHODS	**PRACTICES**	**INDICATORS**
Coordination Skills	**Roles/Task Division**	**Coordination Behaviours**
☐ Directions – Give/take	☐ Planning, Decision making, design	☐ Effectively coordinated group interactions – work flow
☐ Coordinate/Organisation		☐ Interdependency
☐ Recording/Summarising		☐ Discussion
☐ Peer Support		☐ Peer Assessment
☐ Praising/Complementing/ Complement	**Production Line**	
☐ Networking	☐ A process where each user completes a specific task and then passes it onto the next	
Clarifying Skills		**Clarifying Behaviours**
		☐ Clear/Comprehensible
☐ Debate/Negotiate/ Compromise		☐ Explicable (capable of being understood)
☐ Critiquing	**Proposer Critique**	☐ Critical review/Evaluation
☐ Advocate/Challenge	☐ Where one user works on a task and the other is critiquing	☐ Advocate
☐ Perspectives/Empathies		☐ Moving onto next task
☐ Shared Understanding		☐ Completion of task
	Ownership	☐ Quality of completed task
Exchange Information Skills	☐ A user is assigned a specific icon which can be dragged onto an object thus claiming ownership	**Exchange Information Behaviours**
☐ Dialogue		☐ Communication
☐ Supply/Request Information		☐ Directive Skills
☐ Listening		☐ Reciprocity – mutual exchange
☐ Explaining	**Workspace Division**	☐ Relay – the frequency, the relevance, the coordination of spoken communication
☐ Commenting	☐ Dividing the workspace into distinct and specific individual work areas.	☐ Gestures
☐ Pointing/Directing		
Cooperative Learning Skills		**Cooperative Learning Behaviours**
☐ Assigned duty (task)	**Unstructured**	☐ Independent/Autonomous
☐ Planning	☐ That is unrestricted access where everyone may take part (Free for all and no tracking occurs)	☐ Not Controlled
☐ Scheduling		☐ Case-by-case

Figure 5-15: Collaborative Instructional Strategies - Sample of the specification document.

5.6 Collaborative Application Design

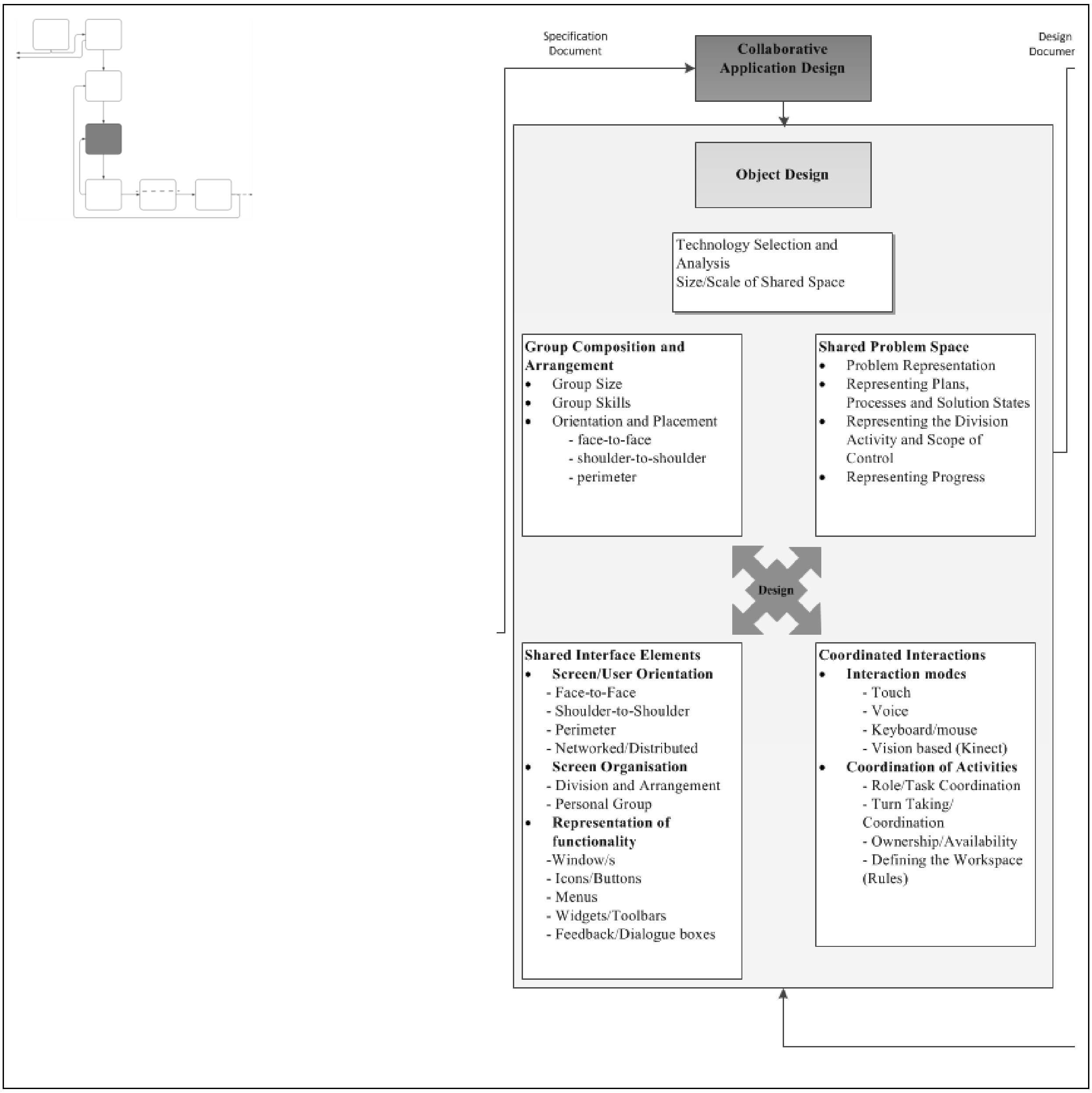


Figure 5-16: Phase Four - Collaborative Application Design

Collaborative Application Design is the *Object Design* phase that will guide the Instructional Designer with the tools to develop the collaborative learning application in the LSSDS context. *Collaborative Application Design* is a combination of instructional design work and project management. To keep the development of the learning application in a manageable process, *Collaborative Application Design* consolidated many of the processes into four elements and sub-elements. These four elements are interrelated, which is represented by the multi-arrow form that is situated in the centre (see Figure 5-16).

The design process begins with the selection and analysis of the technology to be used. For this research, the technology selected is an LSSDS. The Instructional Designer can then move through any of the four elements at any time. No one element is more important than another, but all processes do need to be considered when designing the learning application. For the purpose of explanation, the description of the elements will begin with *Group Composition and Arrangement*.

Group Composition and Arrangement defines the size of the group, the level of skills of the group members and the Orientation and Placement around the LSSDS.

The *Shared Problem Space* is the way to create a common understanding of the type of problem, formulate the shared goals of the learning task, and present a joint solution or solutions.

This begins with the Problem Representation. To ensure that the problem is defined well, it is crucial to determine the best way to represent that problem using the shared problem space. In other words, the instructional designer needs to work out the best way to present/design the learning application for the LSSDS. For example, the instructional designer needs to assess the screen and then consider how to arrange the workspace.

The next step is Representing Plans, Processes and Solution States, to consider strategies or plans, processes, and the best possible solutions. As such, an example of this would be a storyboard, to roughly design or plan out the learning application.

This is then followed by Representing the Division Activity and Scope of Control. Representing the Division Activity is the examination of the learning activity itself. These can be linked back to outcomes from the Phase Two Scoping Document and the Phase Three Specification Document. The outcome of Phase Two considers the characteristics of the learners and the content analysis, which identifies the goals and then sequences the activity of the learning task. From here, the instructional designer will need to work out the best way to represent the sequenced activities in the workspace, influenced by the decided number of learners placed around the large interactive workspace. Following this, relates to the outcome of Phase Three and is based on the analysis of the selected taxonomies. In particular the learning strategy/ies and interaction strategy/ies that are to be implemented, keeping in mind the scope of control. The Scope of Control sets the boundaries of the [learning application] design process and describes the aspects that is [or is not] included (Cox, 2009)
.

Representing Progress demonstrates the deliverables of the learning application. This can include a Work-Breakdown Structure. Cox (2009, p. 74) describes the Work-Breakdown Structure as " … a deliverable orientated, hierarchical decomposition of the work to be executed by the project team.” The importance here is that the Work-Breakdown Structure sets up and maps the project objectives.

Coordinated Interactions considers the types of interaction modes to be included. Interaction modes include direct-touch, hand or indirect touch, specifically designed haptic devices, such as mouse/keyboard devices (Müller-Tomfelde & Schremmer, 2008) or using game objects such as the direct linking of chess pieces and chessboard to a virtual 3D chessboard (Bottino, Martina, Strada, & Toosi, 2016). To further explain these concepts, using the mouse/keyboard or the chess pieces/chessboard device would indicate turn taking, therefore, the activity would need to be designed in a way that would indicate turn taking. In the game of chess, once one player has placed their chess piece into place, are they allowed to move the piece before the next player gets to take their turn or once released is it locked into place? This example is just an indication of the logical flow. Whereas direct touch is a natural and intuitive user approach, regardless of whether the user is left-handed or right-handed. The user can also interact with the screen synchronously, using both hands.

When considering the *Shared Interface Elements* for the LSSDS, the first aspect to be considered is the Screen/User Orientation. The Collaborative Instructional Designer needs to consider learner placement around the screen, which will be based on the type of learning activity being designed. Will the learners be face-to-face, shoulder-to-shoulder, located around the perimeter or will the learning activity be networked/distributed? Another aspect to be considered would be the screen organisation, which relates back to the type of collaborative interaction strategy selected. To accommodate multiple users, how will the screen be divided and how will the users be arranged? Lastly, is Representation of functionality, which relates to the interactive elements necessary for the learner to interact with the selected technology [in this case LSSDS] which then provides feedback to enable the learner to make decisions. How will the graphical interface be displayed and what are the included elements? The elements necessary for the user interface comprises of Window/s, Icons/Buttons, Menus, Widgets/Toolbars, Feedback/Dialogue boxes. An example of the interactive window may consist of a single-level or multi-level window.

5.6.1 Collaborative Application Design Expected Output

Figure 5-17 and Figure 5-18 show four possible group compositions and arrangements. The white rectangle is the shared problem space, the work area, and the dotted lines present the possible areas where the learners can coordinate their interactions.

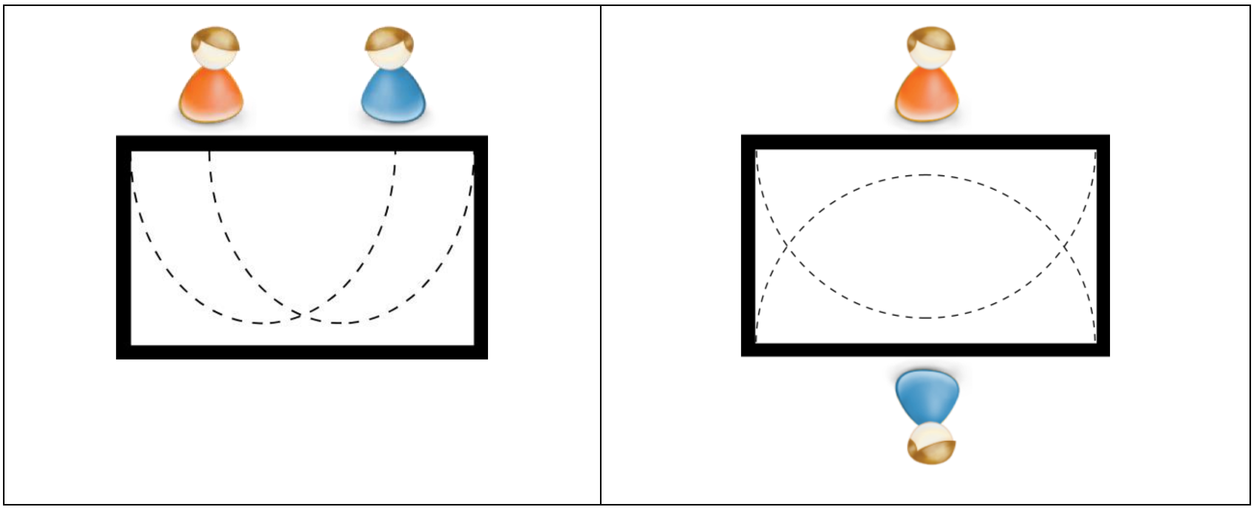


Figure 5-17: Possible arrangements and problem space division for two learners

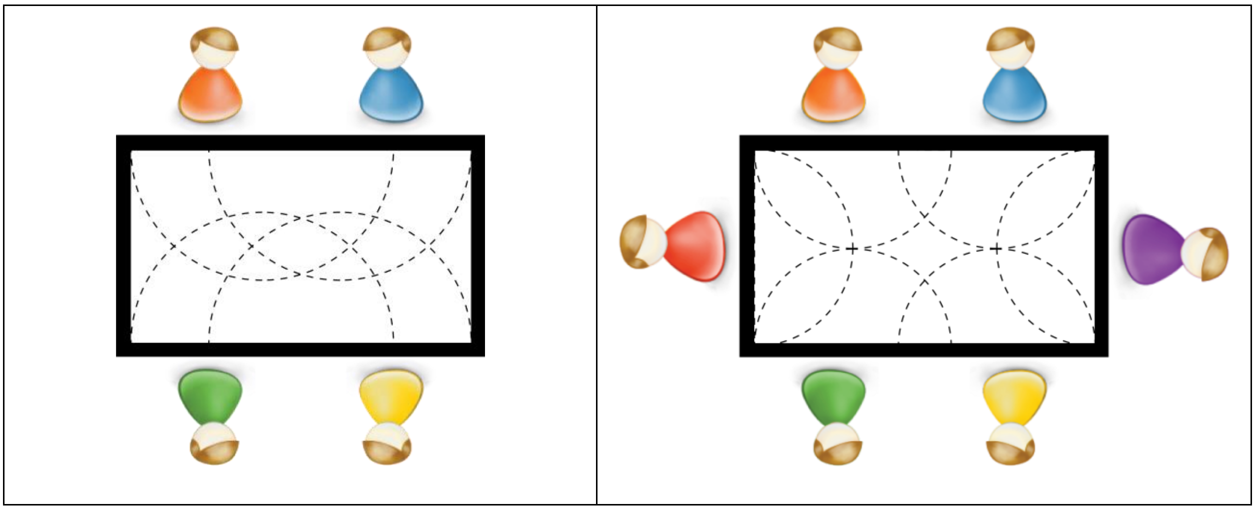


Figure 5-18: Possible arrangements and problem space division for four to six learners

The conclusion of this phase will produce a detailed design document. This design document should include specifics of all four elements in the form of storyboards, along with any major content and necessary media, such as graphics, video, audio and narration. The design document should also include a timeline that relates to specific tasks, resources etc.

5.7 Development/Release – Implementation

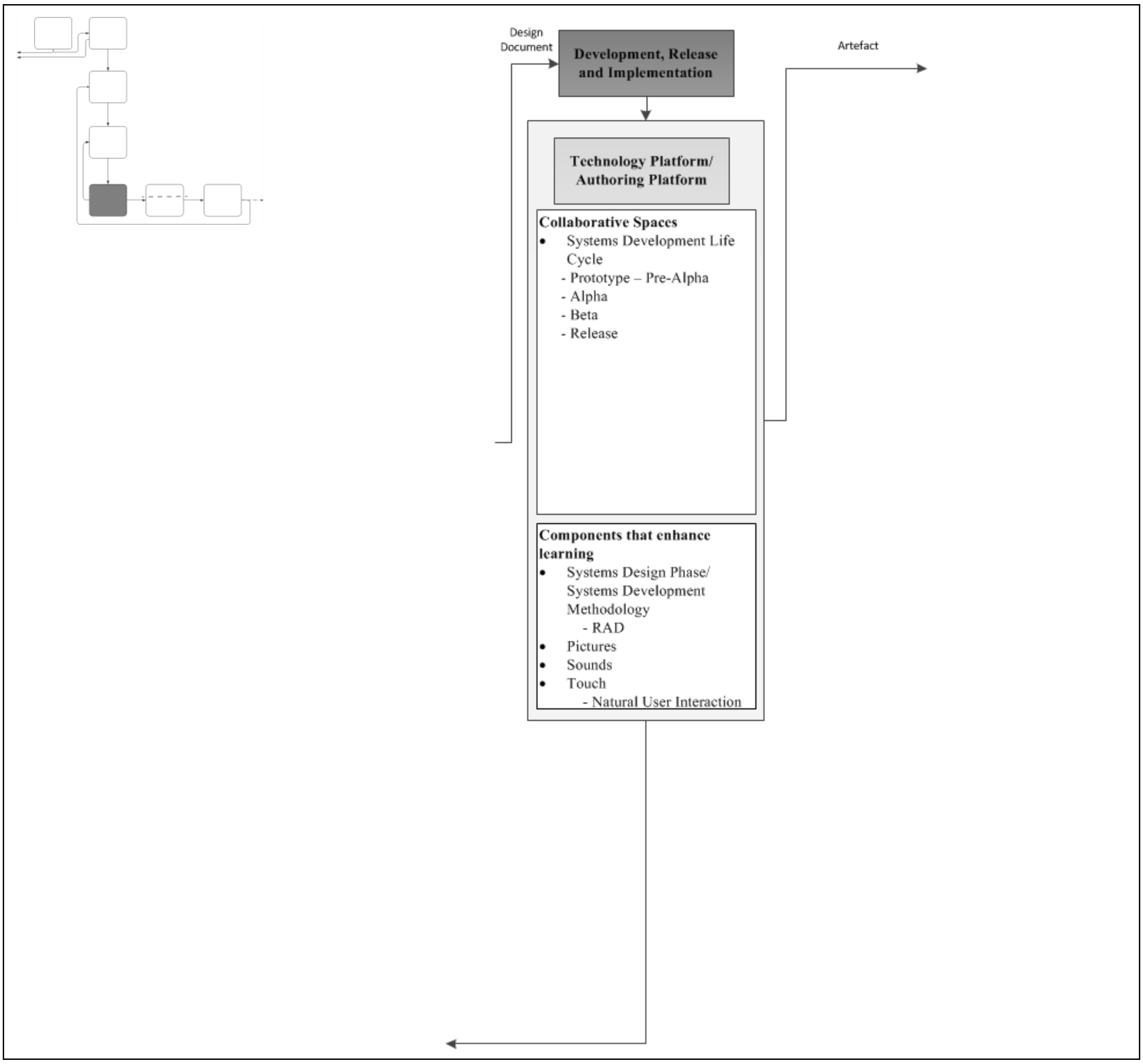


Figure 5-19: Phase Five - Development, Release and Implementation

5.7.1 Technology Platform/Authoring Platform

In this phase, the instructional designer may develop the learning application or subcontract to an external source to have a computer programmer develop the learning application. The developer will need to have an understanding of the technology platform, the platform specifications or the system requirements to ensure that it will be able to run the developed software. The Authoring Platform relates to the computer programming tool, the software language that will be used to create the collaborative learning application. The processes involved in this phase is not very different from that in the standard ISD and is therefore not a focus of this research but is necessary for an ISD model.

The focus of the type of collaborative technology selected for this research is the LSSDS. Much of the background was discussed in Chapter One, Section 1.2, which highlighted the benefits of this interactive technology and how it has been used in the past.

5.7.1.1 Components that Enhance Learning

This is followed by Author, Produce and Implement phase which is based on the Systems Development Life Cycles (SDLC). In developing any learning application, the output such as prototyping (pre-alpha stage), an alpha, beta and finally, implementation, the release of the artefact.

5.7.2 Development/Release Implementation Expected Output

Figure 5-20 is an example of the expected output at this point of the CISD model and would demonstrate a fully functional learning application.

Figure 5-20: The phonics learning application

5.8 Learning Event Instance Use of Artefact

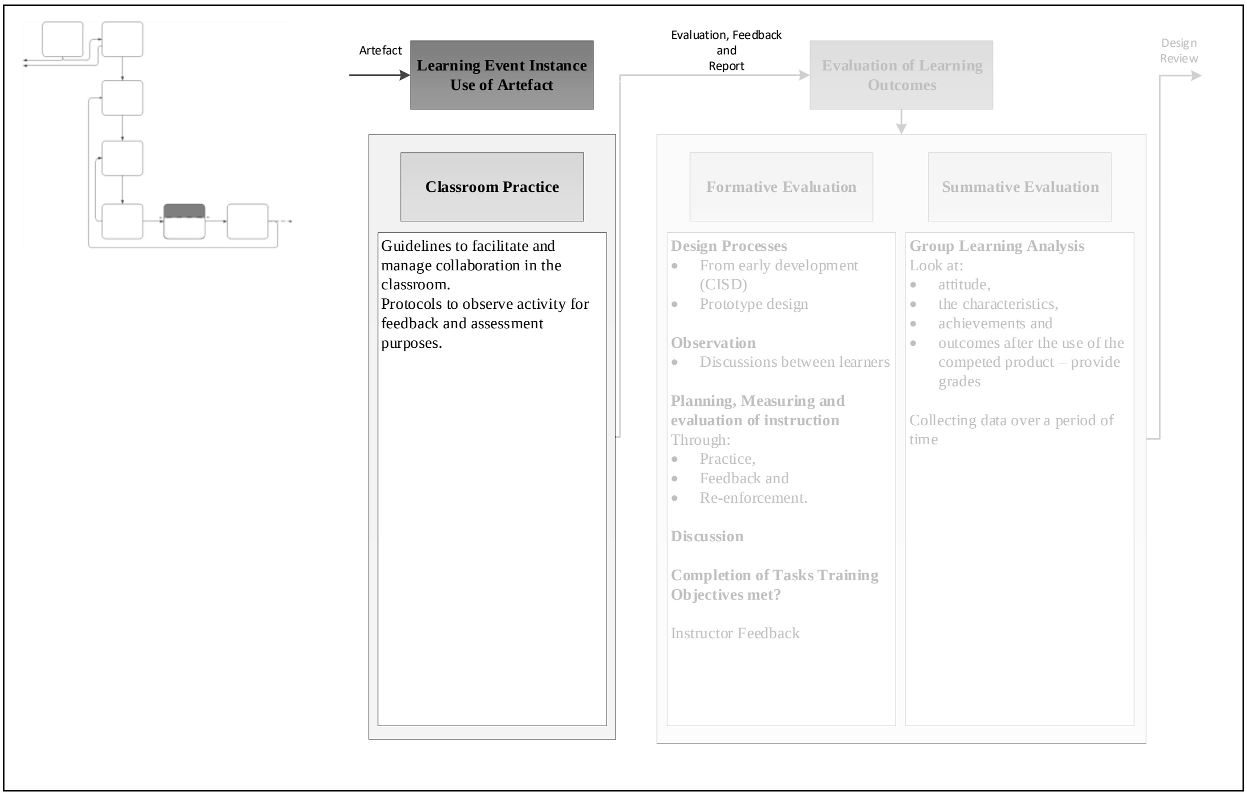


Figure 5-21: Phase Six - Learning Event Instance and Evaluation of Learning Outcomes – A focus on Learning Event Instance Use of Artefact

5.8.1 Classroom Practice

Learning Event Instance Use of Artefact (see Figure 5-21) is the phase that links the *Development* phase (see Figure 5-19) to the *Evaluation* phase (see Figure 5-22). *Learning Event Instance Use of Artefact* provides guidelines and protocols to facilitate, manage and observe collaborative activity in the classroom. The result of these guidelines and protocols are inextricably linked to the *Evaluation* phase in assisting to provide feedback for the final phase.

5.8.2 Learning Event Instance Use of Artefact Expected Output

As discussed above in 5.8.1, the outputs of this stage would consist of guidelines and processes for facilitating, managing and observing the collaboration taking place. Appendices A, B and D describe the research protocol used in the evaluation of the developed Phonics application, which provides an example of the guidelines and processes that can be used. For example, how students are introduced to the collaborative system, what data is collected about the collaborations, etc.

5.9 Evaluation of Learning Outcomes

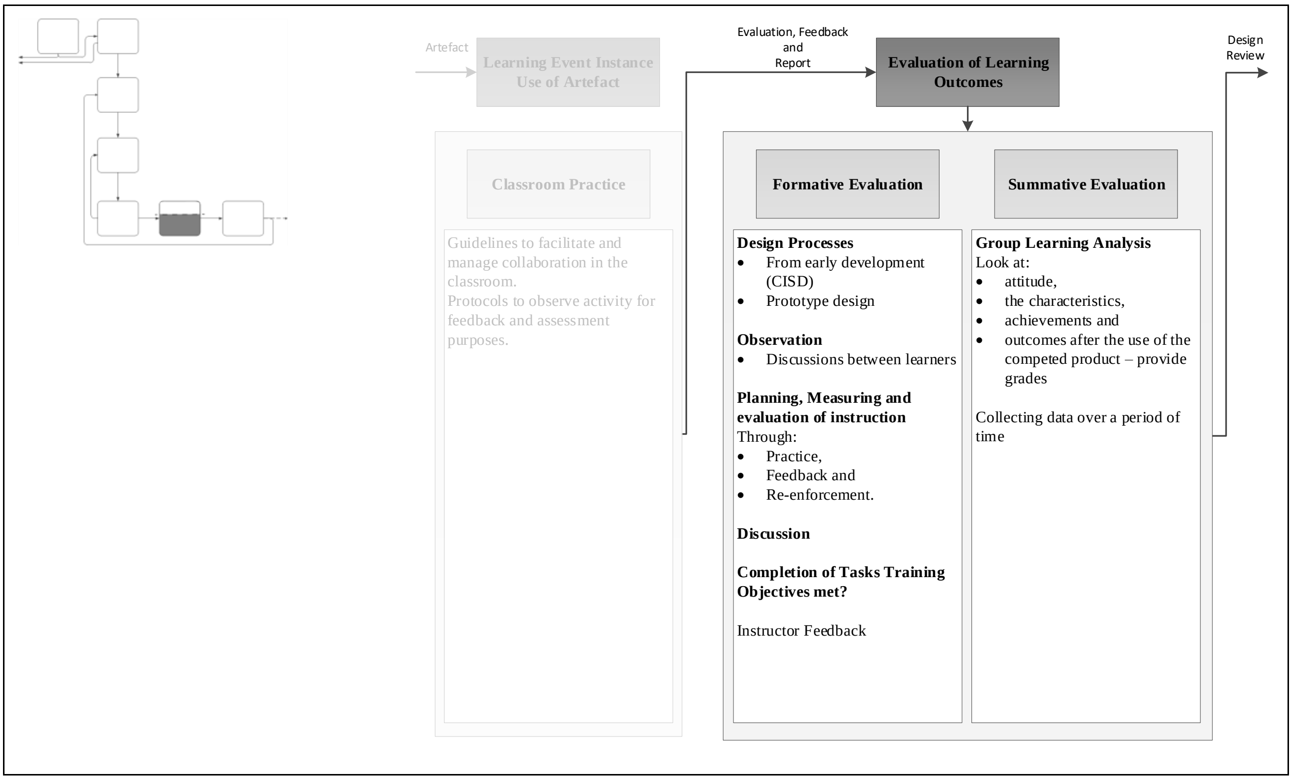


Figure 5-22: Phase Six - Learning Event Instance and Evaluation of Learning Outcomes – A focus on the Evaluation of Learning Outcomes

The *Evaluation* phase provides two evaluative outcomes: *The Evaluation of Learning Outcomes* and the *Evaluation of Design Outcomes*. The *Evaluation of Learning Outcomes* is user-centric which includes both formative evaluation and summative evaluation.

5.9.1 Formative Evaluation

Formative evaluation concentrates on observations such as group discussion, the completion of tasks and if the objectives were met. This also includes planning, measuring and the evaluation of instruction through practice, feedback, and re-enforcement.

5.9.2 Summative Evaluation

Summative Evaluation assesses attitudes, the characteristics, achievements, and outcomes of learners after the use of the completed product.

5.9.3 Evaluation of Learning Outcomes Expected Output

The expected output is a Design Review document. This document is produced to verify the design process and the outcomes of the previous activities and phases. This document will be used in the final phase, Process Evaluation/Reflection.

5.10 Evaluation of Design Outcomes

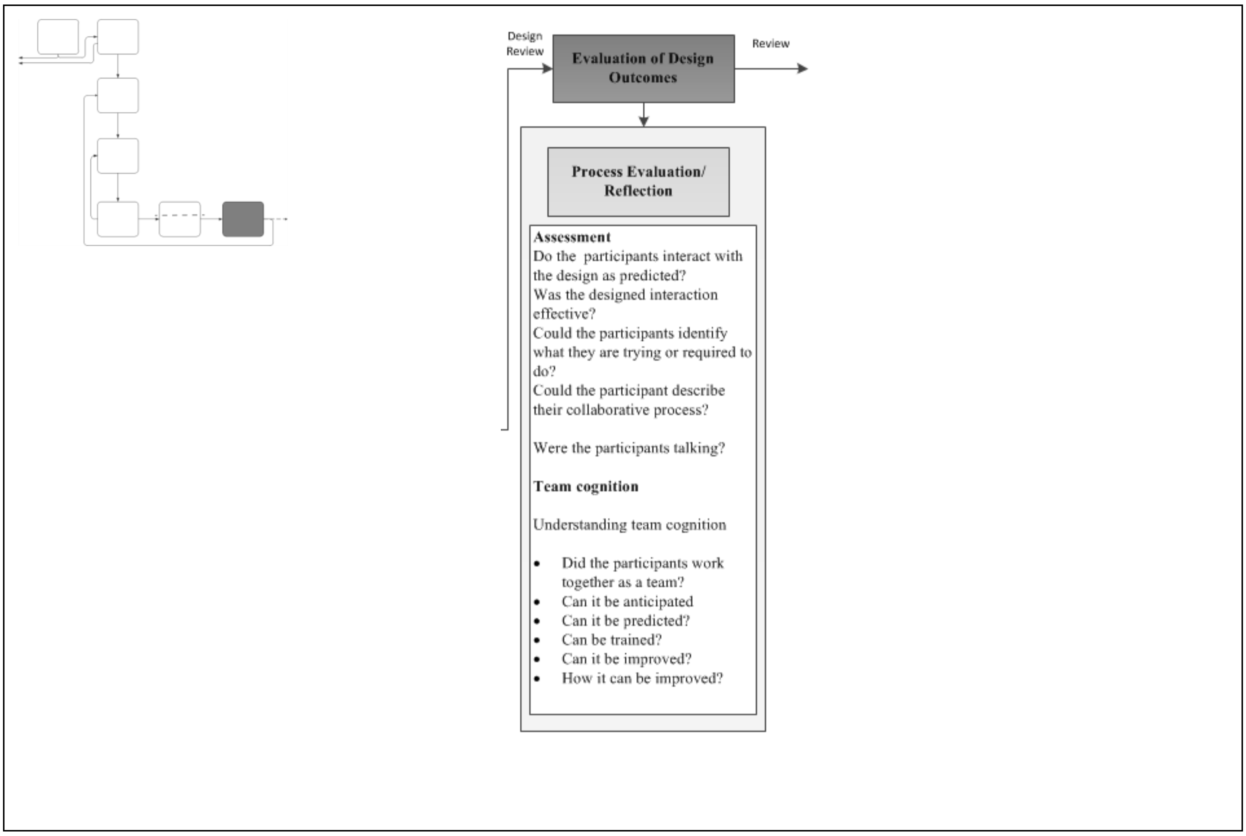


Figure 5-23: Phase Seven - Evaluation of Design Outcomes

5.10.1 Process Evaluation - Reflection

The *Evaluation of Design Outcomes* examines a number of factors relating to the effectiveness of the application design and understanding of learners interaction and collaborative engagement (see Figure 5-23).

The factors that need to be examined in regard to learner interaction include: assessing the nature of the interactions that occurred compared to the predicted interactions; the intuitiveness of the application in assisting participants to identify their learning objectives. Also, what the participants have to do and the ability of the learners to be able to describe their collaborative processes. Collaborative engagement relates to the likelihood that the design encouraged learners to work together; sharing knowledge through communication and exchanging information in order to establish common meaning.

5.10.2 Evaluation of Design Outcomes Expected Output

This is the final output where the Collaborative Instructional Designer would use the feedback based on the instructor/teacher Design Review report, and any other qualitative or quantitative data collected. This may include surveys, interviews, audio and/or video recordings and, consequently, produce a Process Review Report

5.11 The Complete Collaborative Instructional Systems Design Model

The CISD model, shown below, is highly detailed and multi-levelled, thus making it too large for one page. Presenting the model as a double gatefold demonstrates its complexity and highlights the flow between the components, making it easier to read.

The Collaborative Instructional Systems Design Model

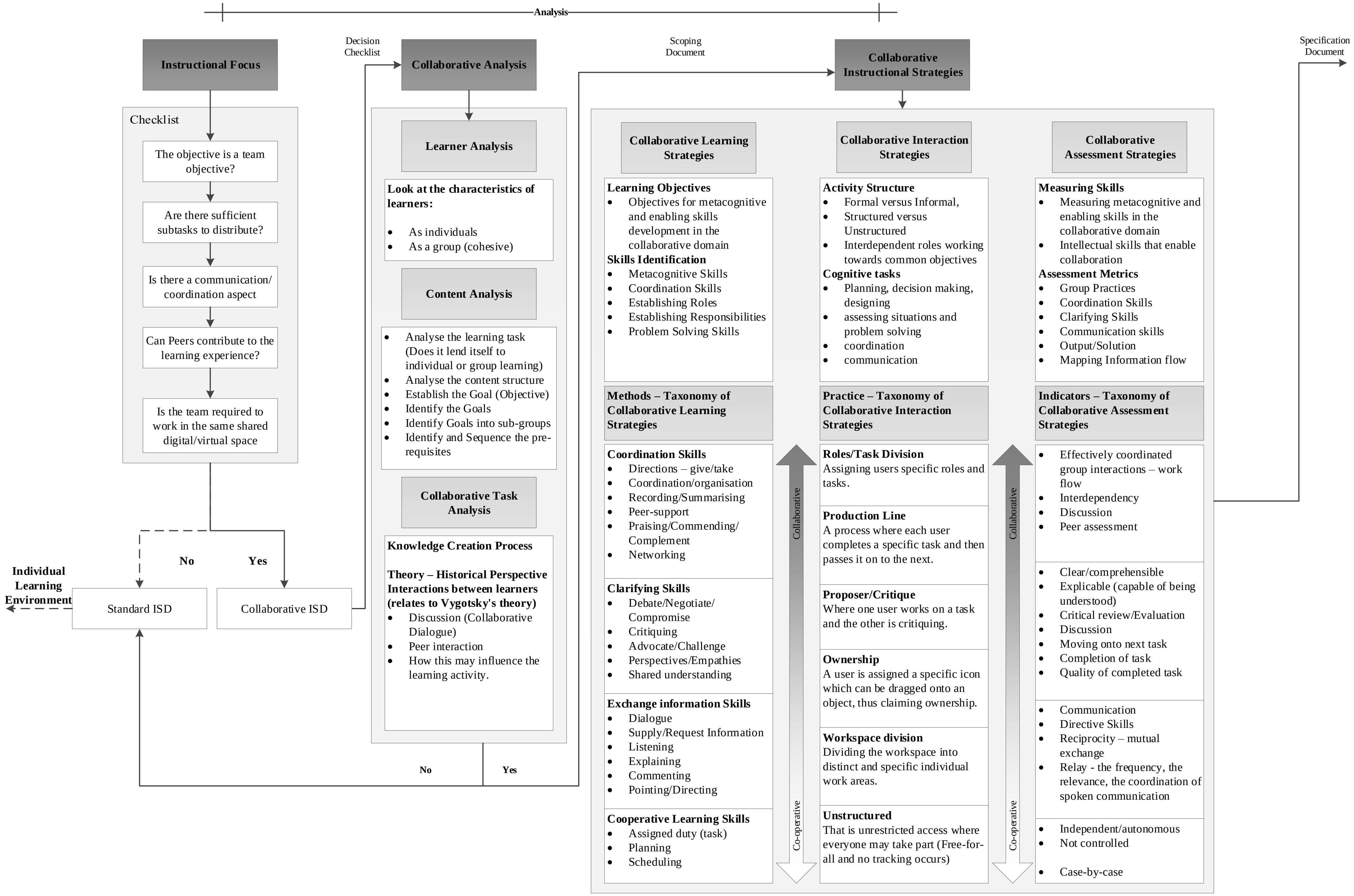
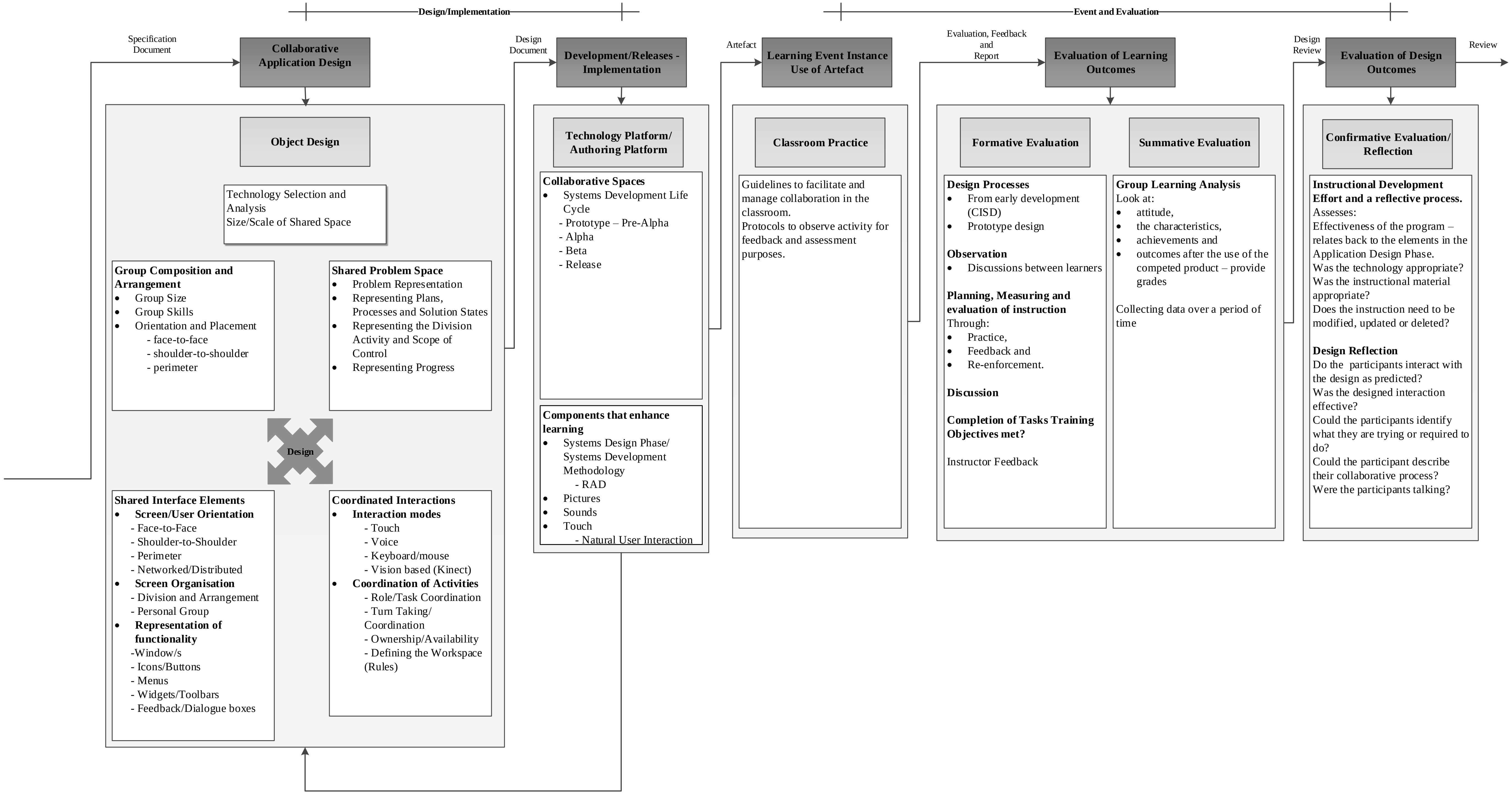


Figure 5-24: The comprehensive view of the Collaborative Instructional Systems Design Model



Design/Implementation
Event and Evaluation
Specification Document
Collaborative Application Design
Design Document
Development/Releases - Implementation
Artefact
Learning Event Instance Use of Artefact
Evaluation, Feedback and Report
Evaluation of Learning Outcomes
Design Review
Evaluation of Design Outcomes
Review
Object Design
Technology Selection and Analysis
Size/Scale of Shared Space
Group Composition and Arrangement
• Group Size
• Group Skills
• Orientation and Placement
- face-to-face
- shoulder-to-shoulder
- perimeter
Shared Problem Space
• Problem Representation
• Representing Plans, Processes and Solution States
• Representing the Division Activity and Scope of Control
• Representing Progress
Design
Shared Interface Elements
• Screen/User Orientation
- Face-to-Face
- Shoulder-to-Shoulder
- Perimeter
- Networked/Distributed
• Screen Organisation
- Division and Arrangement
- Personal Group
• Representation of functionality
-Window/s
- Icons/Buttons
- Menus
- Widgets/Toolbars
- Feedback/Dialogue boxes
Coordinated Interactions
• Interaction modes
- Touch
- Voice
- Keyboard/mouse
- Vision based (Kinect)
• Coordination of Activities
- Role/Task Coordination
- Turn Taking/ Coordination
- Ownership/Availability
- Defining the Workspace (Rules)
Technology Platform/ Authoring Platform
Collaborative Spaces
• Systems Development Life Cycle
- Prototype – Pre-Alpha
- Alpha
- Beta
- Release
Components that enhance learning
• Systems Design Phase/ Systems Development Methodology
- RAD
• Pictures
• Sounds
• Touch
- Natural User Interaction
Classroom Practice
Guidelines to facilitate and manage collaboration in the classroom.
Protocols to observe activity for feedback and assessment purposes.
Formative Evaluation
Design Processes
• From early development (CISD)
• Prototype design
Observation
• Discussions between learners
Planning, Measuring and evaluation of instruction
Through:
• Practice,
• Feedback and
• Re-enforcement.
Discussion
Completion of Tasks Training Objectives met?
Instructor Feedback
Summative Evaluation
Group Learning Analysis
Look at:
• attitude,
• the characteristics,
• achievements and
• outcomes after the use of the competed product – provide grades
Collecting data over a period of time
Confirmative Evaluation/ Reflection
Instructional Development Effort and a reflective process.
Assesses:
Effectiveness of the program – relates back to the elements in the Application Design Phase.
Was the technology appropriate?
Was the instructional material appropriate?
Does the instruction need to be modified, updated or deleted?
Design Reflection
Do the participants interact with the design as predicted?
Was the designed interaction effective?
Could the participants identify what they are trying or required to do?
Could the participant describe their collaborative process?
Were the participants talking?

5.12 Summary

This chapter explored various theoretical aspects that were incorporated into the new CISD model, such as Collaborative Learning, Collaborative Learning Environments, the Sociocultural Theory of Learning, Distributed Cognition Theory, and Instructional Systems Design. When designing a learning application, educators such as teachers and professional specialists, use ISD and Bloom's Taxonomy to design learning activities that focus primarily on individual learners and individual learning tasks. When designing instructional material for multiple learners working synchronously and face-to-face in collaborative learning environments, a new CISD model has been proposed. This new CISD model is important as it provides a sequence of interdependent phases that will be well suited when designing for interactive technologies such as LSSDS. At the completion of each interdependent phase, there is an output produced to assist in the following phase. The main focus is on the first four phases, and emphasis has been placed on the third phase; *Collaborative Instructional Strategies* and their related Taxonomies, which is seen as being an important contribution to this research field. *Collaborative Instructional Strategies* proposed three new and significant domains and related multi-tiered taxonomies to provide a systematic and methodological plan, assisting in the development of collaborative instructional materials.

Chapter Six Stage One: Application Development presents an example output of the new CISD model, in the form of a redesigned phonics learning application. This redesigned phonics learning application pertains to the Evaluation Methodology - Stage One: Application Development. This learning application provides evidence of the output of the new CISD model and will also be used as a research instrument for the Student/Teacher Observational Study.

6 Stage One: Application Development

6.1 Introduction

Chapter Four presented the design procedure of the Collaborative Instructional Systems Design model (CISD). Chapter Five discussed the features of the CISD model in detail, providing an analysis of each phase and the expected outputs. To evaluate the functionality of the CISD model and as part of the design process, this chapter presents examples of a learning application specifically designed for an LSSDS context. The chapter records the outputs of the CISD Model at each stage of the process, phase-by-phase. The development of the phonics learning application will be aligned with each phase of the CISD and will be used as a research instrument for the first part of the next activity of the methodology, Stage One: Application Development (see Figure 6-1).

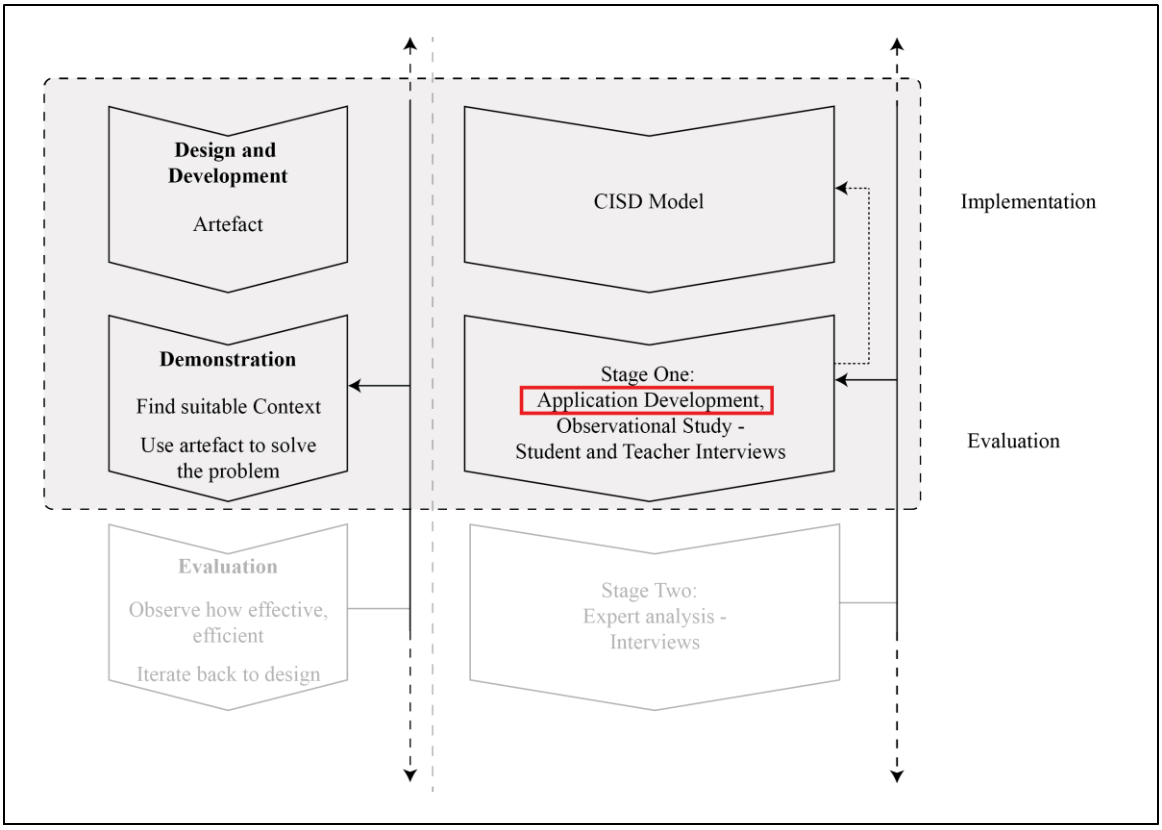


Figure 6-1: Implementation of the new CISD Model and Stage One: Application Development

6.2 A Phonics Application - some background

The Australian Victorian Essential Learning Standards (AusVELS – Now the Victorian Curriculum and Assessment Authority) for the English curriculum in Foundation to Level 6, incorporates three interrelated strands of Language, Literature and Literacy (Australian Curriculum, 2015). A component in the first five years of the Literacy strand from Foundation year to Level 4 incorporates phonics as part of student learning. AusVELS defines the term phonics as a skill whereby a learner is able to recognise letters and sounds when reading and spelling (Australian Victorian Essential Learning Standards, 2012).

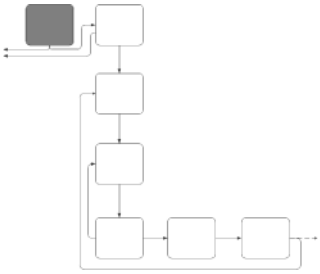
There are two main traditional phonics approaches: Synthetic phonics and Analytical phonics. Synthetic phonics focuses on individual letter shapes (grapheme) and associating the letter sounds (phonemes) to blend and make words, for example: /c/a/t/. Analytical phonics focuses on previously learned whole words that are broken into components and is based on spelling, letter patterns such as rhyme and word families and their sounds. For example, the word is *cat*, the middle letter of this word is a short /a/ sound. Here is a list of words that have a similar sound - sat, mat, fat, and bat.

This design process will focus on the first approach, synthetic phonics, as it is an approach used to decode printed text to assist students to develop an understanding of the alphabetic principle and is also used in remedial literacy instruction. It is a sound-to-symbol skill which provides students with a connecting link between a string of letters and a word (Hiskes, 2011; Mellanby & Theobald, 2014). Central to the sound-to-symbol skills are two basic principles: phonemic awareness and phonics instruction. Phonemic awareness is an understanding that spoken words contain individual and independent letter sounds known as phonemes. For example, *cat* contains three phonemes, c/a/t/. Phonics instruction provides the learner with the skill to connect and blend the independent letter sounds, or phonemes, to the appropriate letter shape. Phonics instruction enables the learner to read and spell words.

The development of designing the phonics learning application is aligned with the CISD model in order to provide learners with a reading technique in a collaborative environment. This phonics learning task (see Figure 6-6: The Phonics Learning Task Breakdown) is designed as a two-player collaborative learning application in the form of a game. Note, a similar phonics application was developed previously as part of an Honours project (McGivern, 2010) but has been extensively redesigned for use as a research instrument in this research project.

The following are design process examples describing the development of the phonics learning application and example outputs at each stage of the CISD Model.

6.3 Instructional Focus



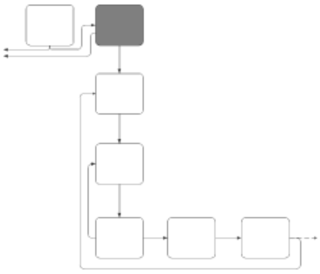
6.3.1 Design Process Example: Instructional Focus

The decision checklist (see Figure 5-3) demonstrates the process of determining if the phonics application meets the required criteria for a collaborative learning approach. The fundamental principle of phonics is that the learners are expected to acquire and develop skills whereby a letter sound (phoneme) and letter shape (grapheme) belong together. By placing two learners together, it is expected that information via dialogue, and even by the body or facial expression, would be exchanged. Articulating letter sounds and exploring letter shapes is an activity well suited to the social interaction between learners and can readily be hosted in one LSSDS. In going through the checklist, if the criteria are met and the feedback points to 'Yes', then the instructional designer can continue and move to the next phase, Phase Two - *Collaborative Analysis*.

Instructional Focus Decision Checklist		
Instruction Type: Phonics Application		
	Yes	No
Is the objective a team objective?	☑	☐
What are the team objectives? exchange information using dialogue, understanding letter shapes & sounds.		
Are there sufficient subtasks to distribute?	☑	☐
Describe the subtasks? phonemic awareness, phonics, vocabulary development, reading fluency/comprehension strategies.		
Is there a communication/coordination aspect?	☑	☐
Describe possible communication/coordination aspects? Verbal, haptic.		
Can Peers contribute to the learning experience?	☑	☐
Is the team required to work in the same shared digital/virtual space?	☑	☐
Recommendation to continue?	☑	☐
Notes: Components to assist in providing basic literacy skills.		

Figure 6-2: The checklist to determine if a Phonics Application is feasible.

6.4 Collaborative Analysis



Phase Two: *Collaborative Analysis* specifies the Learner Analysis, Content Analysis, and Collaborative Task Analysis. The output below (see Section 6.4.1) has been determined by each sub-phase within this part of the model. To begin with, Learner Analysis describes the demographics of the learner, the age of the target audience, the type of the phonics learning application, and the purpose. Content Analysis begins with a point-by-point analysis of the learning task. Phonics is an excellent example as words can be broken down and decoded into individual components and then sequenced between the two learners (see Figure 6-3 and Figure 6-4). At the completion of the tasks, the roles will be reversed, and the sequence begins again.

6.4.1 Design Process Example: Collaborative Analysis

Collaborative Analysis

Learner Analysis

Look at the Characteristics of learners:

- **As Individuals**
- **As a Group (cohesive)**

Description of Learner Analysis:

The Phonics Learning Application.
The target audience for the phonics learning application is primary school students – Foundation to Level 4.
Synthetic phonics has been identified as the method to be used for this case study. The purpose of this phonics learning task is to engage pairs of students in a collaborative social context on a large-scale shared digital space.

Content Analysis

1. Analyse the learning task (Does the task lend itself to individual/group learning)

Provide three letter words with corresponding images, break down words into individual sounds and letters shapes, sound-to-symbol, and learn to associate letter sounds to letter shapes, sound out letters and blending letters to form words.

2. Analyse the content Structure

Synthetic phonics – blend graphemes and phonemes to make words. e.g. /c/a/t/

The players will learn two basic components:
Phonemic awareness – the individual letter sound structure within the spoken word
Phonics – the relationship between phonemes, the sounds of spoken language, and graphemes, the letters in the written language.
Approx. 100 3 letter words have been identified.

3. Establish the Goal (Objective)

The phonics learning task will provide students with the ability to identify and blend letter shapes, graphemes, and letter sounds, phonemes, to make words. Through activity, dividing the roles, distributing the tasks and setting goals and discussion learners will develop and strengthen their understanding of how they can improve their reading skills.

Figure 6-3: Collaborative Analysis, Design Process Example Page One

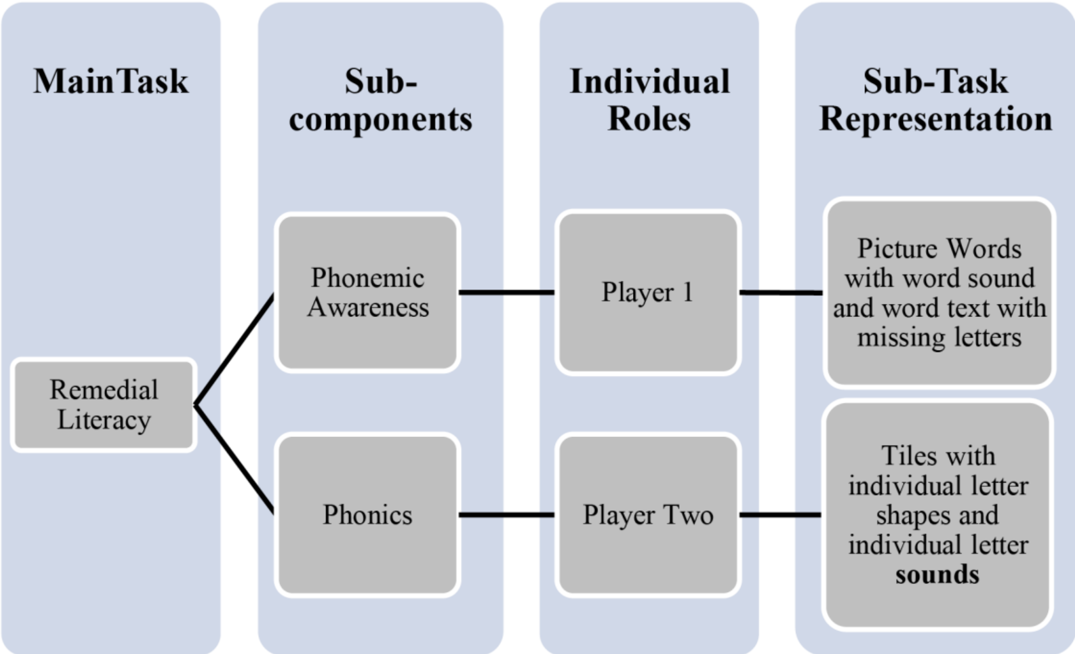
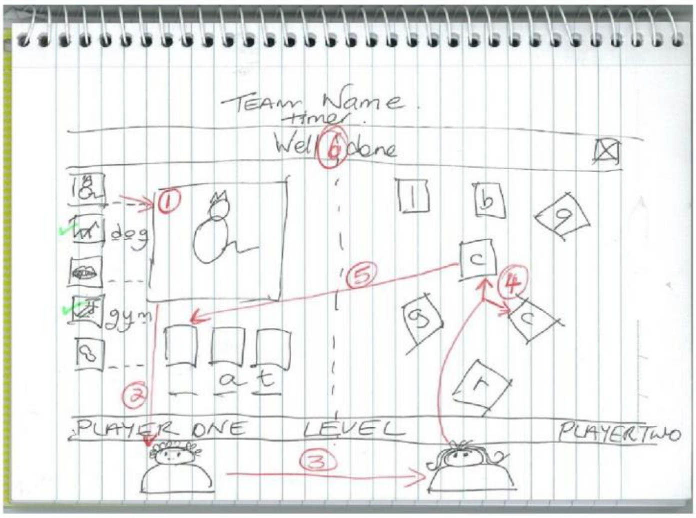
4. Identify the Goals
Two players will obtain basic literacy skills to assist in remedial literacy. The players will learn two basic components: Phonemic awareness – the individual letter sound structure within the spoken word Phonics – the relationship between phonemes, the sounds of spoken language, and graphemes, the letters in the written language.
5. Identify Goals into sub-groups
The goals are broken into sub groups. On completion the roles will reverse. 
6. Identify and sequence the prerequisites
This phonics game is in two player mode. The numbered items and solid arrows indicate the game flow. The divided arrows represent the players thought process. To begin the phonics game: Player One selects a picture-word image (1) from a list of five random words, listens to the word sound (2) and requests the missing text letter, articulating the letter sound, from Player 2 (3). Player 2 taps any letter, listening for the missing letter sound, selects the best matching letter (4) and with their finger/s, directly manoeuvres the object by flicking it across to Player 1. The final step in the process requires Player 1, also using their finger/s, manoeuvres the letter tile into the missing placeholder (5) and the appropriate feedback is given (6).

Figure 6-4: Collaborative Analysis, Design Process Example Page Two



The players roles are then reversed, and the process begins again

Collaborative Task Analysis
Knowledge Creation Process

1. Collaborative Theories

Theory of Sociocultural learning - Lev Vygotsky

Vygotsky saw social interaction as being an important part in the development of cognition, known as the sociocultural principle, which begins long before formal school education. The sociocultural principle puts forward the approach that development relating to how children learn is 'interpersonal': beginning on a social level by sharing information through discussion with their peers, externally, and then 'intrapersonal': moving to an individual level, internally.

2. Discussion/Peer Interaction - How this may influence the learning activity

Assesses the knowledge creation process and looks at the historical perspective of learning, in relation to Vygotsky's sociocultural theory: that in a social context the learners acquire knowledge by sharing information, through the use of dialogue/discussion and with peer interaction.

3. Learning Environment – How this may influence the learning activity

Large-scaled shared digital spaces that have opened doors to new research areas, particularly in the area of education by providing new interactive learning environments. Typically, these devices feature touch sensitive displays of over 50 inches (diagonal) in size, with a resolution high enough to allow up to eight learners to work synchronously and face-to-face. The unique feature of this new technology is that it allows multiple simultaneous user inputs by touching the surface of the display rather than by using a mouse. Therefore, multiple learners can be active at the same time

Figure 6-5: Collaborative Analysis, Design Process Example Page Three

Figure 6-5 presents the third sub-phase; Knowledge Creation Process, which discusses the theoretical background of Vygotsky's Sociocultural Theory (see Section 2.5.1), that has influenced this learning application. After Vygotsky's theory, there is a discussion on Peer Interaction and the type of learning environment, and how the learning process affects these peers in this social context by working in this new LSSDS learning environment.

A more formal representation of the process is shown in Figure 6-6. The numbered items and solid arrows indicate the game flow and the blue dotted arrows represent the players' decision processes.

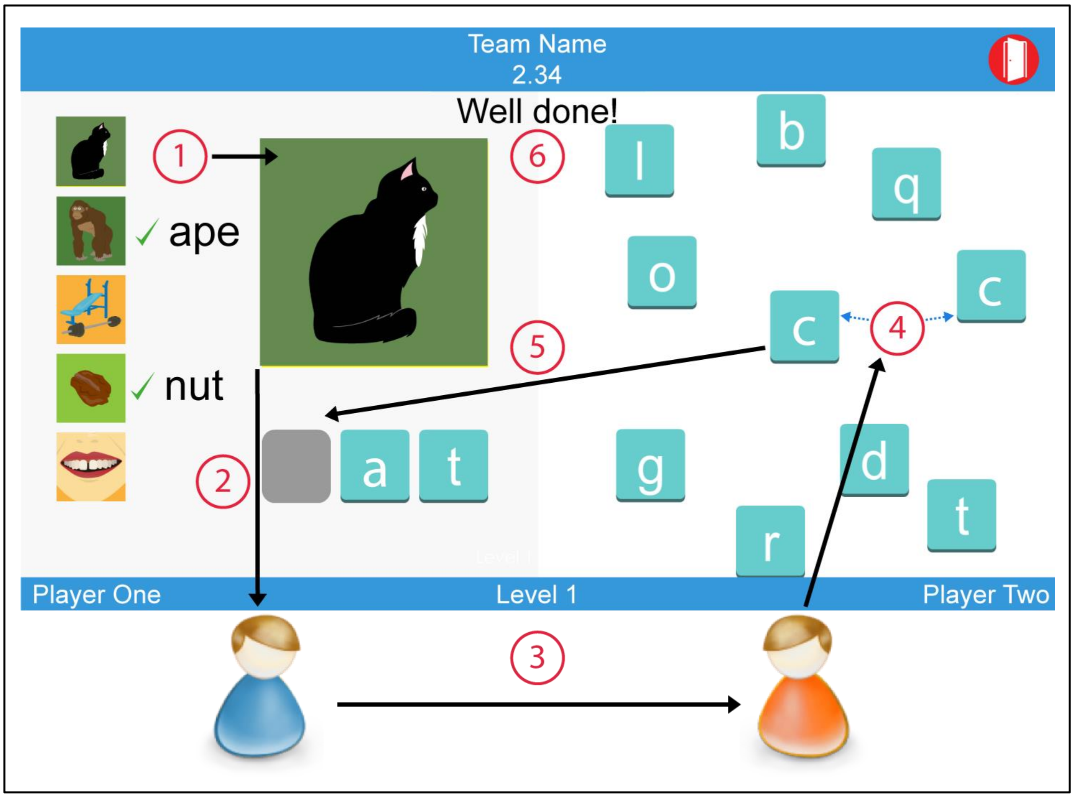
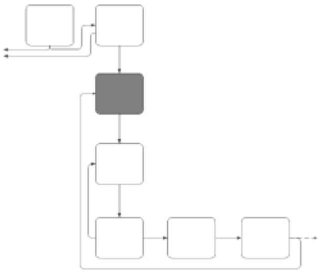


Figure 6-6: The Phonics Learning Task Breakdown

To begin the phonics game, Player 1 selects a picture-word image (1) from a list of five random words. The player then listens to the word sound (2) and requests the missing text letter, articulating the letter sound, from Player 2 (3). Player 2 taps any letter, listening for the missing letter sound, selects the best matching letter (4) and with their finger/s, directly s the object by flicking it across to Player 1. The final step in the process requires Player 1, also using their finger/s, to manoeuvre the letter tile into the missing letter placeholder (5), and the appropriate feedback is given (6). Players can discuss each step of the process with their peer and the roles are reversed after a period of activity.

6.5 Collaborative Instructional Strategies



Phase Three proposes three collaborative strategies and their related taxonomies. The *Collaborative Instructional Strategies* Form (see Figure 6-7 and Figure 6-8) describes the phonics learning activity for each approach.

Collaborative Learning Strategies – Learning Objectives looks at metacognitive and enabling skills development. The learning activity is being developed for children at a certain level of remedial literacy. Therefore, it will focus on specific skills development rather than metacognitive skills. It is anticipated the learners will bring some previous knowledge, as in what they already know, and their own past experiences. For this learning activity, Synthetic Phonics has been identified as the most appropriate method as it teaches the relationship between the letter shape and the letter sound explicitly. Learners are taught about individual sound structure within the spoken word and, by listening to the spoken word, recognise phonemes—the letter sound, and graphemes—letter shapes. The learning activity is set for two players and, based on the output from Section 6.4.1, the tasks have been divided and distributed. The design of the activity would encourage all the identifying skills, as these will be built into the learning activity. Concerning the taxonomies for *Collaborative Learning Strategies – Methods*, the learners should be able to accomplish all of them.

Collaborative Interaction Strategies – describes the structure of the activity. This learning activity is formal and structured. The taxonomies related to this phonics learning activity is specific to four of the Practice taxonomies:

- *Workspace Division* – the learners are placed into distinct and specific areas on the screen;
- *Proposer/Critique* – where one learner will be working on a task and the other learner will assess whether the job has been completed correctly;
- *Production Line* – where one learner will complete a specific task and pass it to the other learner;
- *Roles/Task Division* – designing the learning activity to be fully collaborative by assigning roles and dividing and distributing the tasks between the learners and, consequently, enhancing learning.

This application uses *Workspace Division* and *Roles/Task Division*, as the learners are placed into distinct and specific areas on the interactive screen. They are also given specific sub-tasks to do that require collaboration and discussion.

Finally, *Collaborative Assessment Strategies* is an observable, hierarchical classification type where one would expect to see some of the many assessment metrics listed. The skills that are to be measured are discernible and relate to how the group of learners worked together as a team. Other aspects that one would expect to be noticeable are the team's communication skills, as in, what they did and said to complete the learning task. The learner may have corrected their action, or the other team member may have adjusted the wrong move. For example, here is one possible scenario: Player One may have touched the main image and identified and requested the missing letter sound. The missing letter has two phonic sounds, a long sound or a short sound. Player One may or may not identify and ask for the correct tile. Player Two tries to determine the right letter tile to pass over to Player One. Player Two begins to pass over the incorrect letter tile. Using self-evaluation, Player Two may identify that the letter tile was wrong and retract it, then select and pass over the correct letter tile. Alternatively, Player Two hands over the incorrect letter tile and Player One passes it back, stating that it is the wrong letter sound. These would be observable interactions that can be used to assess the quality of the collaborative interaction.

Some observations may consist of actions or behaviours that occurred to ensure task completion, or the forms of communication or directive skills that happened between the learners, such as pointing, or a verbal statement. There are numerous possibilities.

6.5.1 Design Process Example: Collaborative Instructional Strategies

Collaborative Instructional Strategies Form		
Subject: The Phonics Application		
Collaborative Learning Strategies	**Collaborative Interaction Strategies**	**Collaborative Assessment Strategies**
Learning Objectives	Activity Structure	Measuring Skills
Objectives: • for metacognitive and enabling skills development in the collaborative domain	Activity: • Identify the activity structure and tasks • Formal versus Informal • Structured versus Unstructured • Interdependent roles working towards common objectives	Measuring: • Metacognitive and enabling skills in the collaborative domain. • Intellectual skills that enable collaboration
Describe Learning Objectives	**Describe Activity Structure**	**Describe Skills to Measure**
Synthetic phonics **2 player phonics game** **Phonemic Awareness – individual sound structure within the spoken word.** **Phonics** • **Phonemes – letter sounds** • **Graphemes – letter shapes** **Players' tasks have been divided.**	**5 pictures load on one side of the screen/an array of letter tiles appears on the other side of the screen. P1 has to touch a picture tile; the game loads the picture and the letter tiles. P1 listens to the word, identifies the missing letter sounds and requests P2 for the missing letter tile, by sound. P2 identifies and selects appropriate letter tile and passes it to P1. P1 places the letter tile into the empty slot/s to complete the word. It the word is correct, the next picture word tile loads. When 5 picture words are complete, the player's roles swap and the process begins again.**	**How does the group work as a team?** **Do they communicate?** **Do they self-correct or does one player correct the other player?**

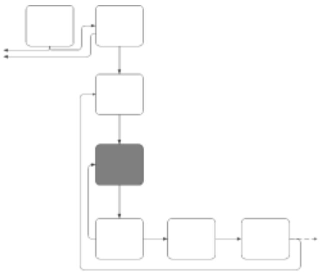
Skills Identification		**Cognitive Tasks**		**Assessment Metrics**	
☑	Metacognitive Skills	☑	Planning, Decision making, design	☑	Group Practices
☑	Coordination Skills	☑	Assessing situations and problem solving	☑	Coordination Skills
☑	Establishing Roles	☑	Coordination	☑	Clarifying Skills
☑	Establishing Responsibilities	☑	Communication	☑	Communication Skills
☑	Problem Solving Skills			☑	Output/Solution
				☑	Mapping Information Flow

Figure 6-7: Collaborative Instructional Strategies, Design Process Example Page One

Notes:					
TAXONOMIES					
METHODS		**PRACTICES**		**INDICATORS**	
Coordination Skills		**Roles/Task Division**		**Coordination Behaviours**	
☑	Directions – Give/take	☑	Planning, Decision making, design	☑	Effectively coordinated group interactions – work flow
☑	Coordinate/Organisation			☑	Interdependency
☑	Recording/Summarising			☑	Discussion
☑	Peer Support			☑	Peer Assessment
☑	Praising/Complementing/ Complement	**Production Line**			
☑	Networking	☑	A process where each user completes a specific task and then passes it onto the next		
				Clarifying Behaviours	
Clarifying Skills				☑	Clear/Comprehensible
☑	Debate/Negotiate/ Compromise			☑	Explicable (capable of being understood)
☑	Critiquing	**Proposer Critique**		☑	Critical review/Evaluation
☑	Advocate/Challenge	☑	Where one user works on a task and the other is critiquing	☑	Advocate
☑	Perspectives/Empathies			☑	Moving onto next task
☑	Shared Understanding			☑	Completion of task
		Ownership		☑	Quality of completed task
		☐	A user is assigned a specific icon which can be dragged onto an object thus claiming ownership		
Exchange Information Skills				**Exchange Information Behaviours**	
☑	Dialogue			☑	Communication
☑	Supply/Request Information			☑	Directive Skills
☑	Listening			☑	Reciprocity – mutual exchange
☑	Explaining	**Workspace Division**		☑	Relay – the frequency, the relevance, the coordination of spoken communication
☑	Commenting	☑	Dividing the workspace into distinct and specific individual work areas.	☑	Gestures
☑	Pointing/Directing				
Cooperative Learning Skills				**Cooperative Learning Behaviours**	
☑	Assigned duty (task)	**Unstructured**		☑	Independent/Autonomous
☐	Planning	☐	That is unrestricted access where everyone may take part (Free for all and no tracking occurs)	☑	Not Controlled
☐	Scheduling			☑	Case-by-case

Figure 6-8: Collaborative Instructional Strategies, Design Process Example Page Two

6.6 Collaborative Application Design



The design process begins with the technology selection, the Large-Scale Shared Digital Space (LSSDS). The Display Dimensions for this selected technology are as follows; Screen size: 1086.7 x 638.3 x 68.6 mm; Screen Resolution: 1920 x 1080 (3M™ Multi-Touch Display C4667PW, 2014). This screen size accommodates two players with ease.

6.6.1 Design Process Example: Collaborative Application Design

The process of the learning application design begins with a simple wireframe (see Figure 6-10). As a design method, a wireframe is described by Steane (2014, p. 50) as "… simple outlined representations of screen elements … ". The wireframe represents the shared problem space and presents the initial screen layout based on the simple paper-based sketch, shown below, and discussed in Section 6.3.1.

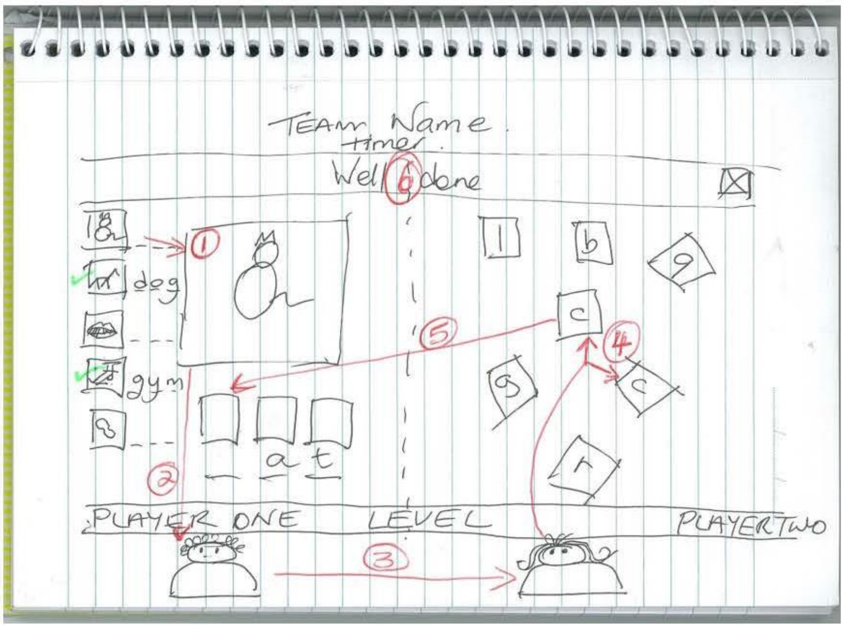


Figure 6-9: Initial paper-based sketch extract from Figure 6-5.

The phonics learning application is divided into two active areas. It is these two active areas where all the learning will take place. The screen orientation is in landscape mode, allowing players to work collaboratively, shoulder-to-shoulder.

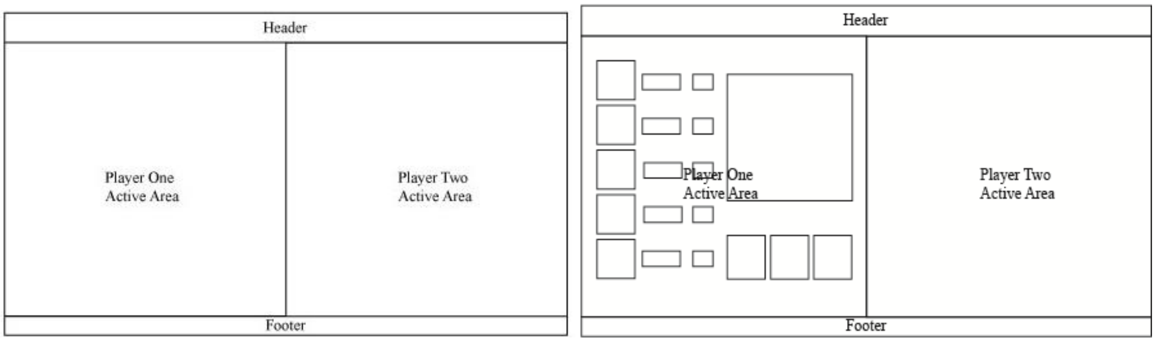


Figure 6-10: Object Design process begins with a simple wireframe

One hundred and three words, each containing three letters along with their related images, have been selected for this learning application. Some examples are shown in Figure 6-12. These three letter words convert into seven game levels that increase in complexity as the game progresses.

Level 1 with the first letter missing, e.g. _nt
Level 2 with the last letter missing, e.g. an_
Level 3 with the middle letter missing, e.g. a_t
Level 4 with the first and second letter missing, e.g. _ _ t
Level 5 with the second and last letter missing, e.g. a _ _
Level 6 is the first and last letter missing, e.g. _ n _
Level 7 where all letters are missing, e.g. _ _ _

Figure 6-11: A break up of the phonics learning application.

Within each level, five words and their related picture tiles are to be randomly selected and presented, with the player having three tries per word.

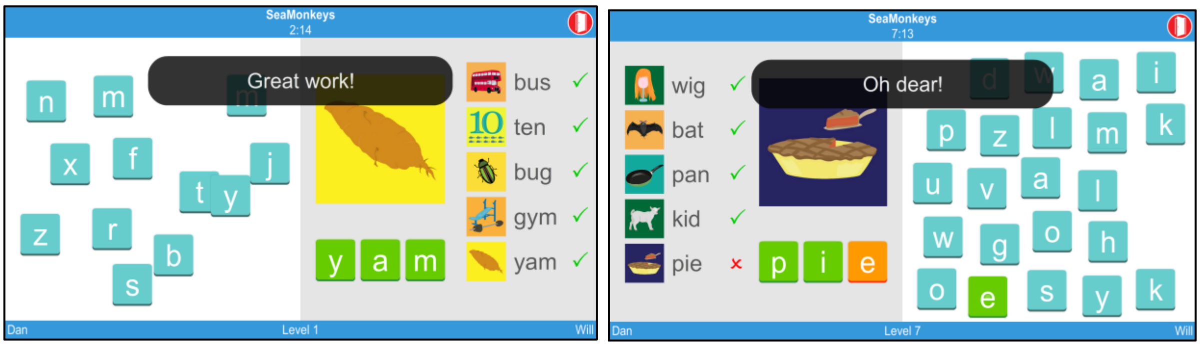


Figure 6-12: An example of Level 1 and Level 7

As the game level of complexity increases, so do the number of missing letter tiles, challenging the learner. Figure 6-13 presents the functionality of the phonics learning application in the form of a flow diagram. This flow diagram presents the division and sequence of the activities.

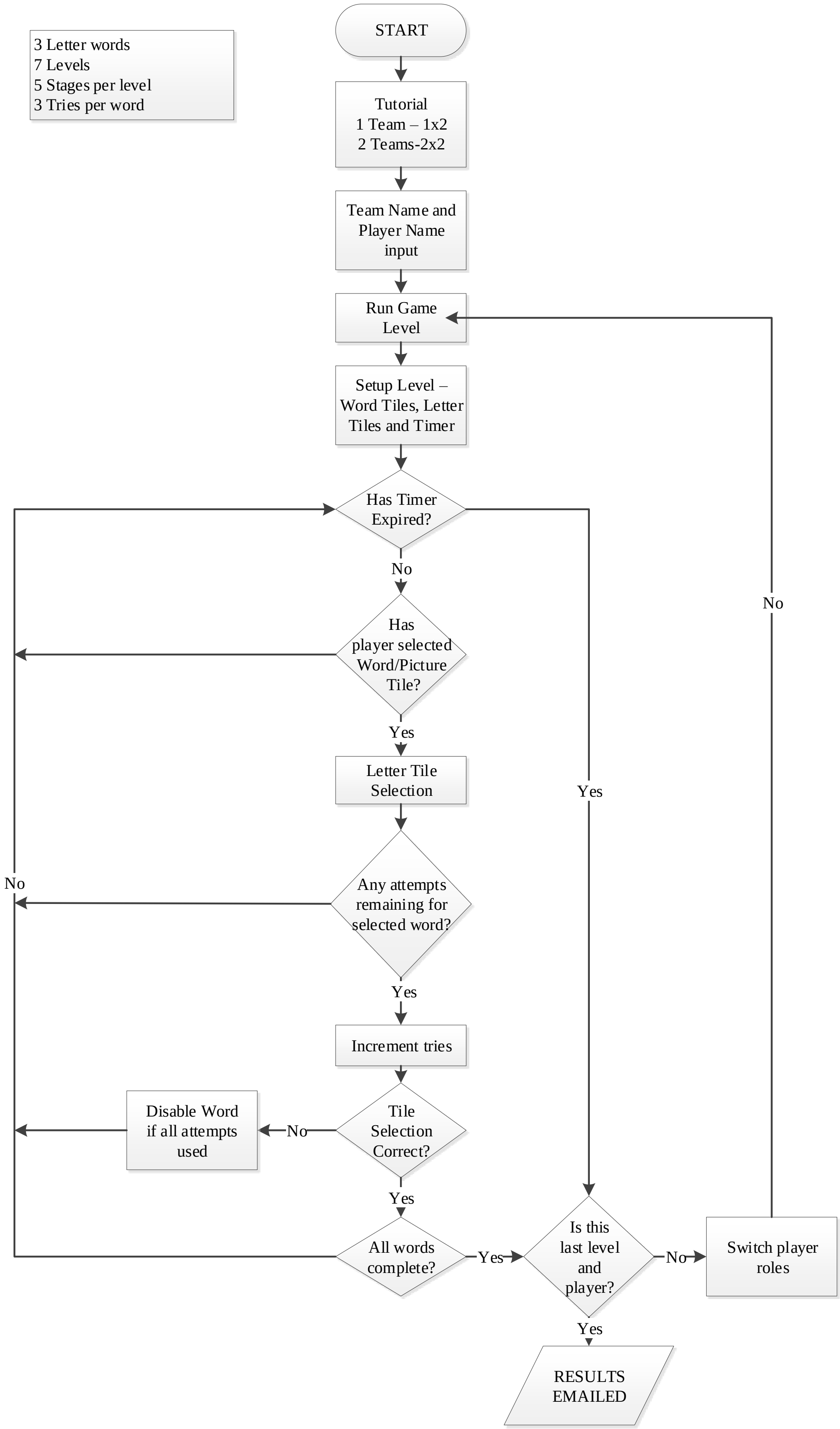


Figure 6-13: Flow diagram representing the division activity and scope of control

Below are examples of the design screens based on the Shared Interface Elements. Figure 6-14 is the first image, which is the populated version of the wireframe. This gameplay screen is a detailed view that includes the functionality of the window (the problem space), buttons and feedback dialogue boxes. Figure 6-15 is a similar view that contains the colour palette for each element.

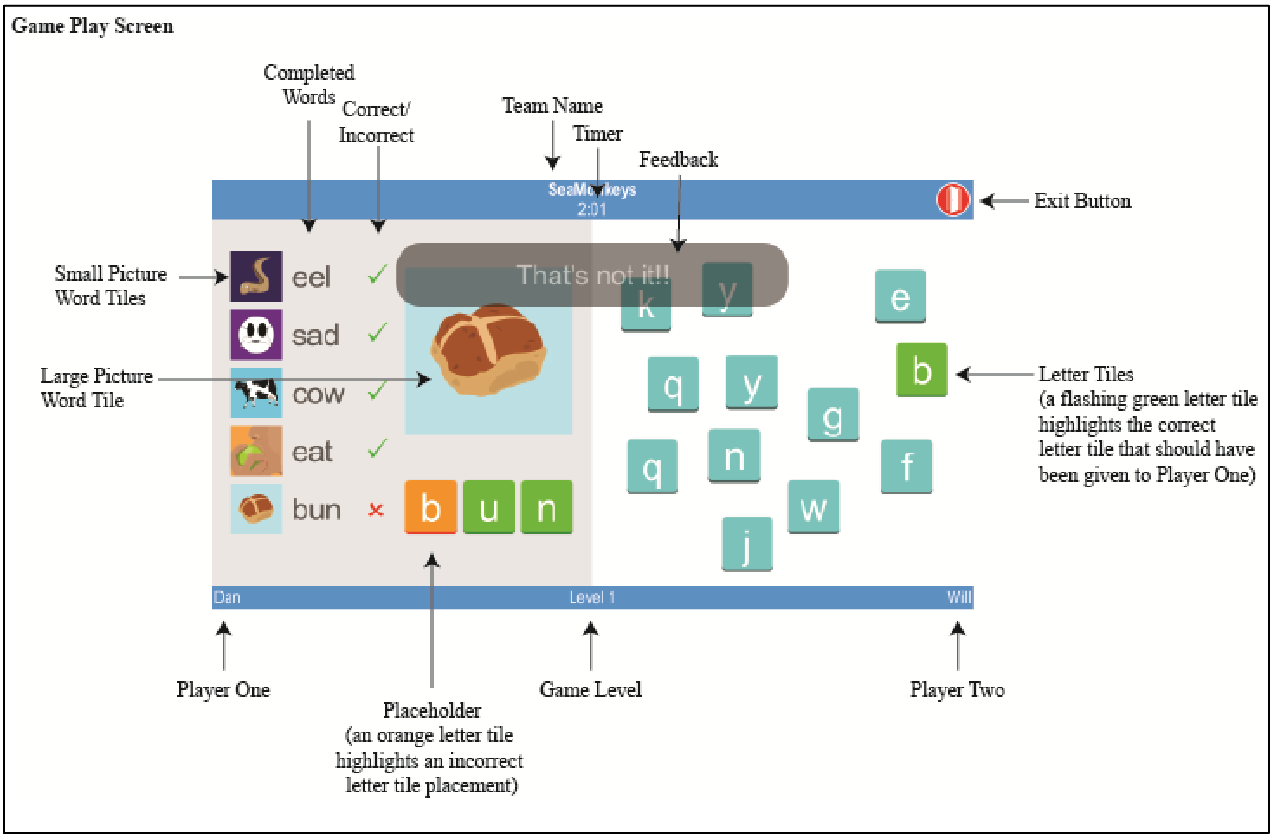


Figure 6-14: Game Play Screen

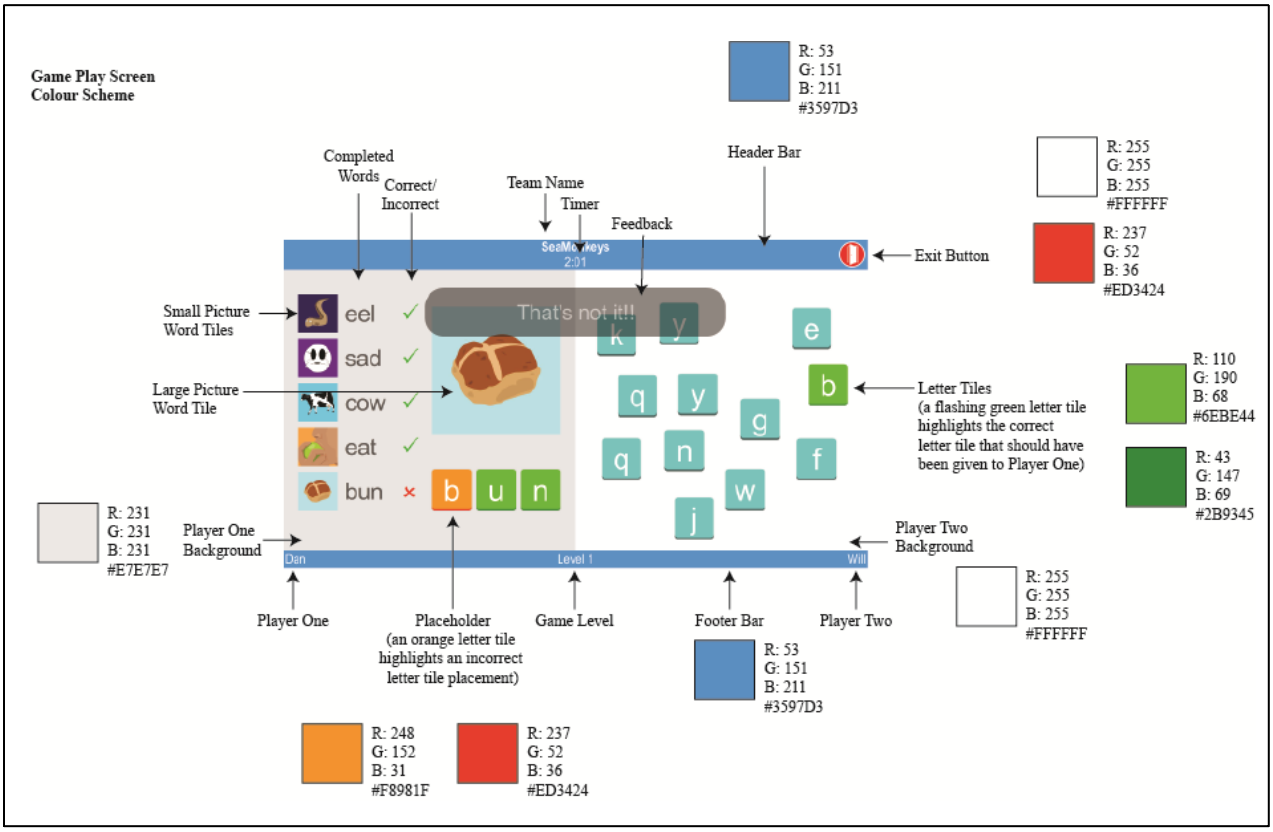


Figure 6-15: Game Play Screen - Colour Palette

Additional design elements included in the learning application are: Audio and a tutorial (see Figure 6-16). Prior to entering the game, it is necessary for the learners to participate in a tutorial. While most learners are familiar with small touchscreen devices, many may not be familiar with large touchscreen devices such as the LSSDS. Therefore, a tutorial was included to give the learners an example of the learning application and types of interactivity involved. On the completion of the tutorial, the learners exited the tutorial and enter the login page.

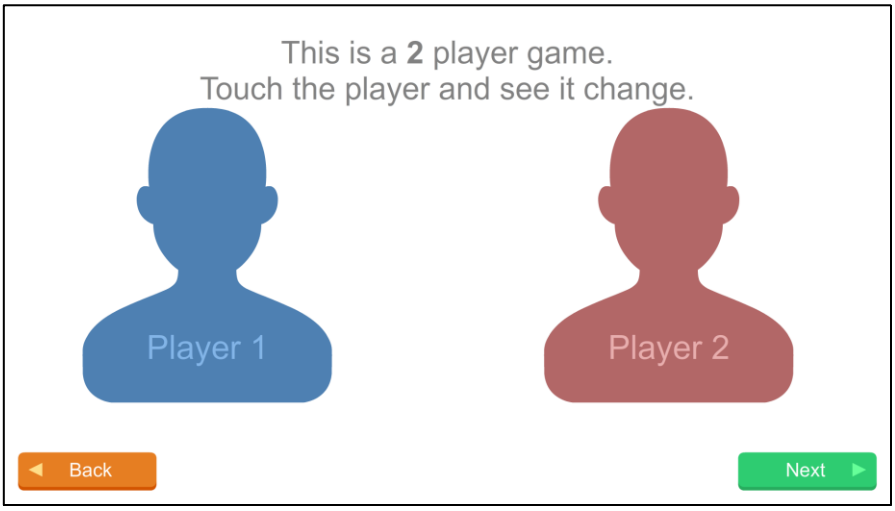


Figure 6-16: Screenshot of the tutorial

The Login and Logout Screen (see Figure 6-17) encourages the learners to create a team name and the individual player names. The names are used to track learner activity during gameplay and is included in the final output, as a detailed feedback report for the teacher.

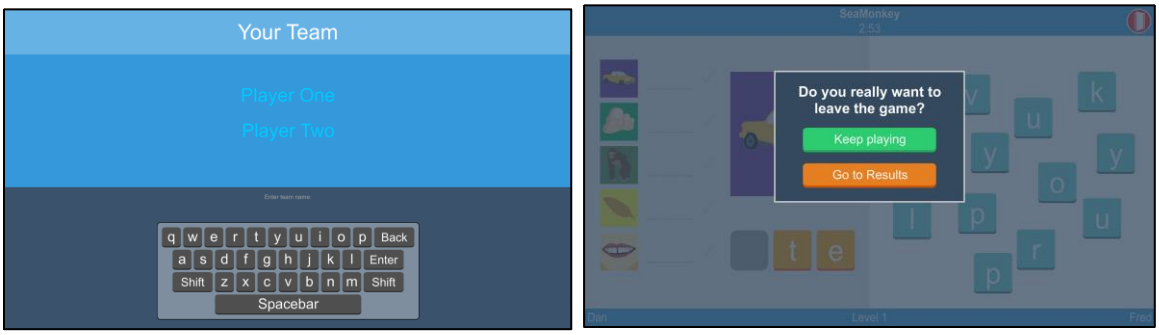


Figure 6-17: Login and Logout (exit) screen

The Learner Feedback Screen (see Figure 6-18). At the conclusion of the gameplay, a Results screen pops up to provide feedback. The feedback information is presented as the team name; ‘Well done, SeaMonkey!’ and the individuals performance is also displayed to highlight the learners strengths and weaknesses.

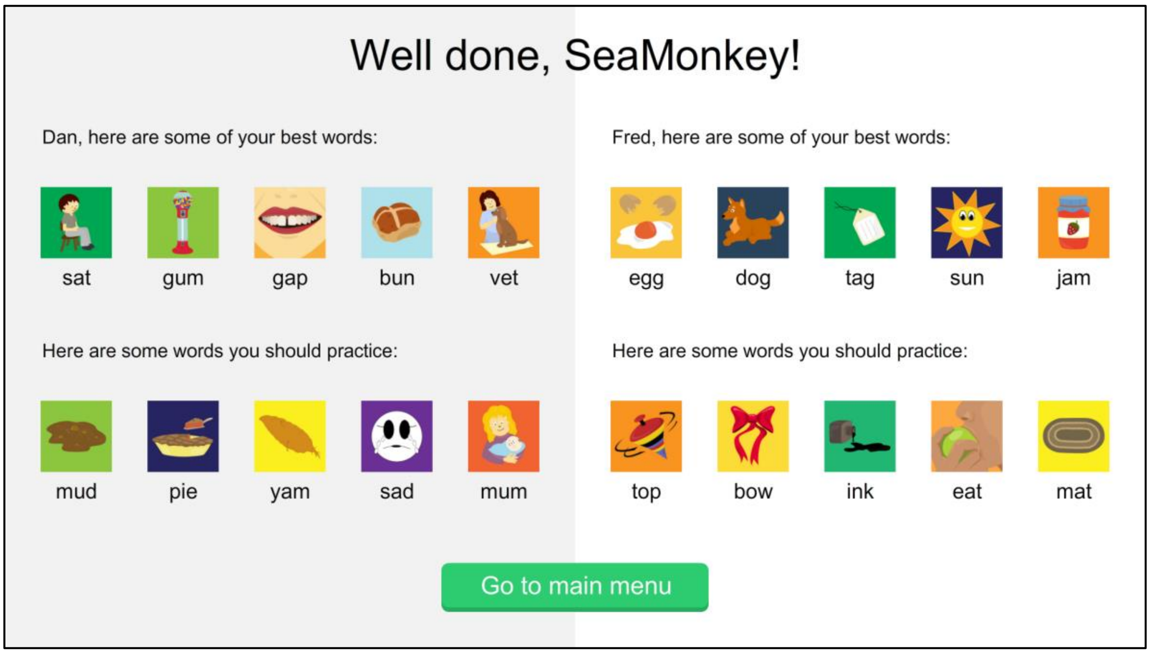


Figure 6-18: Learner Feedback

As discussed in Section 5.2, the final three phases have been included in the instructional design process as they are essential components for developing learning applications/materials, but they are not the focus of this research. Figure 6-19 and Figure 6-20 will provide sample extracts, but an in-depth discussion of all of these phases is beyond the scope of this research.

6.7 Implementation and Evaluation Phases

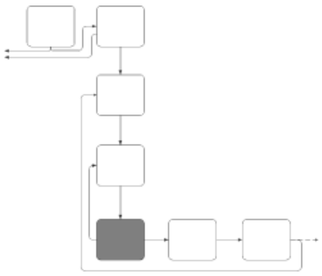


Figure 6-19: Phase Five – Development of the Artefact

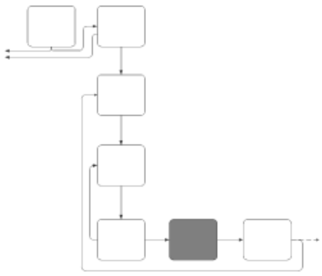


Figure 6-20: Phase Six - Learning Event Instance and Evaluation of Learning Outcomes

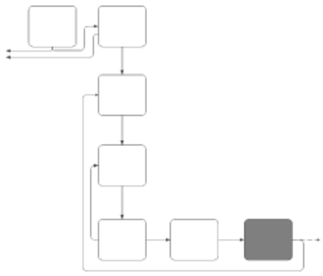
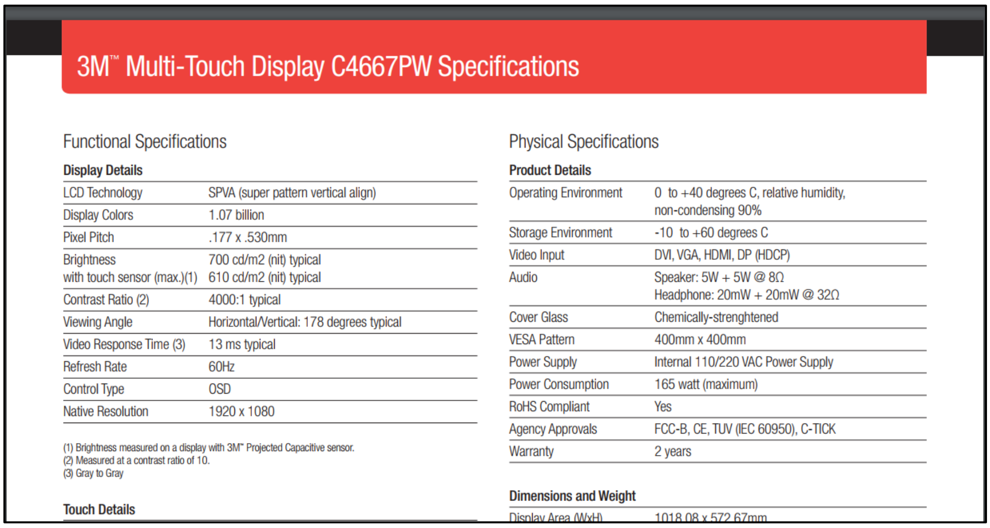


Figure 6-21: Phase Seven – Evaluation of Design Outcomes

Figure 6-19 is *Development/Release – Implementation phase*. The Technology Platform selected for this learning application is a 3M™ Multi-Touch Display C4667PW. Some of the specifications are shown in the image below (see Figure 6-22).



3M™ Multi-Touch Display C4667PW Specifications

Functional Specifications

Display Details

LCD Technology	SPVA (super pattern vertical align)
Display Colors	1.07 billion
Pixel Pitch	.177 x .530mm
Brightness with touch sensor (max.)(1)	700 cd/m2 (nit) typical 610 cd/m2 (nit) typical
Contrast Ratio (2)	4000:1 typical
Viewing Angle	Horizontal/Vertical: 178 degrees typical
Video Response Time (3)	13 ms typical
Refresh Rate	60Hz
Control Type	OSD
Native Resolution	1920 x 1080

(1) Brightness measured on a display with 3M™ Projected Capacitive sensor.
(2) Measured at a contrast ratio of 10.
(3) Gray to Gray

Touch Details

Physical Specifications

Product Details

Operating Environment	0 to +40 degrees C, relative humidity, non-condensing 90%
Storage Environment	-10 to +60 degrees C
Video Input	DVI, VGA, HDMI, DP (HDCP)
Audio	Speaker: 5W + 5W @ 8Ω Headphone: 20mW + 20mW @ 32Ω
Cover Glass	Chemically-strenghtened
VESA Pattern	400mm x 400mm
Power Supply	Internal 110/220 VAC Power Supply
Power Consumption	165 watt (maximum)
RoHS Compliant	Yes
Agency Approvals	FCC-B, CE, TUV (IEC 60950), C-TICK
Warranty	2 years

Dimensions and Weight

Display Area (WxH)	1018.08 x 572.67mm

Figure 6-22: 3M™ Multi-Touch Display C4667PW Specifications (3M™ Multi-Touch Display C4667PW, 2014)

The Authoring Platform selected to develop the phonics learning application was Adobe CC Flash. Ultimately, the learning application was developed by an external software developer and is based on the Specification Document (see Section 6.6.1).

Figure 6-23 is an extract from the Student Log report (see Appendix O). This student log report is a tracking report that is an output of Phase Six (see Figure 6-20). The purpose of this document is twofold. First, it is for the teacher to analyse the groups learning outcomes. Secondly, on the individual level, where the report tracks student progress and demonstrates if there are any learning issues specifically related to phonemic awareness and phonics learning.

```
PHONICS GAME - STUDENT LOG
New game started: Tuesday 17 February 2015 at 11:31AM

Students have not watched the tutorial.

Team name: SeaMonkeys
Player 1: Dan
Player 2: Will

LEVEL 1 START (3:00 limit, missing _XX)
Word controller: Dan
Letter controller: Will
Available Words: eel, sad, cow, eat, bun

Time: 3:00 - Current word changed to: eel
Time: 2:43 - Will touched tile "E" (long sound)
Time: 2:42 - Will touched tile "e" (short sound)
Time: 2:41 - Will touched tile "E" (long sound)
Time: 2:38 - Will passed tile "E" (long sound) to Dan
Time: 2:38 - Dan touched tile "E" (long sound)
Time: 2:38 - Dan moved tile "E" (long sound) to position 1 (correct)
Time: 2:35 - Current word changed to: sad
Time: 2:33 - Will touched tile "S" (long sound)
Time: 2:31 - Will touched tile "s" (short sound)
Time: 2:30 - Will touched tile "s" (short sound)
Time: 2:29 - Will passed tile "s" (short sound) to Dan
Time: 2:29 - Dan touched tile "s" (short sound)
Time: 2:29 - Dan moved tile "s" (short sound) to position 1 (correct)
Time: 2:26 - Current word changed to: cow
Time: 2:24 - Will touched tile "c" (short sound)
Time: 2:24 - Will touched tile "C" (long sound)
Time: 2:23 - Will touched tile "c" (short sound)
Time: 2:22 - Will passed tile "c" (short sound) to Dan
Time: 2:22 - Dan touched tile "c" (short sound)
Time: 2:22 - Dan moved tile "c" (short sound) to position 1 (correct)
Time: 2:19 - Current word changed to: eat
Time: 2:17 - Will touched tile "E" (long sound)
Time: 2:16 - Will touched tile "e" (short sound)
Time: 2:15 - Will touched tile "E" (long sound)
Time: 2:14 - Will touched tile "E" (long sound)
Time: 2:13 - Will passed tile "E" (long sound) to Dan
Time: 2:13 - Dan touched tile "E" (long sound)
Time: 2:13 - Dan moved tile "E" (long sound) to position 1 (correct)
Time: 2:10 - Current word changed to: bun
Time: 2:08 - Will touched tile "B" (long sound)
Time: 2:07 - Will touched tile "b" (short sound)
Time: 2:06 - Will touched tile "B" (long sound)
Time: 2:04 - Will passed tile "B" (long sound) to Dan
Time: 2:03 - Dan touched tile "B" (long sound)
Time: 2:03 - Dan moved tile "B" (long sound) to position 1
(incorrect)
Time: 1:49 - Will touched tile "b" (short sound)

PLAYERS SWAP ROLES
Word controller: Will
Letter controller: Dan
```

```
Available Words: bus, ten, bug, gym, yam

Time: 3:00 - Current word changed to: bus
Time: 2:50 - Dan touched tile "b" (short sound)
Time: 2:50 - Dan touched tile "b" (short sound)
Time: 2:48 - Will touched tile "b" (short sound)
Time: 2:48 - Will moved tile "b" (short sound) to position 1
(correct)
Time: 2:45 - Current word changed to: ten
Time: 2:43 - Dan touched tile "T" (long sound)
Time: 2:42 - Dan touched tile "t" (short sound)
Time: 2:42 - Dan touched tile "t" (short sound)
Time: 2:41 - Dan passed tile "t" (short sound) to Will
Time: 2:41 - Will touched tile "t" (short sound)
Time: 2:41 - Will moved tile "t" (short sound) to position 1
(correct)
Time: 2:38 - Current word changed to: bug
Time: 2:36 - Dan touched tile "b" (short sound)
Time: 2:35 - Dan touched tile "B" (long sound)
Time: 2:34 - Dan touched tile "b" (short sound)
Time: 2:32 - Dan passed tile "b" (short sound) to Will
Time: 2:31 - Will touched tile "b" (short sound)
Time: 2:31 - Will moved tile "b" (short sound) to position 1
(correct)
Time: 2:28 - Current word changed to: gym
Time: 2:27 - Dan touched tile "G" (sound: j)
Time: 2:26 - Dan touched tile "g" (short sound)
Time: 2:25 - Dan touched tile "G" (sound: j)
Time: 2:24 - Dan passed tile "G" (sound: j) to Will
Time: 2:23 - Will touched tile "G" (sound: j)
Time: 2:23 - Will moved tile "G" (sound: j) to position 1 (correct)
Time: 2:20 - Current word changed to: yam
Time: 2:18 - Dan touched tile "Y" (long sound)
Time: 2:17 - Dan touched tile "y" (short sound)
Time: 2:16 - Dan touched tile "y" (short sound)
Time: 2:15 - Dan passed tile "y" (short sound) to Will
Time: 2:14 - Will touched tile "y" (short sound)
Time: 2:14 - Will moved tile "y" (short sound) to position 1
(correct)

LEVEL 2 START (4:00 limit, missing XX_)
Word controller: Dan
Letter controller: Will
Available Words: ink, wok, rat, yes, pig

Time: 4:00 - Current word changed to: ink
Time: 3:54 - Will touched tile "i" (short sound)
Time: 3:43 - Will touched tile "K" (long sound)
Time: 3:31 - Will touched tile "K" (long sound)
Time: 3:29 - Will touched tile "k" (short sound)
Time: 3:29 - Will touched tile "k" (short sound)
Time: 3:28 - Will passed tile "k" (short sound) to Dan
Time: 3:28 - Dan touched tile "k" (short sound)
Time: 3:28 - Dan moved tile "k" (short sound) to position 3 (correct)
Time: 3:25 - Current word changed to: wok
Time: 3:23 - Will touched tile "W" (long sound)
```

Figure 6-23: Extract from the Student Log

Evaluation of Design Outcomes (see Figure 6-21) is the final phase. In this case, the review will be reported in the next chapter, Chapter Seven: Stage One: Observational Study Analysis and Results.

6.8 Summary

This chapter presented systematic output examples of a collaborative phonics learning application based on the CISD model and documents the design of a learning application for an LSSDS context. The development of this game was necessary because it tested the functionality of the CISD model. The phonics learning application forms the next part of the Stage One methodology, in that it provides the research instrument for further testing of an example output of the CISD Model in a classroom environment.

7 Stage One: Observational Study Analysis and Results

7.1 Introduction

Chapter 5 presented the proposed Collaborative Instructional Systems Design (CISD) model to assist in designing collaborative learning applications for interactive environmental technologies such as the Large-Scale Shared Digital Space (LSSDS). Chapter 6 provided a step-by-step (phase-by-phase) design of a phonics literacy application to test the CISC model and present to students in a school learning environment. This chapter will discuss the results of the students and teachers observational study. The intention of this observational study was to test and validate an output of the CISD in its current state. The report of this observational study has been divided into three major sections. The first section focuses on the context of the observational study, describing the location, the participants and type of data that was collected. The second section will present the analysis and results based on the data collected, and the third and final section presents the conclusions arising from the results.

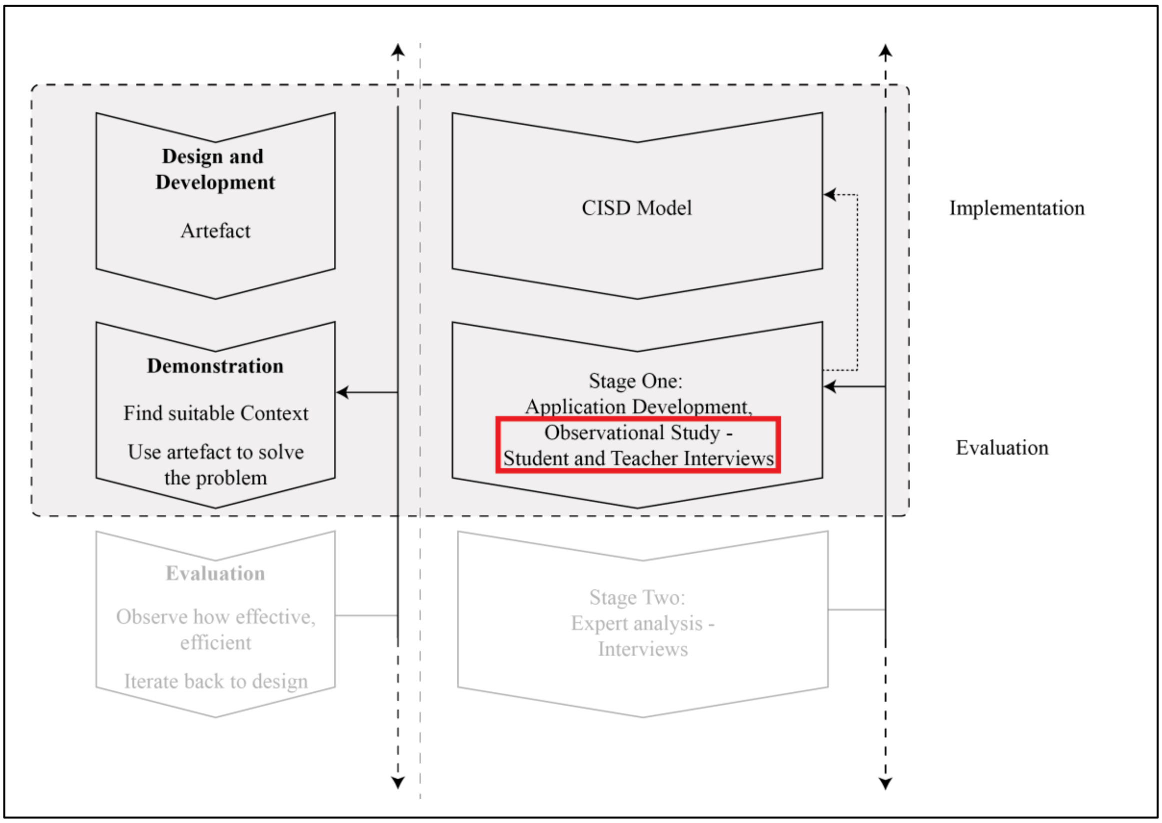


Figure 7-1: Implementation of the new CISD Model and Stage One: Observational Study

As shown in the figure above, once the artefact, or CISD model, was designed (see Chapter 5: The CISD Model), it was important to validate that the artefact worked. This was achieved by using it in a suitable context as a guide to develop a learning application, the design of a phonics literacy application (see Chapter 6: Stage One – Application Design). The purpose of Stage One of this research was to evaluate and validate the CISD model by developing a phonics learning application. The outcomes of the Stage One Observational Study will provide an understanding of the CISD model in its current state. It will also provide the appropriate guidance when designing a collaborative learning application for an LSSDS by observing the activity of learners using the application and seeking the feedback of teachers. Consequently, Stage One of this research concentrated on the following sub-question:

> S3. For a learning application designed using the Collaborative Instructional Systems Design model, what is the experience of the students and teachers in the classroom?

The focus of this stage of the research is to: test the validity of the output of the CISD model and observe the students collaborative experience when participating with the learning activity on the LSSDS.

7.2 Participants and Settings of Stage One: The Observational Study Context

The phonics literacy application was developed specifically with primary school students in mind. This stage of the data collection consisted of five pairs of male students and three teachers, in an observational capacity, from a local boy's only Catholic primary school. The students year levels ranged from year level 4 to year level 6. Seventy student/parent consent forms with explanatory statements and ten teacher consent forms with explanatory statements were provided to the school for distribution. Twenty student participants responded: fifteen 'Yes' responses, which comprised of six students from year level 4, five students from year level 5 and four students from year level 6. Three 'No' responses, which comprised of three students from year level 4 students, and also two incomplete consent forms from year level 6, were also received. The two incomplete consent forms were also automatically eliminated. Three primary school teachers responded, of which, one was the Enhancement Centre Coordinator.

This was an in-depth observational study of the types of activity generated, rather than a study of learning gains. Five pairs of students were set up as teams, from year level 4 and 5 were selected. Year level 6 students were omitted because there were sufficient participants with the lower class levels and it was considered that this year level was too advanced for the phonics learning activity. The student participants were paired by the school's Enhancement Centre Coordinator (ECC), who was also a teacher participant. The ECC based her pairings on the individual student's tendencies, such as personality traits, personality compatibilities and the level of learning capabilities, e.g.

matching a strong learner with a weaker learner. However, only the teachers knew who these students were, and it should be noted that remedial learners/remedial instruction was not part of this experiment.

7.2.1 The Room Environment

The experiment was held in a quasi-classroom environment, as the students came from different year levels (see Figure 7-2). The large table was pushed to the side of the room to allow for the Large-Scale Shared Digital Space (LSSDS). The students, not working on the shared digital space, worked on their other classroom tasks: Maths and English.

Each pair of students participated for approximately fifteen minutes and, at the conclusion of the activity, were asked a series of easy questions in a five-minute interview (see Appendix A). As each pair of students completed the experiment, they could leave the room. Overall, the data collection lasted for one hour and forty minutes.

Figure 7-2: The quasi-classroom work environment for students

7.3 Basic description of the Observational data

The observational data collected consisted of three types: Video, Audio and the Student Activity Log report, recorded by the application.

7.3.1 Observational Data: Video

A Canon digital video camera (DVC) was used as the primary video capture tool, with a GoPro as the secondary video capture tool. The primary video camera captured both visual and audio of the participants using the phonics application. Both video cameras were mounted on tripods which were set up high above the table and students. The primary camera enabled the video to focus directly on the students interacting with the game on the LSSDS (see Figure 7-3). This video was used for data analysis and later used to extract material for presentation to the experts in Stage Two of the experiment.

Figure 7-3: Students interacting with the game – Canon (DVC) view

The GoPro was set up as a backup and, while the video was not directly used in the data analysis, wide perspective still-photos of the paired students playing and interacting with the game have been used to demonstrate the room environment (see Figure 7-2). However, no formal data analysis was undertaken from this source, as the primary video captured all that was needed.

7.3.2 Interview Data: Audio

The teacher interview sessions were audiotaped only. Three teachers were present in an observational capacity at various stages during the gameplay to watch the students playing and interacting with the phonics game on the LSSDS. At the conclusion of all the gameplay sessions, the three teachers were separately interviewed.

7.3.3 Activity Log Data: Students Reports

At the end of each group session, a Student Activity Log report was generated by the application. This activity log report was designed into the learning application to provide teachers with information on student progress and to identify if there were any weaknesses in understanding phonological awareness and/or phonics. It was also used to work out which words were attempted and the outcome of each attempt.

7.4 Data Preparation and Analysis Methods

Once all the video, audio and student log report data were collected, a number of steps were taken to prepare this data for analysis (see Table 7-1 for a detailed summary).

7.4.1 Observational Data: Video/Audio – Students/Teachers

The primary video of the students use of the learning application, with the teachers observing, was captured as one whole session. To prepare the video data for analysis, the video was cut into five segments. Each segment began with the tutorial, followed by the students play activity, and concluded with student interviews (see Table 7-1). The five segmented videos were imported into QSR Nvivo where they were first transcribed and then thematically analysed. The first set of themes focused on the multi-tiered taxonomies of the three learning domains developed in phase three of the CISD model; *Collaborative Instructional Strategies* (see Section 5.5: Collaborative Instructional Strategies). These three new learning domains; Collaborative Learning Strategies, Collaborative Interactive Strategies and Collaborative Assessment Strategies have been developed to complement Bloom's Learning Taxonomy.

At the conclusion of this Nvivo analysis, the data was transferred and tabulated into an Excel spreadsheet to allow for the development of visual representations, pie charts, graphs and a heat map to enable further analysis. The student analysis also included the students group interviews. Each group interview was conducted at the end of their gameplay. The students interviews focused on their experience whilst playing the phonics game on the large-scale shared digital space. The student interviews allowed the students to discuss their collaborative experience while playing the phonics game, as well as learning on *the table*, or LSSDS.

<table>
<tr><th>Purpose</th><th>Tool</th><th colspan="2">Participants Students/ Teachers</th><th>Activity Time mm:ss</th><th>Tutorial mm:ss</th><th>Interview mm:ss</th><th>Total Time mm:ss</th><th>Total Time mm:ss</th></tr>
<tr><td colspan="9">Observation study of the students interacting with tutorial and game.</td></tr>
<tr><td rowspan="5">Observational Data: Primary Video</td><td rowspan="5">Canon HDMI DVC</td><td rowspan="5">Students/ Teachers</td><td>Team One</td><td>08:32</td><td>01:30</td><td>01:20</td><td>11:22</td><td rowspan="5">67:33</td></tr>
<tr><td>Team Two</td><td>06:46</td><td>01:33</td><td>01:24</td><td>*09:43</td></tr>
<tr><td>Team Three</td><td>13:52</td><td>01:12</td><td>01:17</td><td>16:21</td></tr>
<tr><td>Team Four</td><td>10:48</td><td>01:21</td><td>01:53</td><td>14:02</td></tr>
<tr><td>Team Five</td><td>13:19</td><td>01:00</td><td>01:46</td><td>16:05</td></tr>
<tr><td colspan="9">Teacher interviews</td></tr>
<tr><td rowspan="3">Interview Data: Audio</td><td rowspan="3">Sony IC-Recorder</td><td rowspan="3">Teachers</td><td colspan="4">Teacher 1</td><td>13:56</td><td rowspan="3">50:06</td></tr>
<tr><td colspan="4">Teacher 2</td><td>11:55</td></tr>
<tr><td colspan="4">Teacher 3</td><td>24:15</td></tr>
<tr><td colspan="9">System log based on students activity on the large-scale shared digital space.</td></tr>
<tr><td>Activity Log Data:
Student reports. Tracks words and user interactions</td><td>System
Activity Log Report</td><td>Students</td><td colspan="5">See Table 7-4 for a sample excerpt of the report data which lists the number of words, words correct/incorrect, level achieved, game run-time and the total length of time.
See Table 7-2 for the total data output.</td><td>65:23</td></tr>
<tr><td colspan="9">*The students were not able to complete the game due to a system error – the game froze.</td></tr>
</table>

Table 7-1: Stage One Data Collection: A detailed summary of the Purpose, Tools used, Participants and Duration of activities and interviews

7.4.2 Student Activity Log - Report

The Student Activity Log report was designed to provide teachers with a resource that tracks the students progress and to determine if there were any issues in relation to phonemic awareness and phonics instruction. This system-generated report was produced at the completion of each team's gameplay (see Figure 7-4).

```
PHONICS GAME - STUDENT LOG
New game started: Friday 20 March 2015 at 11:07AM

Students have watched the tutorial.

Team name: The Dudes
Player 1: Dave
Player 2: john

LEVEL 1 START (3:00 limit, missing _XX)
Word controller: Dave
Letter controller: john
Available Words: hut, toe, keg, ink, bee

Time: 3:00 - Current word changed to: hut
Time: 2:57 - john touched tile "H" (long sound)
Time: 2:56 - john passed tile "H" (long sound) to Dave
Time: 2:54 - Dave touched tile "H" (long sound)
Time: 2:54 - Dave moved tile "H" (long sound) to position 1
(incorrect)
Time: 2:48 - john touched tile "h" (short sound)
Time: 2:44 - Current word changed to: toe
Time: 2:39 - john touched tile "t" (short sound)
Time: 2:38 - john touched tile "T" (long sound)
Time: 2:35 - john touched tile "T" (long sound)
Time: 2:34 - Dave touched tile "T" (long sound)
Time: 2:33 - Dave moved tile "T" (long sound) to position 1
(incorrect)
Time: 2:30 - john touched tile "t" (short sound)
Time: 2:26 - Current word changed to: keg
Time: 2:22 - john touched tile "c" (short sound)
Time: 2:21 - john touched tile "c" (short sound)
Time: 2:18 - john passed tile "c" (short sound) to Dave
```

Figure 7-4: An excerpt from Team One - Student Activity Log

The Student Activity Log report tracked the number of times the learners interacted on the large-scale shared digital space, to complete each word. The activity in the reports was used to provide a detailed correct/incorrect word count summary of the students group activities interacting on the large-scale shared digital space. As this report data was too extensive to be included in Table 7-1, a separate table (see Table 7-2) was created.

Below is the extracted data from the Student Activity Log report. This report enables the tracking of words, the user interactions, the length of time it would take to complete each word, and the level reached.

Analysis Tool	Team Number	Number Words	Words Correct	Words Incorrect	Level Reached/ Achieved	Game Run Time mm:ss	Total Length of Time mm:ss
QSR Nvivo 11	Team One	30	23	7	3	09:55	65:23
	Team Two	25	23	2	*3	08:04	
	Team Three	58	48	10	*5	16:01	
	Team Four	50	42	8	4	16:18	
	Team Five	59	44	15	*5	15:05	
	TOTAL	222	180	42			
*incomplete level							

Table 7-2: Stage One Data Collection: The detailed data summary based on the output of students activity interacting on the large-scale shared digital space, the System Activity Log Report

The table above shows that all teams did not run for the same length of game time. The game time for Team One was shorter than the others due to a recording issue, however the students managed to complete the level. Team Two also experienced shorter game time due to a technical issue where the application froze. Team's Three, Four and Five performed as planned. The first two teams, despite having a shorter activity duration, did complete several cycles of learning activity where students swapped roles and worked collaboratively. Therefore, this data could still be analysed with the three other data sets.

7.4.3 Teacher Interview Data - Audio

At the conclusion of the student sessions, the three teachers were interviewed, individually, in a thirty-minute, semi-structured interview. The teacher interviews were recorded using a Sony IC-Recorder. These research questions focused on: the children interacting, the design influence of the learning task, specific collaboration aspects and the technology influence on the interactions (see Appendix B). No specific audio treatment was required, and Table 7-1 shows a total time for each interview. The three interviews were imported into QSR Nvivo where they were transcribed and thematically analysed. No data was excluded.

7.4.4 Thematic Analysis of Observational Data: An Overview

This section will focus on the process of the thematic analysis of the students observational data. In order to thematically analyse the observational data, a systemised categorisation system was put in place. The purpose of this thematic analysis was to establish if the types of learning skills, interactions and behaviours suggested by the CISD model could be observed in a collaborative learning application or the phonics learning application. This phonics literacy application was the resulting output based on the processes/procedures of the CISD model.

The CISD model included seven broad categories called Phases. The CISD model, as a whole, was created explicitly for Instructional Designers to plan and design learning materials for synchronous collaborative learning environments, such as the LSSDS. The thematic analysis of the observational data will apply to Phase Three: *Collaborative Instructional Strategies*. Phase Three was the tool selected for this thematic analysis as it provided the explicit and observable elements, describing and articulating the strategies necessary to define the three taxonomies.

In this phase, there are three sub-phases, Collaborative Learning Strategies, Collaborative Interaction Strategies and finally, Collaborative Assessment Strategies. Each sub-phase has a related taxonomy: Methods: Taxonomy of Collaborative Learning Strategies, Practice: Taxonomy of Collaborative Interaction Strategies and Assessment: Taxonomy of Collaborative Assessment Strategies. In each of these taxonomies, there are a series of elements and sub-elements (see Figure 7-5), which lend themselves to an analysis of observations of learner collaborative activities.

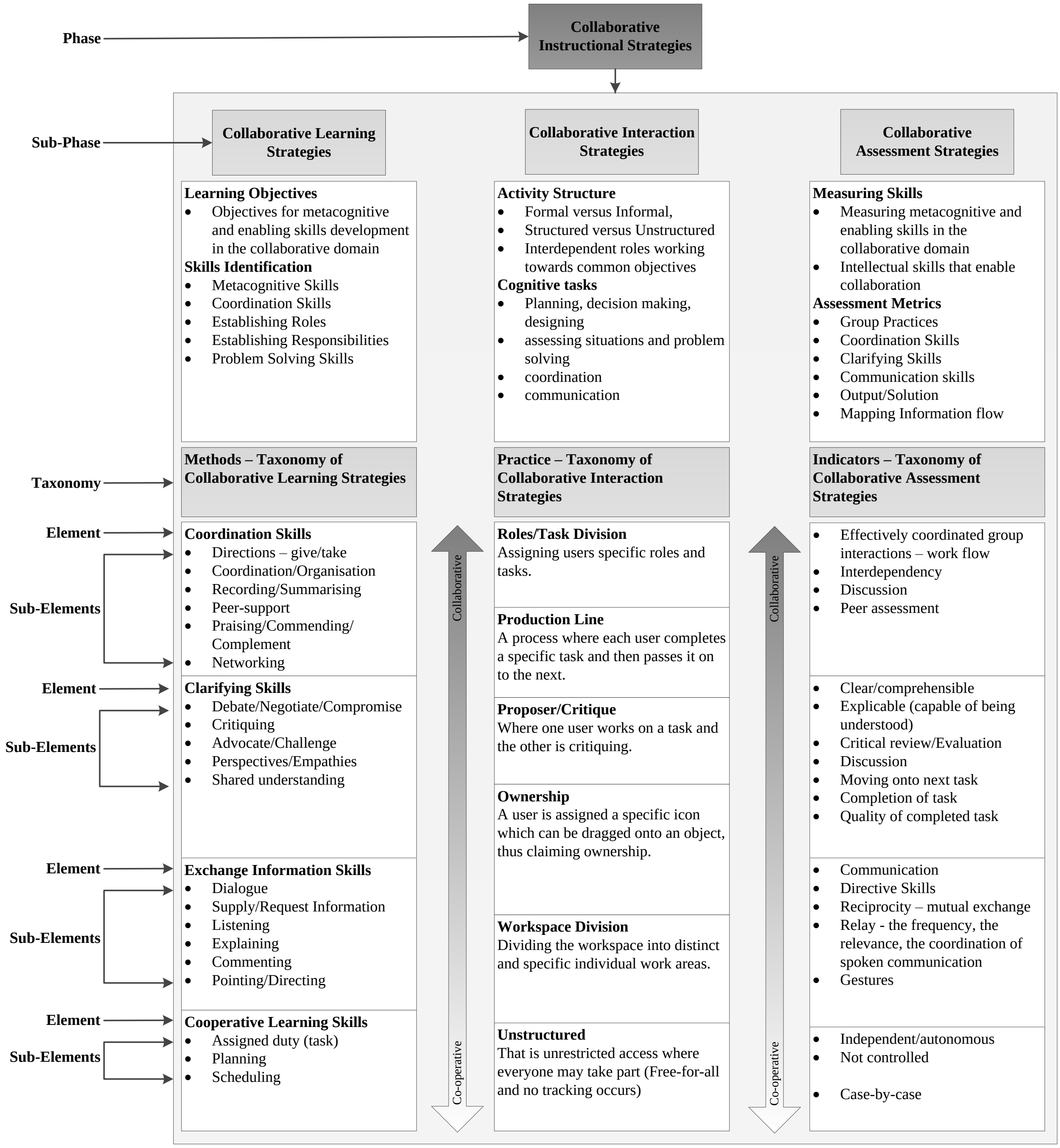


Figure 7-5: Phase Three: The Structure of Collaborative Instructional Strategies

The Phase, Sub-phases, Taxonomies, Elements and their related Sub-elements (see Figure 7-5), set the foundation for the thematic categories of analysis in Nvivo (see Figure 7-6). Within these categories, it is the elements and sub-elements that are analysed.

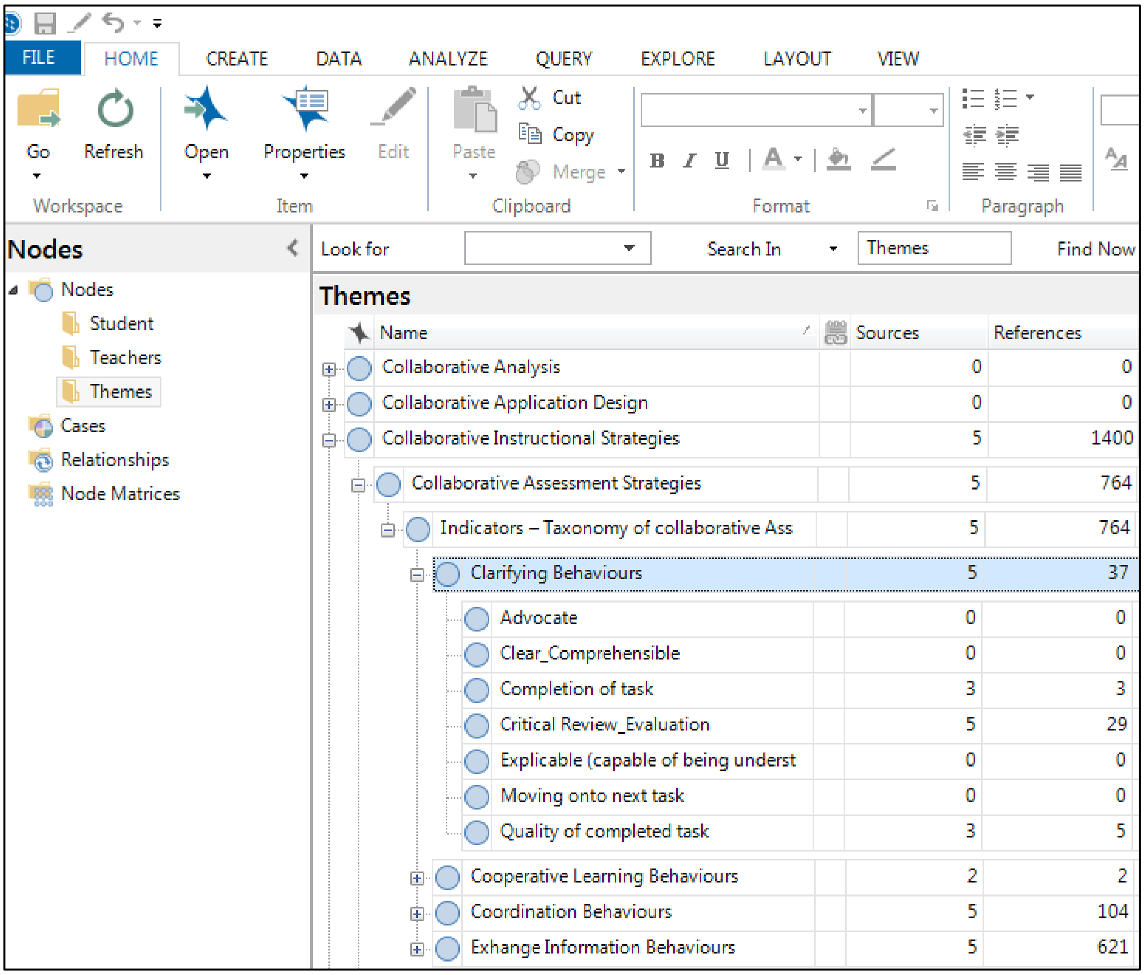


Figure 7-6: Thematic analysis in Nvivo

7.4.5 Data preparation: Transcription Method

The transcription data is rich in that it encapsulates not only the touch activity (action) between the two players (see Figure 7-4), but it also includes dialogue, body language and facial activity. The encapsulated activity was transcribed into chunks. To complete the thematic analysis, the word chunk was placed into its related themes, meaning that a word chunk could be represented in more than one theme.

The Observational Study results of the Taxonomies thematic analysis for this stage will be presented in the same distinct order shown in Figure 7-5, beginning with *Collaborative Learning Strategies*.

7.5 Stage One: Observational Study – Collaborative Learning Strategies

The aim of the first sub-phase presented in this analysis is to investigate if the skill sets, being the sub-elements, presented in the Collaborative Learning Strategies can be observed in the interactions of the student teams. The analysis determines which interactions are observed and what their prevalence was for each group. It is to be noted that some samples and discussions were quite similar for many of the taxonomies, but some interactions display multiple skills.

Collaborative Learning Strategies will begin with an overview, which includes a pie chart. This will be followed by a summary of the Data, a discussion of each element and their related sub-elements. It will conclude with the outcome. The summary of the Data will include a bar graph for each element and provide a discussion for each sub-element using their relevant transcribed data, as examples and as an outcome. The transcribed examples are used to highlight and support the discussion.

The following table provides the legend to the terminology and abbreviations used to describe the tools and participants mentioned in the transcription:

The Tools	
Phoneme	A small unit of sound, e.g. c/ a / t/
Grapheme	Individual letter shape/symbol, e.g. the c in **c**at is a grapheme
Letter Tiles	Individual letter tile, grapheme. When the letter tile is tapped the audio, phonic sound will play a long or short letter sound (phoneme). These are recorded as follows: • The capital letters indicate a long letter sound - /J/ • The lower-case letter indicates a short letter sound - /j/ • When discussing the individual alphabet letter, on its own, it is italicised - *j*
Picture Tile	Refers to the image which is a graphical representation of the object. The picture tile for a cat will show an image of a cat.
FBM	The feedback message is the computer-generated feedback response that indicates correct/incorrect execution, e.g. Well done!, Great Work!, Try again!, Oops! or Oh Dear!.
Game Levels	The examples show the level of the word, _XX indicates level one, where the first letter is missing, X_X, level 2 etc. (see Chapter 5.2: The Phonics Learning Application)

Participants/Participant Roles	
Individual Team Member	Each team member, the learner, was asked not to use their real name, but to use a pseudonym. In the example, the student names will be in **bold,** and their discussions are recorded in quotation marks. E.g. **Tom: "**No, that's not it"
Word Controller	The student in charge of the word who identifies (phoneme) and requests the missing letter tile from the Letter Controller.
Letter Controller	The student who identifies (grapheme) and supplies the missing letter tile to the Word Controller
Teachers	Shown as T1, T2 or T3

Table 7-3: Legend of the terminology and abbreviations used in the transcribed data

The pie chart below represents the outcomes for the Taxonomy of Collaborative Learning Strategies data. The number of activities, in this case, is represented as *n*. The element most dominant was *Exchange Information Skills* showing 94% or n =596, followed by *Coordination Skills*, 3% or n = 21 and closely followed by *Clarifying Skills*, 3% or n = 15 and finally, *Cooperative Learning Skills* which shows a 0% with n = 2. The activity in *Cooperative Learning Skills* was so low that it failed to produce a percentage outcome.

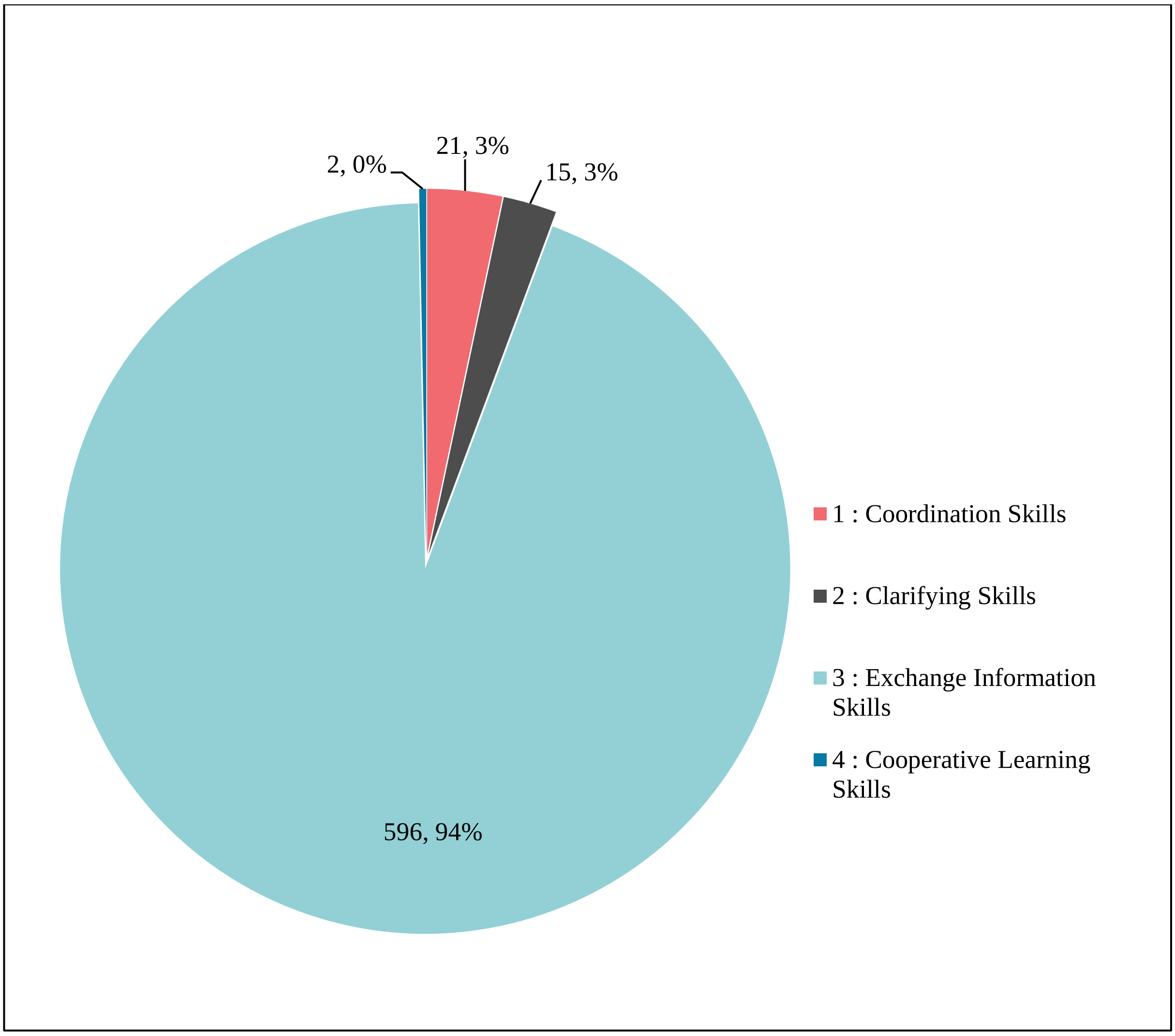


Figure 7-7: Stage One - Taxonomy of Collaborative Learning Strategies. Total of all the student activity (n=number of activities)

The most active and dominant skill was *Exchange Information Skills*. *Exchange Information Skills* is a midrange element (see Figure 7-5), which incorporates important forms of communication skills such as dialogue, listening and nonverbal actions such as pointing/directing. A high level of articulation and interchange activity, for this age group and the level of education of these learners, was expected. These verbal language skills begin to develop from a very early age. *Coordination Skills* and *Clarifying Skills* are the next two elements where the learners demonstrated a moderate use of the learning strategies. These two skill elements are situated at the top level of the scale. Another important point is that the phonics learning game was so well structured, with turn-taking enforced, that this did not require the learners to actively coordinate and organise themselves. Therefore, the level of activities for these two skill sets was foreseen to be normal for these young learners, as *Coordination Skills* and *Clarifying Skills* is aimed at higher education learners, secondary and above, who are more self-directed and self-motivated. *Cooperative Learning Skills* was the lowest on the scale and was the least used. Again, this was expected as the learning application was well structured and designed to be collaborative and interactive.

A breakdown of Figure 7-7 is presented and discussed in Sections 7.5.1 through to 7.5.4. To maintain consistency, the data will be presented in the same order as the elements are shown in the model, from collaborative to cooperative, and will begin with *Coordination Skills*. To assist in categorising each element and sub-elements, as shown in Figure 7-5, the data will begin with an introduction and thumbnail. This is followed by the bar graph, which will support a discussion of each sub-element, and finally the outcome. The order of the data in the sub-elements will range from most dominant to least dominant.

In summary, a wide range of collaborative activity was observed. This was due to the design of the collaborative learning activity, with a focus on *Information Exchange*, which includes a higher level of collaborative activity.

7.5.1 Coordination Skills

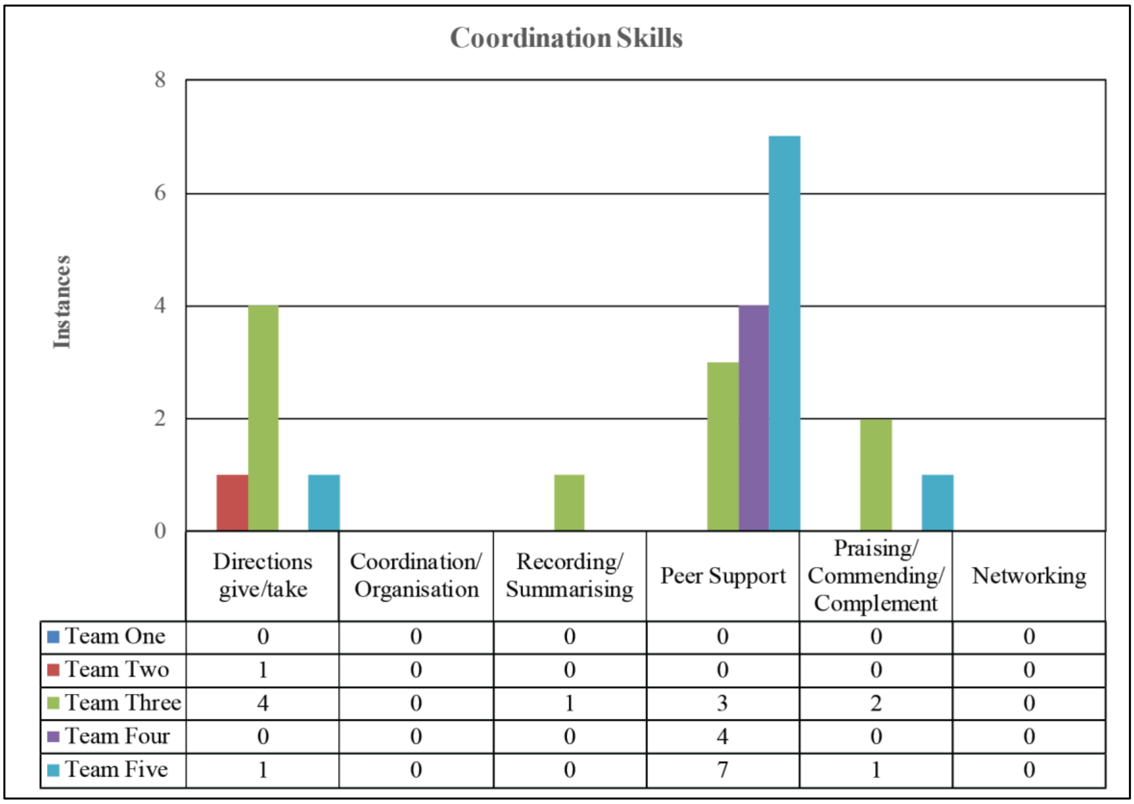
The first element of the Taxonomy of Collaborative Learning Strategies is *Coordination Skills*. *Coordination Skills* is a management function where learners synchronise and/or integrate using high order cognitive skills to pull together and to complete a task or activity through collaboration (see Figure 7-8).

Coordination Skills

- Directions – give/take
- Coordination/Organisation
- Recording/Summarising
- Peer-support
- Praising/Commending/ Complement
- Networking

Figure 7-8: Coordination Skills

The first bar graph (see Figure 7-9) shown below, displays the different taxonomies within *Coordination Skills* demonstrated by the five teams.



	Directions give/take	Coordination/ Organisation	Recording/ Summarising	Peer Support	Praising/ Commending/ Complement	Networking
Team One	0	0	0	0	0	0
Team Two	1	0	0	0	0	0
Team Three	4	0	1	3	2	0
Team Four	0	0	0	4	0	0
Team Five	1	0	0	7	1	0

Figure 7-9: Stage One, Taxonomy of Collaborative Learning Strategies - Instances of Coordination Skills by Team (n=5)

7.5.1.1 Coordination Skills Overview

Based on the analysis and observations within the first element, Peer Support was the dominant element in this taxonomy, followed by Directions - give/take, Praising/Commending/Complement and finally, Recording/Summarising.

7.5.1.2 Peer-support

Peer-support was the most active area, which produced fourteen instances. Comments between team members, such as "its *r*" where one learner points to both letter shapes or "no, it has to be a *g", *and quickly points to both tiles. Short discussions, such as those shown in Figure 7-10, indicate that there is some higher-order thinking with analysis, evaluation and discussion, where one team member was not afraid to state his intentions.

Team Five	Team Four
Game swaps XX_ Word controller: **tntman** Letter controller: **inp**	Level 3 X_X Word controller: **Torchic** Letter controller: **Genesect** **Genesect** whispers something indecipherable to Torchic - something to do with sound
EEL loads **tntman:** says /L/, **inp:** points to /l/ and says, "Eelllll, LLLLL", **tntman:** helps *tntman* look for the *L* tile, and when located says, "that one", **inp:** goes to drag the /L/ tile over to inp. **inp:** then relocates the /L/ tile and flicks it across to inp **tntman:** places /L/ tile into placeholder **FBM:** Good job!	FAN loads **Torchic:** goes to select an *f* shaped letter tile **Genesect:** says, (whispers) "No, /A/, /A/" and points to an *a* shaped letter tile **Torchic**: touches, selects and passes the /A/ letter tile **Torchic**: also, touches, swirls and passes an /f/ letter tile **Genesect:** says (whispers - indecipherable) "?? the other *a*?" **Torchic:** selects /a/ and flicks it across to Genesect **Genesect:** selects and places /a/ into placeholder **FBM:** Fantastic!

Figure 7-10: Two examples of Peer-support

From the analysis of the Data, Team Three had four instances of Directions – give/take and Team Five had only one instance. Three of the four instances demonstrated by Team Three required extra guidance by the teacher, T2, and the Researcher, in order to provide the students with further help. Figure 7-11 shows two examples of directions being given by participants. As can be seen in the example below, both the teacher, T2, and the Researcher briefly intervened very early in the first level to provide extra guidance and encourage the students.

Team Three	**Team Five**
LEVEL 1 START (3:00 limit, missing _XX) Word controller: tom Letter controller: peter JOG loads **peter:** presses /j/ and passes it over to tom's side of the screen and directs it straight into the placeholder **FBM:** Oh Dear! **peter:** says something (indecipherable)?? "Huh?" **tom:** I have to (indecipherable)??? **T2:** says, "Now listen", and prompts the players to listen for the correct letter sound (/J/, /j/) There is some discussion between both players peter: touches /j/ **FBM:** Well done!	LEVEL 1 START (3:00 limit, missing _XX) Word controller: inp Letter controller: tntman BUN loads **inp:** repeats the word and says, "it's /B/" **tntman:** waves finger over letter tile searching for the *b* shaped letter tiles **tntman:** goes to select /t/ (which is close to d) **inp:** No, that's *t* **inp:** pointing to a *b* shaped letter tile says, "That's /B/" **inp:** impatiently touches the /B/ letter tile **tntman:** pauses and looks on **inp:** touches the b letter tile then points back to the B letter tile **tntman:** selects the /B/ letter tile and goes to pass it over, placing the tile over the empty placeholder **inp:** touches the /b/ letter tile and then watches as *tntman* passes over the /B/ letter tile **inp:** says, "No" and then drags it back to the letter tile side of the screen **tntman:** says, "Yeah" and passes it back over to the word picture tile side **inp**: says, "bun" **tntman:** places the /B/ letter tile over the empty placeholder and it locks into place FBM: Oh dear! the correct letter tile /b/ highlights, *inp* touches the /b/ letter tile **Researcher:** If you don't agree with the letter, you are allowed to say that it is not the right letter and then you swap it over. **FBM:** Good job!

Figure 7-11: Two examples of Direction – give/take

Finally, Praising/Commending/Complement; simple statements such a "Yes, it's /O/" or "Yes, that's the one", are simple forms of communication. By praising, commending and/or complementing one another, this demonstrates recognition of good work that enables the development of good team-work relationships and stimulates motivation.

7.5.1.3 Coordination Skills Summary of the Data

Coordination Skills is at the top of the *Collaborative Learning Strategies*. The Year 4 and 5 students demonstrated a few instances of higher-order *Coordination Skills*, by asking or giving directions, praising and/or commending. These were expected results for students at this age and year level as they align with the taxonomies in the CISD model. However, a point of concern was identified while observing student interaction during the walkthrough tutorial at the very beginning of the gameplay. The walkthrough tutorial needed to be more specific at the beginning of the tutorials to provide the students with some extra assistance in establishing their game player roles, as some involvement and further explanation was required by the Researcher. Rather than the game narrator saying, "Touch the picture to hear the word" or "Touch all the letters to hear the sound", it would have been better for the game narrator to state the roles first and then the rules, such as "Player One: Touch the picture to hear the word", "Player Two: Touch all the letters to hear the sounds".

7.5.1.4 Coordination Skills Outcome

As a result of this analysis, it was determined that the CISD model would require a new element, to be placed in the Collaborative Design Phase. This new element, *Induction to Interaction Strategies*, will provide a rigorous framework to specify a method to assist collaborative instructional designers with the goal of creating collaborative interaction tutorials for collaborative learning applications. The Induction to Interaction Strategies element could introduce students to the new interactions and instruction on interface familiarisation; provide an introduction into the *Collaborative Learning Strategies*, Collaborative Interaction Strategies and Collaborative Assessment Strategies; and finally, provide tutorial support to scaffold learning and collaboration. The aim is to introduce the students to the new form of interactive engagement, by working with this new interactive computer technology. This specific set of instructions would need to be explicit in order to provide students with specific support and scaffolding/guidance to promote interaction strategies for learning.

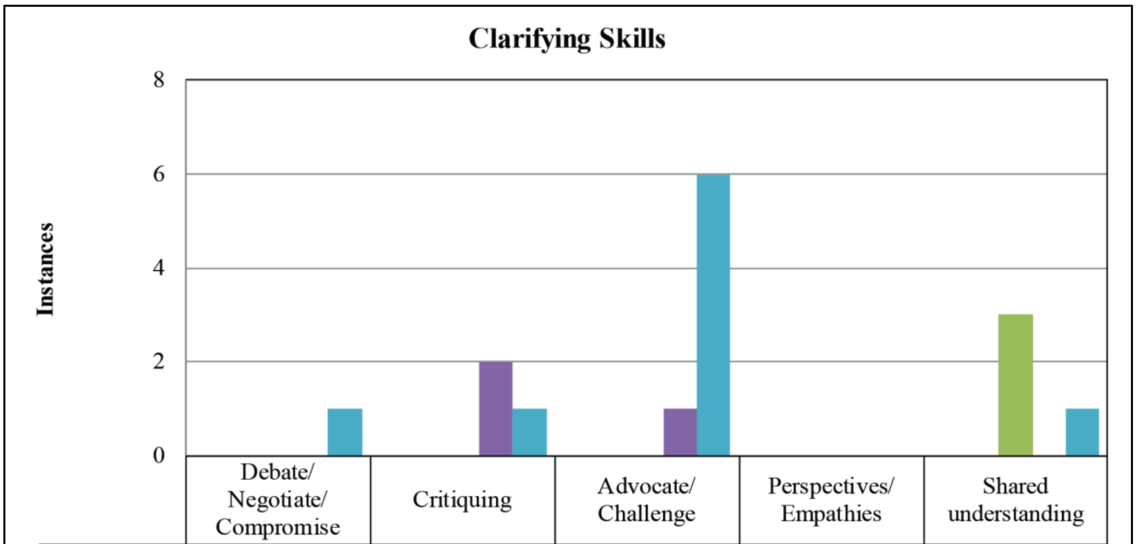
7.5.2 Clarifying Skills

The second element in the Taxonomy of Collaborative Learning Strategies is *Clarifying Skills* (see Figure 7-12). *Clarifying Skills* can be in the form of a statement, some knowledge and/or activity use, or implemented by a learner or learners in order to make a situation clearer or more apparent. While this skill is not considered to be as highly collaborative as *Coordination Skills*, it is still a higher-order skill set.

Clarifying Skills
- Debate/Negotiate/Compromise
- Critiquing
- Advocate/Challenge
- Perspectives/Empathies
- Shared understanding

Figure 7-12: Clarifying Skills

The next bar graph (see Figure 7-13) displays the next series of taxonomies relating to *Clarifying Skills*. *Clarifying Skills* provides some specific interpersonal skills that promote reflection, listening and encourages collaborative discussion. Advocate/Challenge was the most dominant skill in this taxonomy, followed by Shared understanding, Critiquing and finally Debate/Negotiate/Compromise.



	Debate/ Negotiate/ Compromise	Critiquing	Advocate/ Challenge	Perspectives/ Empathies	Shared understanding
Team One	0	0	0	0	0
Team Two	0	0	0	0	0
Team Three	0	0	0	0	3
Team Four	0	2	1	0	0
Team Five	1	1	6	0	1

Figure 7-13: Stage One, Taxonomy of Collaborative Learning Strategies - Instances of Clarifying Skills by Team (n=5)

7.5.2.1 Clarifying Skills Overview

Team One and Team Two show no instances in this set of skills. One explanation for this is that these two teams were not as active as the other three teams: with Team One being active for approximately ten minutes and Team Two being active for approximately eight minutes (see Table 7-2). The remaining three teams, in particular Team Five, had two advantages: the first being that while in their work area completing classwork, they were able to observe the actions of the first two teams. The second being that the extra time in gameplay gave the students more opportunity and confidence to express, talk, and speak up for themselves. This was particularly evident as the game progressed to higher levels and became more difficult.

7.5.2.1.1 Advocate/Challenge

Advocate/Challenge is midrange in the *Clarifying Skills* taxonomy. To advocate, in a collaborative sense, is where one participant would argue or support the other participant’s decision or choice. To challenge the choice is to question the other participant’s choice or selection (see Figure 7-14).

Team Five	**Team Four**
LEVEL 4 START (6:00 limit, missing _ _X) Word controller: inp Letter controller: tntman IVY loads **inp:** says, "IVY... /I/, /I/" **tntman:** begins to reach for the *v* shaped letter tile, but then touches the /I/ …. **inp:** (at the same time) repeats "IVY..." /I/.../V/... **tntman**: …then touches the /I/ lettersound, repeating the sound /I/ and passes it over **inp:** says, "No, wait..." repeating /I/, and then places the tile into the placeholder **tntman:** repeating the /v/ /v/ /v/ sound reaches for a *v* shaped letter tile. **inp:** is still talking about the /I/ letter tile and agrees that that is it (correct) **tntman:** reaches for the same /v/ letter tile and passes it over to inp **inp:** goes to place the letter tile into the placeholder, and says, repeatedly, the /v/ sound out aloud again **tntman:** reaching for the /V/ sound says “wait” **inp:** but inp has placed the v letter tile into the placeholder **FBM:** Good job! Note: inp repeats the letter sounds many times before placing it in the empty placeholder.	LEVEL 4 Word controller: Genesect Letter controller: Torchic MUG loads **Torchic:** selects and flicks across /M/ **Genesect:** says (whispers), "it's the other one" **Torchic:** selects /M/ and drags it back to the letter tile side and then selects and passes /m/ **Torchic:** touches and plays /m/ a few times (there is some lag) **Genesect:** drags slowly (lag) to the first empty placeholder in the meantime, **Torchic**: selects and passes /u/ (the /u/ letter tile) **Genesect:** reaches over and takes the /u/ letter tile. The /u/ letter tile lags and both players attempt to drag the letter across. **Genesect:** places the /u/ letter tile into placeholder **FBM:** Yay!

Figure 7-14: Two examples of Advocate/Challenge

It was found that as the game progressed, the teams began to find the game challenging. They became more vocal and would question the other team member and, sometimes, their own actions, either verbally – “Wait” or by a non-verbal action – dragging a letter tile back. The members in Team Five, in particular, would repeat the letter sound, demonstrating phonemic awareness, before handing over the letter tile, grapheme, or before placing the tile into the placeholder. The progressive levels of difficulty designed into the application encouraged communication skills, problem-solving skills, as well as verbal and non-verbal action. These were all expected and became more evident in the higher game levels.

7.5.2.1.2 Shared Understanding

Shared Understanding is where new knowledge creation is influenced through participation and collaboration; it is achieved by exchanging/moving from 'individual knowing' to 'group knowing'. As a result, the new knowledge that emerges from collective contributions changes from an individual perspective to a joint perspective (see Figure 7-15).

Figure 7-15 highlights Shared Understanding. Team Three and Team Five demonstrated two different ways of acquiring this skill. Team Three, at the beginning of the gameplay, lacked a clear understanding of the game rules. The Researcher and T2 stepped in on two occasions to provide a brief explanation of the game rules. The Researcher points out: "When you play the game you know that there are two letters …" and "It's actually Player One's (*tom's*) decision to make". T2 states: "One has the sound and one has its name". The point where Shared Understanding was reached was when *tom* states, "So, we have to put the sound of the letter…" After this point, the two team members went from 'individual knowing' to 'group knowing'. This is also highlighted in the second example where the students discuss the correct letter sound and when the word controller, whose role is to detect the missing letter sound, reaffirms the letter sound and agrees, "Ok".

Team Three	**Team Five**
LEVEL 1 START (3:00 limit, missing _ XX) Word controller: peter Letter controller: tom COW loads **peter** points to *C* **tom:** selects /C/ and passes it to peter **peter:** places /C/ into place holder (tries 2 times to get the tile in place) **FBM:** Oops! **tom:** touches and drags the letter /c/ into placeholder (all he had to do was touch the tile) tom says something, and peter shrugs his shoulders **FBM:** Well done! **Researcher:** When you play the game, you know that there are two letters that have different sounds. So, try both of them before you make a decision. SAT Loads **T2:** One has the sound, and one has its name. **tom:** selects and listens to /t/ at the same time, **peter:** selects /T/ and drags it over to the placeholder **The Researcher:** It's actually player ones (tom) decision to make **tom:** reselects the /T/ and places it back on the tile side of the screen. **tom:** reselects the /T/ and places it in the placeholder (which is peters role). **FBM**: O-oh! **tom:** "So, we have to put the sound to the letter?" **tom:** selects the highlighted /t/ and places the letter into the placeholder. **T2:** "you tell us???" (not sure if this was what was said) **tom:** "ok" **FBM:** Fantastic!	LEVEL 2 START (4:00 limit, missing XX_) Word controller: tntman Letter controller: inp OAR loads (there is a lot of external background noise – students changing class) **tntman:** says "it's *R* and points to both letters **inp:** tries to touch the letter **tntman:** says "its /R/" and begins to drag *R* to the placeholder there is a discussion between the two about the letter sound, **inp:** touches the letter /r/ **tntman:** states that it is an *r* sound - touching the letter tile /R/ both touch the *r* letter tiles - lots of /r/ and /R/ sounds (repeated letter sounds) **tntman:** finally agrees, "Ok" and takes the /r/ sound to the placeholder **FBM:** Well done!

Figure 7-15: Two examples of Shared Understanding

7.5.2.1.3 Critiquing

Critiquing provides a careful judgement, where one gives an opinion about the good and/or bad parts of something. Of the three portions of data allocated to this element, the one example in Figure 7-16 exemplifies Critiquing.

Team Four
LEVEL 2 (4:00 limit, Missing XX _)
Word controller: Genesect
Letter controller: Torchic

VET loads
Genesect: says, "/T/, /T/" (not the right sound)
Torchic: selects and passes in a flick motion the /T/ letter tile (the letter tile slides in a smooth motion across to the other side of the screen)
Genesect: selects /T/ but then stops and questions Torchics selection and says (whispers), "No, the other one because this one is...” (I cannot define what he has said) Genesect then pointing to the other /t/ letter tile
Torchic: selects /t/ and automatically flicks it over to Genesect
Genesect: places /t/ into placeholder (the /T/ tile is just above the /t/ tile)
FBM: Good job!

Figure 7-16: An example of Critiquing

The example shown in Figure 7-16 shows *Genesect* critiquing his own original decision, “No, the other one because this one is… ”. *Genesect* was able to identify the mistake via self-reflection. He was able to evaluate his choice, and correct his original judgement. The outcome here is the FBM result, “Good job!”.

7.5.2.1.4 Debate/Negotiate/Compromise

Only one team, Team Five, demonstrated the ability to debate/negotiate/compromise: *inp*, Word Controller, tried to discuss and talk through the problem, identifying and requesting the correct letter in the word BUN (see Figure 7-17). One of the challenges faced by *inp*, and other teams, was that *tntman* did not pay attention, no matter how much cajoling or encouragement. This would, at times lead to some frustration and impatience. For example: *inp,* who is the word controller, reaching over to touch both the /B/ and /b/ letter tiles, whilst *tntman* is thinking *t*, which is next to the *d* shaped letter tile, or when *tntman* decides that the /B/ is the correct letter, and even if *inp* is saying “no, wait”, completes *inp’s* role by inserting the letter into the placeholder.

Team Five
LEVEL 1 START (3:00 limit, missing _XX)
Word controller: tntman
Letter controller: inp

BUN loads
inp: repeats the word and says, "it's /B/"
tntman: waves finger over letter tile searching for the *B* shaped letter tile
tntman: goes to select /t/ (which is close to d)
inp: No, that's *t*
inp: pointing to a *b* shaped letter tile says, "That's *b*"
inp: impatiently touches the /B/ letter tile
tntman: pauses and looks on
inp: touches the /b/ letter tile then points back to the /B/ letter tile
tntman: selects the /B/ letter tile and goes to pass it over, placing the tile over the empty placeholder
inp: touches the /b/ letter tile and then watches as *tntman* passes over the /B/ letter tile
inp: says, "No" and then drags it back to the letter tile side of the screen
tntman: says, "Yeah" and passes it back over to the word picture tile side
inp: says, "bun"
tntman: places the /B/ letter tile over the empty placeholder and it locks into place
FBM: Oh dear!
the correct letter tile /b/ highlights, **inp** touches the *b* letter tile
FBM: Good job!
Researcher: If you don't agree with the letter, you are allowed to say that it is not the right letter and then you swap it over.

Figure 7-17: An example of Debate/Negotiate/Compromise

7.5.2.2 Clarifying Skills Summary of the Data

The data in *Clarifying Skills* demonstrated that three of the five groups were able to perform four skills within this element: Advocate/Challenge, Shared Understanding, Critiquing and finally Debate/Negotiate/Compromise skills. While the number of activities exhibited by the students at this skill level was slightly higher than those in *Coordination Skills*, again, this is considered appropriate for the age group of these students. Group dynamics/dominance/frustration was highlighted when *tom* grabs *peter's* letter tile to complete the learning task and in the interaction between *inp* and *tntman*. The learning task is considered to be appropriate for students at this level and would improve with the players' roles being better defined in the walkthrough tutorial

7.5.2.3 Clarifying Skills Outcome

The outcome in this level indicated that all the subsections in this part of the CISD model were in order. The issues of frustration and dominance experienced by the learners would be assisted with an improved walkthrough tutorial, as discussed in the Coordination Skills Outcome (see Section 7.5.1.4).

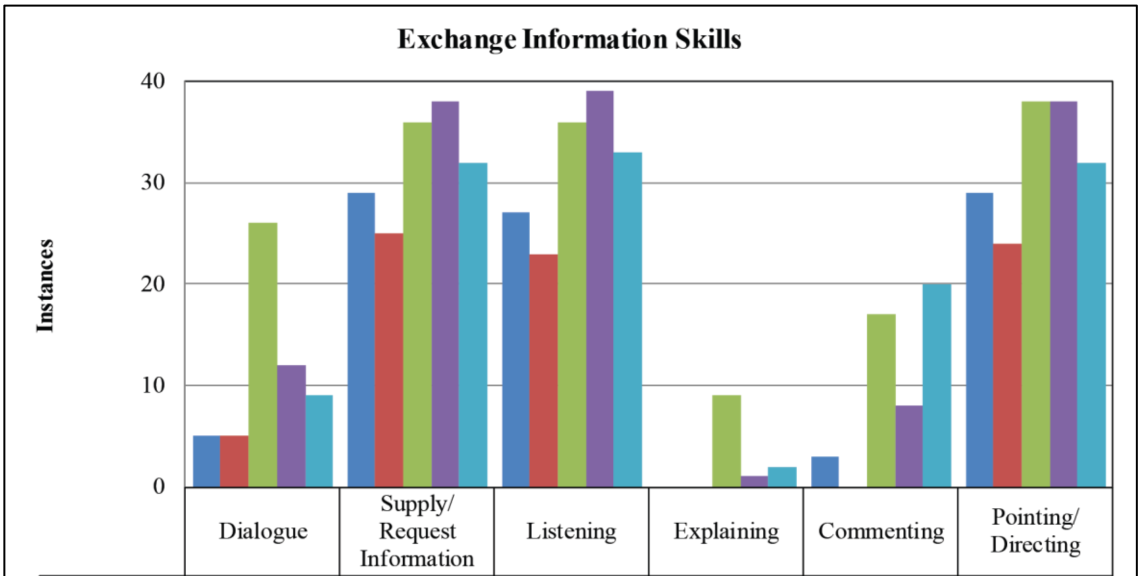
7.5.3 Exchange Information Skills

Exchange Information Skills
- Dialogue
- Supply/Request Information
- Listening
- Explaining
- Commenting
- Pointing/Directing

Figure 7-18: Exchange Information Skills

Exchange Information Skills is the third element shown in the Taxonomy of Collaborative Learning Strategies and is a two-way process of sharing information or a message transaction that can be verbal, using dialogue, or non-verbal, pointing. *Exchange Information Skills* rely on the learners (as two or more people), to be able to transmit and receive, code and decode, ideas and information. It is a method of communication. Figure 7-18 demonstrates the skills required for this activity.

The bar chart below (see Figure 7-19) shows that Pointing/Directing was the most dominant activity, very closely followed by Supply/Request Information, then Listening, Dialogue, Commenting and, finally, Explaining.



	Dialogue	Supply/ Request Information	Listening	Explaining	Commenting	Pointing/ Directing
Team One	5	29	27	0	3	29
Team Two	5	25	23	0	0	24
Team Three	26	36	36	9	17	38
Team Four	12	38	39	1	8	38
Team Five	9	32	33	2	20	32

Figure 7-19: Stage One, Taxonomy of Collaborative Learning Strategies - Instances of Exchange Information Skills by Team (n=5)

7.5.3.1 Exchanging Information Skills Overview

Exchanging Information Skills is the most active of all the subsections in Taxonomy of Collaborative Learning Strategies. The ability for students/learners to be able to exchange information involves specific interpersonal communication skills, both verbal and non-verbal.

7.5.3.1.1 Pointing/Directing

Pointing/Directing had the highest level of activity, followed by Supply/Request Information, Listening, Dialogue, Commenting and Explaining.

Pointing is a non-verbal action that is generally a hand-gesture, such as pointing the finger or a nod of the head. Directing can have two meanings: 1. Moving an object from one place to another, and 2. Using simple comments such as “No!”, “that one” or “over there”, to provide some form of guidance (see Figure 7-20). Pointing and Directing was expected to be the highest activity, in that the learning application was designed to work in a collaborative learning environment, using large-scale shared digital technology. This type of technology, in conjunction with the design of the phonics literacy application, encourages the sensory registers such as sight, touch, sound (see Section 6.2: The Phonics Learning Application).

Team Four
LEVEL 2 START (4:00 limit, missing XX_)
Word controller: Genesect
Letter controller: Torchic

TUB loads
Genesect: says, /B/, then proceeds to point and touch a (any) *b* shaped letter tile from the other side of the screen
Torchic: at the same time, goes to select and touch the same /B/ letter tile. The tile plays /B/
Torchic: nudges *Genesects* hand away and reselects, listens and tries to flick over the /B/ letter tile
Genesect: says, "No, that's not it. It's the other one"
Torchic: automatically touches and tries to flick across the /b/ letter tile (more lag)
Torchic: in flicking frustration accidently passes the /P/ letter tile
Torchic: reselects and tries to flick the /b/ letter tile.
(It maybe that in his haste to flick the letter tile over he is not touching the tile firmly enough to connect and pass - haptic motion)
Torchic: finally gets the /b/ letter tile to pass to *Genesect*
Genesect: selects and places /b/ into placeholder
FBM: Well done!

Figure 7-20: An example of Pointing/Directing

Team Two had the lowest number of activities, with 24 pointing/directing instances. This was followed by Team One, with 29 instances, followed by Team Five with 32 instances and, finally, Teams' Three and Four with 38 instances. The number of instances, in this case, correlates with the length of game time (see Table 7-2). Team Two was only active for just over eight minutes. The reason that Team Two was only active for such a short period of time was a technical issue, where the game froze and ceased to function. The only option for this team was to exit the game. This technical issue did not occur during the game testing and did not occur again in the remaining game sessions.

7.5.3.1.2 Supply/Request Information

Supply/Request Information showed the second highest level of instances. To supply information refers to the need for one to contribute or prove a learnt fact about something of someone else. To request information is where one asks for details, facts, or calls for a detail or fact about something or someone. Requesting information can be verbal and non-verbal using point gesture. One key design element of this phonics literacy application was the division of the tasks. The learners were given a specific task. One was to touch the picture, listen to the word and request the missing letter tile, and the other was for the student to touch, listen to the letter sounds and supply the missing letter tile or tiles.

Team Two	**Team Three**
LEVEL 2 START (4:00 Limit, missing XX_) Word Controller: lightning mcqueen Letter Controller: kobest AXE loads **kobest:** touches /e/ then touches /E/ **kobest:** begins to pass /E/ to *lightning_mcqueen* (there is a quiet inaudible discussion between the two players) **lightning_mcqueen:** points to the /e/, **kobest**: selects the /e/ (briefly) and passes it over to lightning_mcqueen **lightning_mcqueen:** places the /e/ into placeholder **FBM:** Great work!	LEVEL 2 START (4:00 Limit, missing XX_) Word Controller: tom Letter Controller: peter APE loads They are whispering to each other, and there is a discussion as there is a silent *e* **peter:** selects /e/ and passes it to tom **tom:** places /e/ into placeholder **FBM**: Great work!

Figure 7-21: Two examples of Supply/Request Information

The learners would request for the missing letter tile using the point gesture most of the time (see Figure 7-21), and at other times, quietly speak to one another to discuss the selection, or call for the missing letter. The phonics application was specifically designed for the learner to verbally request the missing letter tile, but the outcome showed that non-verbal gestures, such as pointing, worked just as well.

7.5.3.1.3 Listening

Listening was the next highest ranked exchange information skill. Listening is a communication skill that requires the learner to pay heed to something with thoughtful attention and to give consideration; to be able to make a decision, be able to reflect etc. Listening requires practice and focus. Listening is also a skill that can be verbal and non-verbal. The phonics game required that the learners use a number of listening skills, whether it was via listening to one another, and/or listening to the learning application, and to also watch for non-verbal cues such as body orientation, eye contact, facial expressions and so on.

Team One	**Team Four**
LEVEL 2 START (4:00 limit, missing XX_) Word controller: john Letter controller: Dave SUN loads **Dave:** selects and listens to /s/ and passes it over (the letter tile should be an *n*) **john:** goes to put it into place and **Dave:** realises his mistake **Dave:** selects and listens to /n/ and passes it over (the /s/ tile is still floating around) **john**: places the /n/ into placeholder **FBM:** Yay!	LEVEL 3 START (5:00 limit, missing X_X) Word controller: Genesect Letter controller: Torchic FAN loads **Torchic:** goes to select *f* shaped letter tile **Genesect:** says, (whispers) "No, /A/,/A/" and points to an *a* shaped letter tile **Torchic:** touches, selects and passes the /A/ letter tile **Torchic:** also, touches, swirls and passes an /f/ letter tile **Genesect:** says (whispers - indecipherable) "??the other *a*?" **Torchic:** selects /a/ and flicks it across to Genesect **Genesect:** selects and places /a/ into placeholder **FBM:** Fantastic! (while Genesect is placing the tile into the blank placeholder, Torchic is playing with the N letter tile and Genesect, having completed the word, passes the spare tiles back to Torchics side of the screen)

Figure 7-22: Examples of Listening

The examples in the table above demonstrate two forms of listening skills: the first is quite basic, in that, *Dave* makes his selection, which is incorrect; he was focusing on the first letter sound /s/. *Dave* realises he has made a mistake and corrects this by refocusing his attention, locates the correct letter shape, tapping and listening to the letter shape, and then passes it over. The second example demonstrates a mixture of listening/non-listening skills. It appears *Torchic* is not concentrating and begins the game by assuming that the missing letter is an *f*. *Torchic* is also being quite distracting with his finger swirling, letter flicking antics. *Genesect* is, however, very patient and focused on completing the task, listens to *Torchic's* selection and corrects him, *"No, /A/, /A/... ",* and *"[it's] the other a".* The tone *Genesect* uses while using the pointing gesture towards the correct letter tile at the same time, brings *Torchic's* attention back to the task. *Torchic* selects the correct letter and passes it over. *Genesect* completes the task objective.

7.5.3.1.4 Dialogue

Dialogue is the fourth skill in *Exchange Information Skills*. Learners at this age level are expected to be able to participate in a discussion and conversation. In terms of *Exchange Information Skills*, it is one method used to achieve something either both learners or groups of learners, want together. In other words, Dialogue creates a social interaction which encourages discussion and enables the construction of knowledge and facilitates learning.

Team Two	**Team Three**
LEVEL 1 START (3:00, missing _XX) Word Controller: kobest Letter Controller: lightning mcqueen GYM loads **lightning_mcqueen:** selects and listens to g and then selects *g* /j/ (Note: the *j* in this instance is the substitute for the *g* sound in *g*ym) They whisper to one another (indistinguishable) **lightning_mcqueen:** passes *g* /j/ over to *kobest* **kobest:** takes the *g* /j/ and places it into the placeholder (there is some game lag, and kobest has to touch and drag it twice) **FBM:** Great work!	LEVEL 4 START (6:00, missing _XX) Word Controller: tom Letter Controller: peter APE loads **Both:** say *"Ape"* **tom:** says /A/? **Both:** say /a/ **peter:** looks for the /a/ tile **peter:** touches /a/ and passes it to tom **tom:** places /a/ into placeholder **tom:** says /P/ **peter:** touches /p/ and then the letter tile /k/ (finger waves indicating he selected the wrong tile and continues to look for the other *p* letter tile) **tom**: points to the other *p* letter tile and says, "that one down there". **peter:** touches /p/ and passes it over to tom's side of the screen and the tile locks into the placeholder **FBM:** That's not it!! The letter A highlights **tom:** says "oh?" peter: touches the A tile and passes it to tom (this action is not necessary)

Figure 7-23: Examples of Dialogue

The examples above demonstrate the use of dialogue by learners in order to achieve their objective. It was hoped that the teams would have been more open to group discussion among themselves. In many instances, the learners would whisper to one another. This was more evident in the two early teams and, to some extent, the latter teams. Given that this was the first and only time the learners used the large-scale shared digital environment and application, the outcome was low. However, as learners interact and become more comfortable with this new collaborative learning environment, it is expected that the dialogue should increase.

7.5.3.1.5 Commenting

Commenting is the penultimate Exchange Information Skill where learners were expected to provide a verbal observation or remark, and/or be able to express an opinion or attitude.

Team Three
LEVEL THREE START (5:00, missing X_X)
Word Controller: tom
Letter Controller: peter

VAN loads
tom: says *a* (*aye*, but not for the sound he has heard, more for the shape of the letter), “it's up top” - and point to the letter tile
peter: touches and listens to the tile - sound of /a/
tom: ‘yes, that's the one’
peter: passes /a/ to tom
tom: places /a/ into placeholder
FBM: Well done!

Figure 7-24: An example of Commenting

Team Three and Team Five had the highest proportion of this skill, with Team Five (see Figure 7-19) demonstrating 20 instances and Team Three demonstrating 17 instances. Examples like the one above where *tom* states, “Yes, that’s the one”, or in another chunk of text where *tom* says, “that doesn’t sound like it” also illustrate this. *Tom* was the dominant player in this team; it is his ability in expressing himself that would provide *peter* with the assistance required in making decisions to complete their task

7.5.3.1.6 Explaining

The fourth feature in *Exchange Information Skills* was Explaining. Explaining was the lowest rating skill. Explaining, in this research, is defined as making (something) clear or easy to understand, to tell, show, or be the reason for an action or cause of something; an event. Explaining, in relation to this thesis, relates to two points: 1. learners being able to explain an idea, concept and/or plan from one to another and 2. the learning application designed for the large-scale shared digital space having practical affordances, such as letter tiles or picture tiles to represent the interactive content being straightforward and working correctly.

Team Four
LEVEL 2 START (4:00 limit, missing XX_)
Word controller: Genesect
Letter controller: Torchic

VET loads
Genesect: says, /T/, /T/ (not the right sound)
Torchic: selects and passes in a flick motion the /T/ letter tile (the letter tile slides in a smooth motion across to the other side of the screen)
Genesect: selects /T/ but then stops and questions Torchics selection and says (whispers), "No, the other one because this one is...” (I cannot define what he has said, but he is pointing to the other /t/ letter tile)
Torchic: selects /t/ and automatically flicks it over to Genesect
Genesect: places /t/ into placeholder (the /T/ tile is just above the /t/ tile)
FBM: Good job!

Figure 7-25: An example of Explaining

Genesect uses a simple statement like, “No, the other one because this one is …” to explain what was required when *Torchic* passes over the wrong letter (see Figure 7-25). Teams One and Two, had a zero number of instances, as they were the two early teams, and Team Two were only active for a short time. Teams Four and Five experienced a low number of instances. These two teams demonstrated a higher level of understanding as they were able to observe the previous teams. Having said that, Team Three accrued a higher number of instances in explaining as, at different times, one member or the other would observe the required letter tile and point it out, making statements like *tom*, “That one sounds like the letter”, or when *tom* points to the other *p* letter tile and says, "that one down there". This does not mean that they lacked in understanding the application, they were just more vocal. At times, one was more dominant, but they were prepared to work through the problem.

7.5.3.2 Exchanging Information Skills Summary of the Data

Exchanging Information Skills aligns closely with the cooperative learning end of the scale. As discussed in Section 5.5.1, the *Taxonomy of Collaborative Learning Strategies* – Methods, *Cooperative Learning Skills* is where learners begin to work together in small groups and is an important starting point. This is also where learners begin to gain their social skills and practice working together. This accounts for the higher ‘activity and instance’ count for this element and is expected of learners at this age level.

7.5.3.3 Exchanging Information Outcome

The tutorial did not demonstrate to the students the necessary/complete interpersonal skills required for the activity, nor did it indicate that talking/discussion was allowed. This data shows that the tutorial required a more stringent approach to encourage the learners to interact with each other, face-to-face, to exchange information, put forward their opinions and to discuss the task.

7.5.4 Cooperative Learning Skills

Cooperative Learning Skills is the least collaborative of all the elements listed in the Taxonomy of Collaborative Learning (see Figure 7-26).

Cooperative Learning Skills
• Assigned duty (task) • Planning • Scheduling

Figure 7-26: Cooperative Learning Skills

Cooperative Learning Skills is where the learner or learners begin to practice their social skills by working together in small groups but are working towards their own individual goals.

7.5.4.1 Cooperative Learning Skills Overview

Assigned duty (task), Planning and Scheduling are the three characteristics of *Cooperative Learning Skills*. The number of instances recorded for this element in the taxonomy was very low; with only two instances being recorded in Assigned Duty.

7.5.4.2 Cooperative Learning Skills Summary of the Data

Assigned duty was the only element that was active. Assigned duty is where one player gives someone a particular job or duty or requires someone to do a particular task. Teams' One and Three recorded one instance each. Team Three's occurred early in the game, where the team members were not entirely sure of what was required of one another, and the second in Team One, occurred late in the game, where one player, the word controller, reminds the letter controller that he was required to complete his role in the task.

7.5.4.3 Cooperative Learning Skills Outcomes

The learners have brought the least possible; *Cooperative Learning Skills*, to the table. This is because the individual tasks were built into the phonics learning application (see Section 6.2: The Phonics Learning Application). The phonics literacy application was explicitly designed for the learners to work in a collaborative sense, in a collaborative environment. This outcome was expected and indicates that no changes were required in the CISD model

7.6 Stage One: Observational Study – Collaborative Interaction Strategies

Collaborative Interaction Strategies is the second sub-phase in *Collaborative Instructional Strategies*. This second sub-phase provides a number of activity structures or role types to be used as a guiding principle, ranging from formal to informal, structured to unstructured or entirely independent. Collaborative Interaction Strategies includes a taxonomy that provides a series of elements relating to the different interaction strategies available. These elements ranged from being highly collaborative in nature, *Roles/Task Division*, to those considered to be more cooperative; *Unstructured* or unrestricted, that offers a free-for-all (see Figure 7-27).

Practice – Taxonomy of Collaborative Interaction Strategies
Roles/Task Division Assigning users specific roles and tasks.
Production Line A process where each user completes a specific task and then passes it on to the next.
Proposer/Critique Where one user works on a task and the other is critiquing.
Ownership A user is assigned a specific icon which can be dragged onto an object, thus claiming ownership.
Workspace Division Dividing the workspace into distinct and specific individual work areas.
Unstructured That is unrestricted access where everyone may take part (Free-for-all and no tracking occurs)

Figure 7-27: Taxonomy of Collaborative Interaction Strategies

7.6.1 Data Analysis

The element *Roles/Task Division* is a highly organised collaborative process where the learning tasks were divided or broken down into basic components, and the learners have been assigned specific roles and tasks (see Figure 2-28 Task Decomposition for a phonics application in Section 2.7.2.1: Task Analysis and Cognitive Learning Task Analysis).

Regarding task decomposition, the activities or sub-components were reduced to smaller sub-tasks, and these small divisions were distributed between the learners. In relation to the phonics technique, the main task was divided into two sub-components; phonemes and graphemes, which were distributed between two learners. The first learner (word controller) would control the picture tile with a word sound. Situated below the picture tile was the related word text that included specific missing letters, depending on the level of the game. The second learner (letter controller) would be in control of the letter tiles with the phonic sounds. The learners would each complete five-word tiles in a level. As each learner completed their five words, the roles would reverse, and the process would begin again.

The phonics literacy application was the result of an extensive design process (see Section 6.2: The Phonics Learning Application). The interaction strategies selected for the phonics literacy application were formal, *Roles/Task Division*, where the learners activities were highly structured, with each learner being assigned a role and specific tasks being allocated and distributed. Tools and interactions specifically associated with a role were then located in the screen space adjacent to that learner. Therefore, when the roles were swapped after five turns, the interface layout was also rearranged to provide the required tools and interactions to each learner.

The data for this taxonomy is the result of merging the two data types available for analysis in Task/Role division: The Student Activity Log report, and the observational data captured in the transcription from the video analysis.

As discussed in Section 7.4.2: Student Activity Log - Report, this report provides an invaluable tool for the teacher, specifying where students may need extra support and/or help. The initial analysis of the Student Activity Log data provided insight into the learners activities. The observational data provided a comprehensive picture of the discussion/s and activities that occurred. This observational data, when merged with the Student Activity Log, filled the gaps for the analysis of the Taxonomy of Collaborative Interaction Strategies.

These rich datasets were then aligned with the task/sub-tasks breakdown and distribution shown in Chapter 6, Figure 6-6: The Phonics Learning Task Breakdown, resulting in a sequence of activities as shown in Tables 7-5 to 7-7. Table 7-4 provides the task-type description legend to be used to explain the activities from the merged data sets. The numbered items relate to the tasks/sub-tasks, and the coloured items relate to the type of activity involved. *Roles/Task Division path* reveals the trail sequence of the learner’s activities. *System Generated* relates to an activity that has been built into the game, as the learner has no control over the words that load up. If the learners choose to, however, they are able to select any of the words, in any order, to complete. *In task* relates to when the learner completes the correct task in their role. *Out of task* relates to when the learner completes the other learner's task. Finally, *Tactile Exploration* relates to when a learner completes extra tactile activity; an inquiring mind who is curious and inquisitive.

Task	Sub-Task	Description
0.0PAL		The picture with Audio autoloads
1.0WC		WC touches the picture to listen to the sound
2.0WC		WC requests missing letter tile
3.0LC		LC selects and passes letter tile over to WC
4.0LC		LC selects and passes letter tile over to the WC
	4.1LC	LC returns letter tile
5.0WC		WC touches letter tile, and places letter tile into missing placeholder
	5.1WC	WC returns letter
6.0AF		Automatic Feedback
WC		Word Controller
LC		Letter Controller
		Roles/Task Division path
		System Generated
		In task
		Out of task
		Tactile Exploration

Table 7-4: Legend to the Taxonomy of Interaction Strategies

Table 7-5 and Table 7-6 are interrelated. The analysis of the activity shown in Table 7-5 is the last word, completed by Team 5 in level one, with *inp* as the word controller. This is also evident in Table 7-6, which demonstrates the role reversal with the first word completed by *tntman* as the word controller.

The task sequence begins, as shown in Table 7-5, with a system-generated entry; the word "bun". During the gameplay session, the learners are in their allocated roles, and to begin, *inp* is the word controller.

LEVEL 1 START(3:00 limit, missing _XX)				
Word controller: inp				
Letter controller: tntman				
Available Words: kid, gum, fox, tub, bun				
Time	**Task Type**	**WC**	**LC**	**Activity**
0:00	0.0PAL			**Current word changed to: bun**
0:01	2.0WC	inp		says "bun"
0:03	2.0WC	inp		says, "it's /B/"
0:03			tntman	goes to select /t/
0:04		inp		says, "no, that's *t*"
0:04	2.0WC	inp		points to a *B* shaped letter tile
0:05	2.0WC	inp		says, "That's *B*",
0:07	3.0LC	inp		touched letter tile /B/
0:08	3.0LC	inp		touched letter tile /b/
0:09	3.0LC		tntman	touched letter tile /B/
0:09	4.0LC		tntman	selects /B/
0:12	4.0LC		tntman	passed letter tile /B/ to inp
0:12		inp		says, "No"
0:13	5.1WC	inp		returns letter tile /B/ to LC
0:14	3.0LC		tntman	touched letter tile /B/
0:14			tntman	says, "yeah"
0:14	4.1LC		tntman	passes same letter tile /B/ to WC
0:16	5.0WC		tntman	placed /B/ letter into placeholder
0:16	3.0LC		tntman	touched letter letter tile /B/
0:16	2.0WC	inp		repeats word, "bun"
0:16	6.0AF		tntman	moved letter tile /B/ to position 1 (incorrect)
0:17	6.0AF			**FBM: Oh dear!**
0:18	3.0LC	inp		touched highlighted letter tile /b/
0:19	6.0AF			**FBM: Good job!**

Table 7-5: Team 5 - Phonics Game Activities

In Table 7-6, *inp* is the letter controller. The *Roles/Task Division* path flows backwards and forwards. This demonstrates that the design process of this taxonomy, where the learners are assigned their specific roles and tasks, is taking place. The learners are dynamically interacting, discussing and switching roles.

Table 7-6 also demonstrates this same process. Again, here is what the system is doing: the screen populates with picture words and text load. The learners are in their roles: the word controller and the letter controller. The learners are then engaging, dynamic and interactive and finally, they are switching their roles to begin the process again. All these features were part of the design process which took into consideration task division and task roles and then incorporated these into the collaborative learning environment such as the large-scale shared digital space (LSSDS). The learning application was designed to be flexible, as there are times where one learner would reach over to touch the other learner's side of the screen and see the task types that are orange. This flexibility enables one learner to peer mentor the other learner, in that, a stronger learner helps the weaker learner in a social context (see Section 7.5.1.2: Peer-support). This is expected in a student-centred learning environment.

PLAYERS SWAP ROLES				
Word controller: tntman				
Letter controller: inp				
Available Words: cow, eel, ice, fox, run				
Time	**Task Type**	**WC**	**LC**	**Activity**
0:00	0.0PAL			**Current word changed to: cow**
0:02			inp	says, "Cow"
0:02		tntman		says, "Cow" at the same time
0:04	3.0LC		inp	touched letter tile /w/
0:05	3.0LC		inp	touched letter tile /w/
0:05	3.0LC		inp	touched letter tile /w/
0:06	4.0LC		inp	passed letter tile /w/ to tntman
0:07	5.0WC	tntman		touched letter tile /w/
0:08	5.1WC	tntman		passed letter tile /w/ to inp
0:08	5.1WC	tntman		returns the w letter tile and says, "C"
0:09	3.0LC		inp	touched letter tile /w/
0:09	4.0LC		inp	goes to pass /w/ back over
0:10	4.1LC		inp	realises mistake, saying, "oh, cow" and retrieves the /w/
0:11	4.0LC		inp	selects /C/
0:12	4.0LC		inp	touched letter tile /C/
0:14	5.0WC	tntman		touched letter tile /C/
0:14	5.0WC	tntman		moved letter tile /C/ to position 1 (incorrect)
0:15	6.0AF			**FBM: That's not it!!**
0:17	3.0LC		inp	touched letter tile /c/
0:18	6.0AF			**FBM: Well done!**

Table 7-6: Team 5 - Phonics Game Activities – players swap roles.

Table 7-7 is another example, using Team 4. The pattern shown here is similar to those in Table 7-5 and Table 7-6, where the learners are interacting together and swapping roles, with a similar backward and forward flow. This flow indicates that the design process is working and that in a social activity the division of the tasks and the distribution amongst learners is necessary for learners to be able to collaborate effectively.

Table 7-7 also provides an example of an extra activity, shown in pink. This learner, *Torchic*, could be a kinaesthetic learner, in that, he is learning to process information in this new LSSDS learning environment. This new learning environment provides *Torchic* with a new way of engaging his senses through visual and auditory senses. *Torchic* is benefitting through exploration. It should also be noted that in this case, it was *Torchic's* role as the letter controller to touch the letters, and his playing with the letter tiles could have been a way for him to familiarise himself with the different letter tile sounds.

LEVEL 3 START(5:00 limit, missing X_X)				
Word controller: Genesect				
Letter controller: Torchic				
Available Words: gum,fan, cup, wig, log				
Time	**Task Type**	**WC**	**LC**	**Activity**
0:00	0.0PAL			**Current word changed to: fan**
0:01	3.0LC		Torchic	goes to select *f* shaped letter tile
0:03	3.0LC		Torchic	touched letter tile /f/
0:04	3.0LC		Torchic	touched letter tile /f/
	2.0WC	Genesect		whispers, "No, A, A" and points to an *a* shaped letter tile
0:04	3.0LC		Torchic	touched letter tile /A/
0:05	4.0LC		Torchic	passed letter tile /A/ to Genesect
0:05			Torchic	touched letter tile /f/
0:07		Genesect		touched letter tile /f/
		Genesect		whispers, (indecipherable) "It's the other *a* ?"
0:09	3.0LC		Torchic	touched letter tile /a/
0:10	4.0LC		Torchic	passed letter tile /a/ to Genesect
0:10	5.0WC	Genesect		touched letter tile /a/
0:10	5.0WC	Genesect		touched letter tile /a/
0:11	5.0WC	Genesect		touched letter tile /a/
0:12	5.0WC	Genesect		moved letter tile /a/ to position 2 (correct)
	6.0AF			FMB: Fantasic!
(while Genesect is placeing the tile into the blank placeholder, Torchic is playing with the N lettertile and Genesect, having completed the word, passes the spare tiles back to Torchics side of the screen)				
0:12			Torchic	touched letter tile /N/
0:13			Torchic	passed letter tile /N/ to Genesect
0:14		Genesect		touched letter tile /N/
0:15		Genesect		passed letter tile /N/ to Torchic
0:15		Genesect		touched letter tile /A/

Table 7-7: Team 4: Phonics Game with additional activities

7.6.2 Data Results

As the learners completed each level, the complexity of the game would increase. These roles and tasks alternated at the completion of a set of words. To begin, the learners were not that open to discussion. This may be the result of having come from a traditional classroom environment where students, most of the time, are expected to listen to the teacher. The Researcher observed that as the learners progressed through the levels, they became more vocal and animated as the level of interactivity increased.

The increased level of interactivity was more apparent with Teams Three to Five, who managed to complete Level Four (see Table 7-2). The activity shown in Levels' One and Two are consistent with nearly all players

This is an outcome that was expected, and no changes were identified for this sub-phase of the model.

7.7 Stage One: Observational Study – Collaborative Assessment Strategies

The third and final sub-phase in *Collaborative Instructional Strategies* is Taxonomy of Collaborative Assessment Strategies. The Taxonomy of Collaborative Assessment Strategies was developed to measure and provide specific activities/behaviours, group practices and skills such as the coordination of *group interactions – workflows*. These strategies are highly collaborative, down to practices that are measured case-by-case, and are considered to be more cooperative in (see Figure 7-28).

Indicators – Taxonomy of Collaborative Assessment Strategies
• Effectively coordinated group interactions – work flow • Interdependency • Discussion • Peer assessment
• Clear/comprehensible • Explicable (capable of being understood) • Critical review/Evaluation • Discussion • Moving onto next task • Completion of task • Quality of completed task
• Communication • Directive Skills • Reciprocity – mutual exchange • Relay - the frequency, the relevance, the coordination of spoken communication • Gestures
• Independent/autonomous • Not controlled • Case-by-case

Figure 7-28: Taxonomy of Collaborative Assessment Strategies

In analysing this sub-phase of the model, there is a need to consider how the previous sub-phase, Taxonomy of Collaborative Interaction Strategies - *Roles/Task Division*, would influence the outcome of activities in this sub-phase. The phonics learning activity was conceived to encourage or prompt many of the behaviours and reactions in this observational study. The phonics learning activity was designed to be flexible, especially in regard to the different levels of collaboration and collaborative learning, and this is demonstrated in the outcomes of the different groups. The pairing of the groups would also have an influence, in that a stronger learner could be paired with a weaker learner. Therefore, it would be anticipated that there would be a correlation between the outcomes of the Taxonomy of Collaborative Interaction Strategies - *Roles/Task Division*, which is a highly organised collaborative process, to the direct lateral assessment strategies, also considered to be a high-order collaborative skill.

7.7.1 Data Analysis

Table 7-8 below is the complete visual matrix representation of the data analysis from the third sub-phase, Taxonomies of Collaborative Assessment Strategies.

Collaborative Assessment Strategies	Team One	Team Two	Team Three	Team Four	Team Five
Effectively coordinated group interactions - Work Flow	31	31	44	44	46
Interdependency	54	30	44	47	48
Discussion	9	7	28	11	36
Peer Assessment	6	0	9	12	19
Clear_Comprehensible	0	1	7	22	29
Explicable (capable of being understood)	0	4	20	8	18
Critical Review_Evaluation	4	1	3	4	20
Advocate	0	0	7	6	1
Moving onto next task	0	0	0	0	0
Completion of task	0	0	0	1	1
Quality of completed task	0	0	0	0	0
Communication	10	6	24	30	31
Directive Skills	3	2	19	21	25
Reciprocity - Mutual Exchange	26	22	37	50	43
Relay	29	22	39	17	42
Gestures	29	25	40	43	43
Independent_Autonomous	0	0	0	1	1
Not Controlled	0	0	0	0	0
Case-by-case	0	0	0	0	0

Table 7-8: Stage One Taxonomy of Collaborative Assessment Strategies - Total of the student activity (n=total number of Collaborative Learning Strategies)

In order to tell a more meaningful story, these strategies are chunked (see Figure 7-28), and discussed in order of dominance.

Interdependency is the most dominant strategy, followed by *Effectively coordinated group interactions – workflow*, then followed by Discussion and finally, Peer Assessment.

Collaborative Assessment Strategies	Team One	Team Two	Team Three	Team Four	Team Five
Effectively coordinated group interactions - Work Flow	31	31	44	44	46
Interdependency	54	30	44	47	48
Discussion	9	7	28	11	36
Peer Assessment	6	0	9	12	19
Clear_Comprehensible	0	1	7	22	29
Explicable (capable of being understood)	0	4	20	8	18
Critical Review_Evaluation	4	1	3	4	20
Advocate	0	0	7	6	1
Moving onto next task	0	0	0	0	0
Completion of task	0	0	0	1	1
Quality of completed task	0	0	0	0	0
Communication	10	6	24	30	31
Directive Skills	3	2	19	21	25
Reciprocity - Mutual Exchange	26	22	37	50	43
Relay	29	22	39	17	42
Gestures	29	25	40	43	43
Independent_Autonomous	0	0	0	1	1
Not Controlled	0	0	0	0	0
Case-by-case	0	0	0	0	0

Table 7-9: Activity Logistic Strategies

The role/task Interdependency is where the participants are reliant on each other, via a sequence of operations. This is specifically evident in the workflow where one learner is reliant on the other learner to complete a specific task (see Figure 7-29). Following group interaction is Effectively coordinate group interactions. *Effectively coordinate group interactions – workflow*, is where the learners were required to actively work together from beginning to end. All the teams demonstrate a high number of interdependencies and coordinated group interactions, especially Teams Three to Five.

Team Three
LEVEL 4 START (6:00 limit, missing _ _X)
Word controller: **tom**
Letter controller: **peter**
Available Words: nut, ape, ham, owl, sad

NUT loads
tom: says *"N"*
peter: locates /N/ and then /n/
peter: selects /n/ and passes it to tom
tom: places /n/ into placeholder
at this same time
peter looks for and locates the second missing tile
peter: touches /U/ and then /u/
peter: passes /u/ to tom
tom: places u into placeholder
FBM: Good job!

Figure 7-29: An example of Effectively coordinated group interactions and Interdependency

Discussion is where the activity encouraged the learners to verbally interact with each other. Discussion is a type of activity which could include open discussion or whispering to each other. All teams exhibited the ability to do this, and in most cases, the type of discussion that occurred was related to the clarification of the phoneme. Examples of these are shown below (see Figure 7-30).

Team Five
LEVEL 2 START (4:00 limit, missing XX_)
Word controller: **inp**
Letter controller: **tntman**
Available Words: cup, sat, oar, tag, ten

OAR loads
(lots of background noise)
inp: says, "/r/"
tntman: says *"it's /r/"* and points to both letters
inp: tries to touch the second *R* letter tile
tntman: says *"its /R/"* and begins to drag /R/ to placeholder
there is a discussion about the letter sound between the two,
inp: touches the letter /r/
tntman: states that it is an /R/ sound - touching the letter tile /R/
both touch the letter tiles - lots of /r/ and /R/ sounds
tntman: finally agrees, "Ok" and takes the /r/ sound to the placeholder
FBM: Well done!

Figure 7-30: An example of Discussion and Peer Assessment

Figure 7-30 also demonstrated a form of Peer assessment. Peer assessment relates to the giving and receiving of feedback for learning and is very much part of the constructivist approach to learning. Peer assessment can be verbal, non-verbal or both. For example, a non-verbal peer assessment may include gestures such as shaking/nodding of one's head and/or pointing. Verbal peer assessment includes responses/feedback such as "yes, that's it" or "No, it's that one". The high level of activity is to be expected in this area and relates back to the selection of the interaction; Strategy - Role/Task Division, where the users were assigned specific roles and tasks.

The next set of assessment strategies are Clear Comprehensible, Explicable (capable of being understood), Critical Review and Evaluation, Advocate, Moving onto next task, Completion of task and lastly, the Quality of completed task.

Collaborative Assessment Strategies	Team One	Team Two	Team Three	Team Four	Team Five
Effectively coordinated group interactions - Work Flow	31	31	44	44	46
Interdependency	54	30	44	47	48
Discussion	9	7	28	11	36
Peer Assessment	6	0	9	12	19
Clear_Comprehensible	0	1	7	22	29
Explicable (capable of being understood)	0	4	20	8	18
Critical Review_Evaluation	4	1	3	4	20
Advocate	0	0	7	6	1
Moving onto next task	0	0	0	0	0
Completion of task	0	0	0	1	1
Quality of completed task	0	0	0	0	0
Communication	10	6	24	30	31
Directive Skills	3	2	19	21	25
Reciprocity - Mutual Exchange	26	22	37	50	43
Relay	29	22	39	17	42
Gestures	29	25	40	43	43
Independent_Autonomous	0	0	0	1	1
Not Controlled	0	0	0	0	0
Case-by-case	0	0	0	0	0

Table 7-10: Critical Discussion Strategies

These strategies relate to what and how the learner/learners respond or react and/or behave when presented with a situation that required further clarification or was not comprehensible. These strategies are considered to be synchronous and could be verbal or non-verbal.

The first area that is evident is the activity of Team One and Team Two, which are lower than the remaining three teams. This is possibly due to the length of gameplay and lower overall number of words completed. These teams were the first two who seemed unsure of what was required of them and may have been getting a feel for the game. Team Two also experienced the unexplained technical issue, thus shortening their gameplay.

The first two teams set a precedent with the phonics play, in that the remaining teams, (while working on their class work), were still able to observe gameplay and listen from the sidelines, giving these team members more confidence. This is apparent in the first two activities, where the learners would be Clear/Comprehensible: be able to clarify their actions, and/or be Explicable: understandable or able to explain their actions/reactions in a clear and concise manner when playing the game. Critical Review and Evaluation and Advocate have fewer instances, as do Moving onto next task, Completion of task and Quality of completed task.

Team Five was the most active of the teams; Team Five also had a high number of recorded activities in all the above strategies. This high level of activity can, in part, be attributed to the fact that they were able to observe the other teams at play and that they were able to complete nearly all the levels of phonics gameplay. However, Moving onto next task and Quality of completed task, recorded zero number of activities, and Advocate and Completion of task recorded one instance each. This low level of activity relates to the design of the phonics learning application. In this group of strategies, these interactions were not expected as the groups did not have to make a conscious decision to move onto the next task, nor did the group have to evaluate and decide if the criteria or the goals for the task were met. The system was designed to make these decisions for them.

The two activities recorded for the Completion of the task related to Team Four and Team Five, who have one instance each where they placed a letter tile into the incorrect placeholder and, when realising their mistake, tried to remove it. This was a design matter which was not discovered during the system testing phase in Phase Five: *Development/Release – implementation* and would need to be considered for further development.

Where two or more letters were missing, in levels 4-7, if the word controller placed the letter tile into the incorrect placeholder, the letter tile would lock and could not be corrected if the word controller realised their mistake. Therefore, in these two instances, the teams were not able to finish their task. Once the letter tile locks into the placeholder, it is the system that judges if the word is right or wrong. These two separate instances are minor and did not impact on the teams' ability to continue the gameplay, but this has been noted as a software update for future research.

The third series of strategies in the Taxonomy of Collaborative Assessment Strategies concerns what and how the teams respond, react and/or behave when sharing and exchanging information. Reciprocity – Mutual Exchange, Relay, Gestures are the most dominant activities, followed by Communication and Directive Skills (see Table 7-11).

Collaborative Assessment Strategies	Team One	Team Two	Team Three	Team Four	Team Five
Effectively coordinated group interactions - Work Flow	31	31	44	44	46
Interdependency	54	30	44	47	48
Discussion	9	7	28	11	36
Peer Assessment	6	0	9	12	19
Clear_Comprehensible	0	1	7	22	29
Explicable (capable of being understood)	0	4	20	8	18
Critical Review_Evaluation	4	1	3	4	20
Advocate	0	0	7	6	1
Moving onto next task	0	0	0	0	0
Completion of task	0	0	0	1	1
Quality of completed task	0	0	0	0	0
Communication	10	6	24	30	31
Directive Skills	3	2	19	21	25
Reciprocity - Mutual Exchange	26	22	37	50	43
Relay	29	22	39	17	42
Gestures	29	25	40	43	43
Independent_Autonomous	0	0	0	1	1
Not Controlled	0	0	0	0	0
Case-by-case	0	0	0	0	0

Table 7-11: Information Exchange

Reciprocity-Mutual Exchange is the ability to exchange something with others for mutual benefit, be it verbal or non-verbal. This idea of *quid pro quo* can foster relationship building, promote social interaction and encourage collaboration. Reciprocity was achieved by designing the game so that the players stood side-by-side. This encouraged the sharing of information and, at times, one player would question the other player's motives (see Figure 7-31).

This is followed by Gestures. Gestures are a form of non-verbal communication and relate to the movement of the limbs or body as a means of expressing an idea or feeling. Pointing and nodding are two of the most common gestures. All teams demonstrated a high level in this area, as certain strategies such as body language are unavoidable and necessary in the table environment.

The next strategy is Relay. Relay relates to the ability to pass information, verbally, from one person to another. This includes the frequency, the relevance of the discussion and how the method of communication was coordinated. All teams demonstrated the ability to relay. Team Five demonstrated a high level and Team Four a low level of relaying information instances. Team Five were an active team, and were quite vocal, whereas Team Four performed and completed the required tasks in a quieter, non-verbal manner.

Team Four
LEVEL TWO START (4:00 limit, missing XX_)
Word controller: Genesect
Letter controller: Torchic
Available Words: nut, ten, tub, ivy, vet.

IVY loads
Torchic: points, listens and drags the /I/ letter tile
Genesect: says, "No, this one" Pointing to a *y* (any) letter tile
Torchic: touches and tries to pass using a flicking motion the /Y/ letter tile. Again, the tile moves but not in a smooth motion.
Genesect: says, "No, it's the other one" and touches the /y/ (sounds out /E/) letter tile
Torchic: touches /y/ (/E/) and passes it to Genesect. (the tile does not move across in a smooth motion)
and
Genesect: just selects the /y/ tile and drags is down into the placeholder
FBM: Fantastic!

Figure 7-31: Example of Exchange of Information

This can only be attributed to the team pairing and characteristics of these particular team members, *Genesect* and *Torchic*. But in terms of Communication, Team Four demonstrated a high level. Communication and Directive skills, considered to be specific interpersonal skills that are ingrained from an early age, are synchronous and can also be verbal and non-verbal. In relation to Communication strategies, Team Five and Team Four were close in dominance. These two teams were able to demonstrate high levels of Communication, in that they were able to construct meaning, possibly based on previous knowledge or skills and behaviour they have brought to the large-scale shared digital space. They were also able to impart, interchange, and transmit their thoughts and ideas.

Finally, Directive Skills requires the team to be able to verbalise and/or provide guidance to one another. The structure of the phonics literacy application did not require the players to have to ask too many questions for clarification. However, the instances that did occur related to comments such as, “It’s that one” with the finger pointing to the correct and sometimes incorrect letter tile, or something simpler where the word controller would point towards a specific letter tile. Team Five was the most dominant, while Team One and Team Two demonstrated low instances, possibly relating to their lack of confidence, their inexperience of the gameplay, and the fact that their output of ‘number of words completed’ was low. Teams Three to Five were more confident, in most cases more vocal, played longer games, completed more words and, overall, were able to demonstrate a similar level of activity.

The final set of strategies from the Taxonomy of Collaborative Assessment Strategies are the cooperative strategies. Independent/Autonomous, not controlled and case-by-case is considered more a cooperative practice rather than a collaborative practice (see Table 7-12). In designing a cooperative learning application, the designer would need to create something that encourages learners to work independently or autonomously, and there would be little or no interaction between learners and/or, no control over how the activities are performed together. This approach points towards an independent learning structure - one user, one computer paradigm. In the case of this application, there were two independent/autonomous instances. These were: Team Four, where the word controller was playing with the letter tiles and the picture halfway through gameplay, and Team Five, who were showing signs of getting tired towards the end of gameplay.

Collaborative Assessment Strategies	Team One	Team Two	Team Three	Team Four	Team Five
Effectively coordinated group interactions - Work Flow	31	31	44	44	46
Interdependency	54	30	44	47	48
Discussion	9	7	28	11	36
Peer Assessment	6	0	9	12	19
Clear_Comprehensible	0	1	7	22	29
Explicable (capable of being understood)	0	4	20	8	18
Critical Review_Evaluation	4	1	3	4	20
Advocate	0	0	7	6	1
Moving onto next task	0	0	0	0	0
Completion of task	0	0	0	1	1
Quality of completed task	0	0	0	0	0
Communication	10	6	24	30	31
Directive Skills	3	2	19	21	25
Reciprocity - Mutual Exchange	26	22	37	50	43
Relay	29	22	39	17	42
Gestures	29	25	40	43	43
Independent_Autonomous	0	0	0	1	1
Not Controlled	0	0	0	0	0
Case-by-case	0	0	0	0	0

Table 7-12: Cooperative Activity

The remaining teams produced no activities in this area and overall, and in nearly all cases demonstrated their ability to work together, collaboratively, in cohesive groups.

7.7.2 Data Results

The data from the Taxonomy of Collaborative Assessment Strategies has demonstrated that all teams worked collaboratively in the large-scale shared digital environment. All the assessment strategies have been identified as being behavioural, meaning that the learners reacted to a particular situation or stimulus as a result of the implementation of the Taxonomy of Collaborative Learning Strategies and the *Role/Task Division* from the Taxonomy of Collaborative Interaction Strategies.

On reflection, the Researcher identified that headings, and subheadings in brackets, should be put in place for each element in the Taxonomy of Collaborative Assessment Strategies. The previous version is shown in Figure 7-28, and the newer version is shown below in Figure 7-32. While the subheadings are truer to the nature of the element, the main headings have been aligned headings from *Taxonomy of Collaborative Learning Strategies*, making each element more meaningful. This also made it easier to define each element and sub-element in the Glossary of the Three Taxonomies (see Appendix Q).

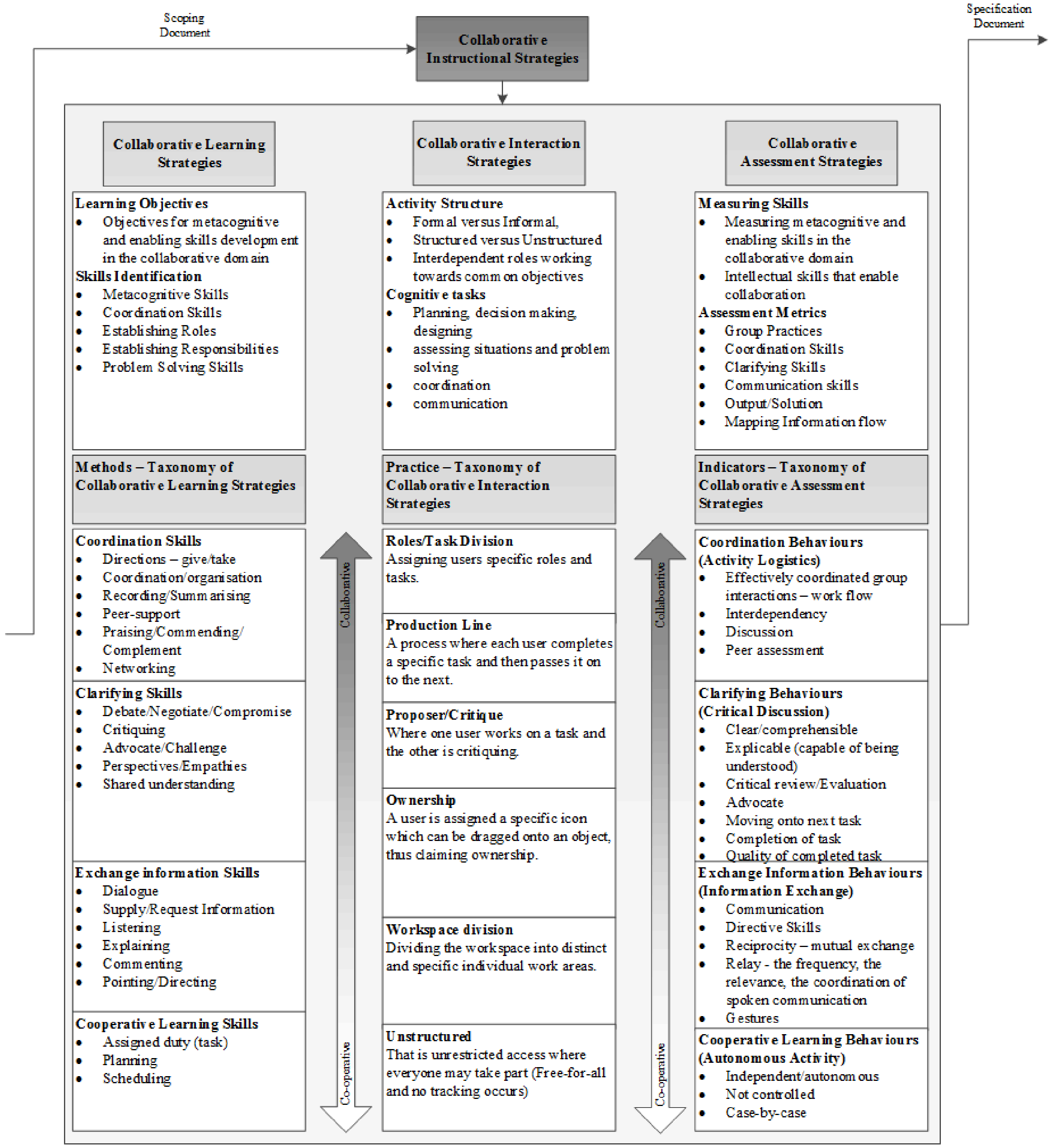


Figure 7-32: Heading alignment between Taxonomy of Collaborative Learning Strategies and Taxonomy of Collaborative Assessment Strategy

7.7.3 The Student Experience

The student experience outcome is based on the reaction and responses to the phonics literacy application design, using the CISD model captured in the interviews with the students.

As discussed in Chapter 3: Section 3.6.1 Phase One: Student Observational Study, the student teams were asked to participate in the phonics literacy game for approximately fifteen minutes and were allocated a short, five-minute group discussion at the end of the game to gauge their experience.

When asked what the students had to do in the phonics literacy game, all had a basic understanding of what was expected, with the following comments: *john*, “Well, you had to figure out the sounds for the word, the letter in the word”, *Genesect*, “spell the words and listen to the sounds”, *Torchic*, who is still playing with the screen says, "pass the letter over to you”, referring to *Genesect*, and points to the other side of the screen.

The students were asked about their capability when helping each other out; collaboration. All said that they were able to help their friend, and when asked in what way, one team stated, “communication” and “sometimes he helped me with some words”. All students found that the technology, the large-scale shared digital space, made learning “more fun” and “it helped me with a few words”.

Finally, when asked about the phonics game, all students enjoyed the phonics learning activity, “I thought it was a fun way to learn phonics”, and another said he enjoyed “Everything”. When asked what they didn’t like about the phonics game, some students were hesitant, and others were outright, “I liked everything” and “I thought it was a fun way to learn phonics”. For the group that was hesitant and did not respond, I asked an extra question, “Was there anything hard about it [the game]?”, both replied, “No”, and then they began to discuss their experiences about their difficulty with certain sounds – long and short sounds in some words. When asked which ones, however, they were unable to answer.

Overall, the students enjoyed their learning experience interacting on the large-scale shared digital space.

7.7.4 The Teachers Experience

The role of the three teachers was to provide a practical view of how the students worked together, making shared decisions and completing the required tasks together on the large-scale shared digital space. Once the students completed their activities, the teachers participated in a semi-structured interview of approximately twenty to thirty minutes’ duration. The teachers interviews were transcribed and thematically analysed. The main points that emerged related to collaboration and the technology, an LSSDS.

The teachers were asked a series of questions relating to collaboration aspects of the phonics literacy application on the LSSDS. For example, if the learning task enabled the students to work together, did the screen layout guide the students to work together effectively, and if the application was intuitive enough or easy to use without the teacher intervening? The three teachers believed that the students worked collaboratively. T2 stated,

> I thought it was a great learning task and the way it is prepared, the fact that it is a board and of course, anything that visual like that. Yeah, they did well in interacting. I thought it was an effective tool.

T3 also agreed that the students collaborating were apparent, but felt that the collaborative aspect was more evident as the game progressed.

> Yes, well ... because they had to choose a letter, but I'm not sure in the beginning it was clear that the person who had the letter in front of them was the one who was supposed to select the letter and shoot it over to the person beside them [Word Controller]. Then if that person felt that it was the wrong letter, they should have been able to say ..."NO, the other one". Quite a few times...."NO, the other one", and as they progressed through, they worked it out, that there was two of everything and they had to tap on them to hear the long and short sound and determine the delineation of the role at any given time. I think it only emerged through the practice and the swapping of the screens.

The collaboration was a direct result of the way the application was designed and the way the roles and tasks were divided. Vygotsky theorised that learning occurs through social processes and mediation. As the students familiarised themselves with the application and the technology they were able to interact and communicate better.

However, the teachers did observe that there were times when the learners would display particular characteristics of dominance and/or frustration. When asked what interactions were observed, T1 said,

> … [t]here was cooperation, there was some frustration - when one was getting it wrong the whole time, Player 1-Player 2 they would reach across each other. If you paired a strong with a not so strong player, they tend to take over a little bit.

When asked if the group dynamics encouraged collaboration and discussion, T 1 stated, “Yes, it does, but once again you can have a situation where one guy takes over, because he can reach over and do whatever he needs to.”

Regarding dominance, T2 did not see it as being an unusual characteristic, stating:

> … [t]hat's always in the situation. That's the norm, and I suppose if you had a group in your own classroom you would - pair it according to needs or whether you wanted another one to be taught by somebody or if you wanted them both to be on the same level of understanding and that ...they were good.

Or as T3 said,

> I tried to match even personalities. And if you already know the answer, you could get frustrated if the other person doesn't. But if you know your role is to collaborate and help that person, then that would alleviate some of the frustration, and it becomes a more positive experience if they both think ... Ok, we together got to do this. And for boys, when we say team, they are thinking footy and things like that. Which, therefore, they have got the idea of working together but actually physically to be working together to create a result is probably needs to be crystal clear.

The learners at times did demonstrate dominance and/or frustration where one learner would just reach across to take the letter tile, while the other learner was searching for the correct tile. While the teachers identified these characteristics, they should not be seen to be a negative experience for the learner but should be seen to be a part of the collaborative learning experience. However, these characteristics are a challenge for the instructional designer and raise the question of how much a designer can or should design out dominance.

The next point relates directly to the design influence of the learning application and how it was applied to the technology, Large-Scale Shared Digital Space (LSSDS). The teachers acknowledged that the design influenced the way the students worked together on the LSSDS. T2 said, “Yes, it was good. They could reach across without crowding, it was well spaced visually and presented very well. I thought it was great.”

Their response was also very supportive of the way the application was designed, especially relating to the aesthetics such as the screen layout, which allowed the learners to directly manipulate and work with the letter tiles. T2 simply states, “I liked its layout, I thought that was good.”

The teachers liked the way the students were encouraged to take ownership and correct themselves when prompted. T1 observed,

> Yes, it was good… because you had a voice prompt, you had a visual prompt, so when they got it wrong, or when they got it right. So, for example, when they got it wrong - the right letter would come up and prompt them to touch it and say it, so that led them to the right one.

What the teacher has observed was the result of the analysis and instructional strategies identified in the previous two phases (see Figure 7-33). What the teacher saw here was not the CISD model, but the resulting output of the model.

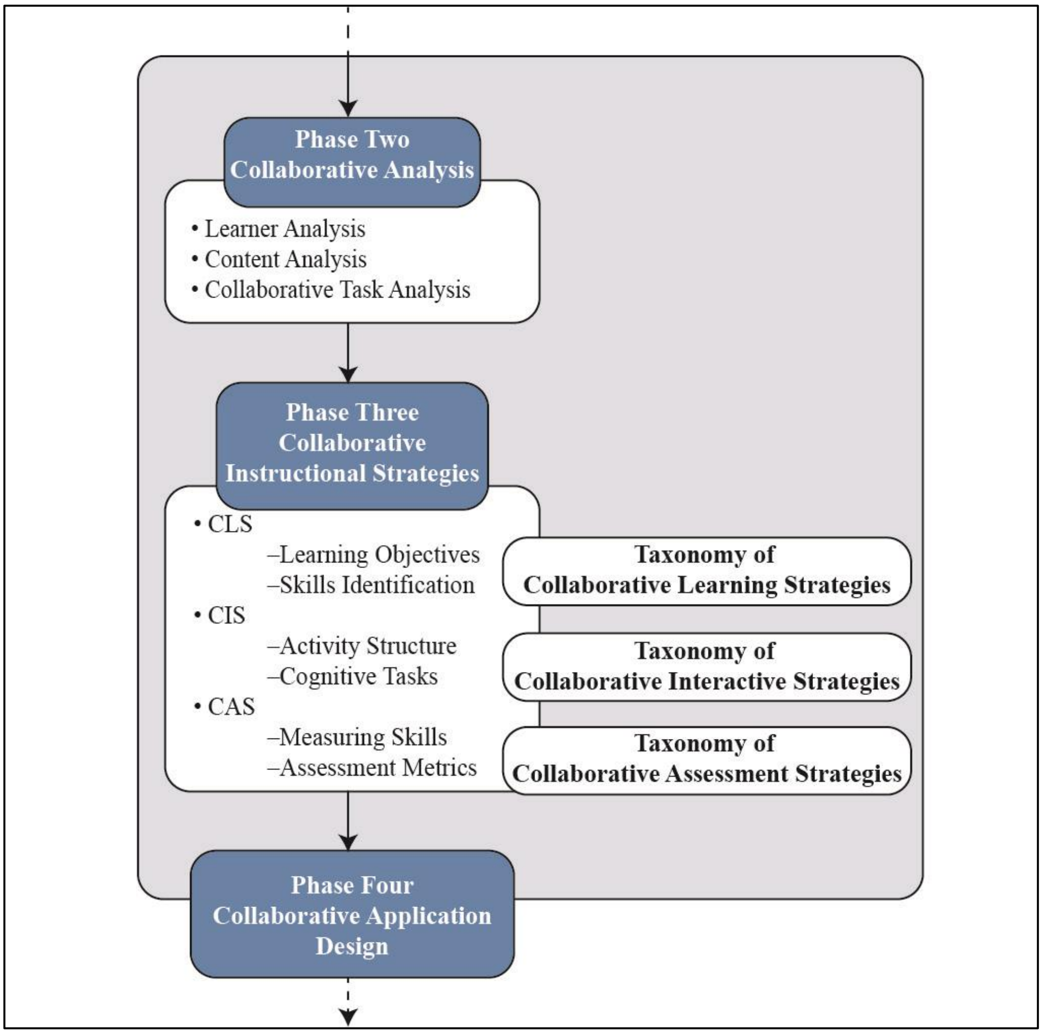


Figure 7-33: Example of the flow of the design process

This output, the application, is an incorporation of the specific elements, skills and strategies and how they are distributed between the learners. This influences how the learners interact on the LSSDS. This technology is the tool, which provides a synchronous, face-to-face social learning environment. Overall, the teachers supported the functionality and consistency of the learning application design as it allowed the learners to familiarise themselves with the interface and encouraged interpersonal collaborative learning interactions.

7.8 Summary

This chapter presented the results of Stage One of the experimental methodology to test and validate the research artefact, being the first draft of the CISD model. A number of data collection methods, observations, interviews and student log reports were used to evaluate the output of the CISD model.

To begin, a phonics learning application (the research instrument) was developed using the CISD model as a guide. This phonics learning application was presented to students, with teachers observing, to test their collaborative experience when participating and interacting using the LSSDS.

This observational study primarily focused on three new taxonomies in Phase Three. The observational data collected was thematically analysed to establish if learning skills, interactions and behaviours suggested by the CISD model could be observed in a collaborative learning activity. Many of the expected collaborative learning activities designed into the application were indeed observed, as demonstrated by the analysis above.

The thematic analysis produced the following suggested improvements for the CISD model. Section 7.5.1.4 discussed the need to update Phase Four to include a new element, an Induction to Interaction Strategies. This new element is considered to be an important resource for the instructional designer as it provides specific and necessary features that need to be included when designing the learning activity. This feature will provide the learners with the necessary instruction on the skills needed to use a novel interface layout and outline the expected flow of interaction events, such as turn-taking and touch-based interactions. As the LSSDS is a new technology and the collaborative learning design may require new interaction sequences, the ability to induct new users into the use of the system was seen as essential.

Section 7.7.2 identified that headings should be included in the third Taxonomy of Assessment Strategies. These new headings point to specific and expected behaviours that are a result of implementing the previous two taxonomies. These headings have been aligned with the first Taxonomy of Collaborative Learning Strategies.

Two other outcomes were the result of the Researchers observations. The first relates to the third element of Phase Two - Collaborative Task Analysis. Collaborative Task Analysis has been updated to include all Collaborative Theories, Discussion, Peer interaction and Learning environment. This will broaden the scope for the instructional designer to include other educational theories and not just the one initially shown, which was developed by Vygotsky.

The second relates to the terminology used within the three taxonomies. In working through the Stage One data, the Researcher discovered that the production of a glossary describing each of the strategies used within the taxonomies would be advantageous for the instructional designer. As with any glossary or dictionary, it was important to define each term used in the three taxonomies, as it will provide greater instruction for the instructional designer.

The research sub-question, “For a learning application designed using the Collaborative Instructional Systems Design model, what is the experience of the students and teachers in the classroom?” was addressed in sections 7.6.1 and 7.6.2. While the students were somewhat hesitant or unsure how to answer some questions, their overall response was positive, in that they enjoyed their learning experience interacting on the LSSDS. Teacher feedback was positive and confirmed that the learning application designed for the LSSDS encouraged collaborative activity and discussion.

The next chapter will discuss the evaluation, or second stage of analysis, where the updated CISD model and the resulting video data shows the students interact on the LSSDS. This will be presented to experts in instructional design.

8 Stage Two: Experts Analysis - Experimental Results and Analysis

8.1 Introduction

This chapter will discuss and evaluate the experimental results and analysis of the experts response to the amended Collaborative Instructional Systems Design (CISD) model. The first section will present the details of the purpose of the interviews, the interview environment (describing the locale), the participants and the type of interview data collected. The second section will present the qualitative data analysis of the interview data, with a specific focus on the key features of Phases One through to Four of the CISD model. The chapter will finish with the conclusions and results.

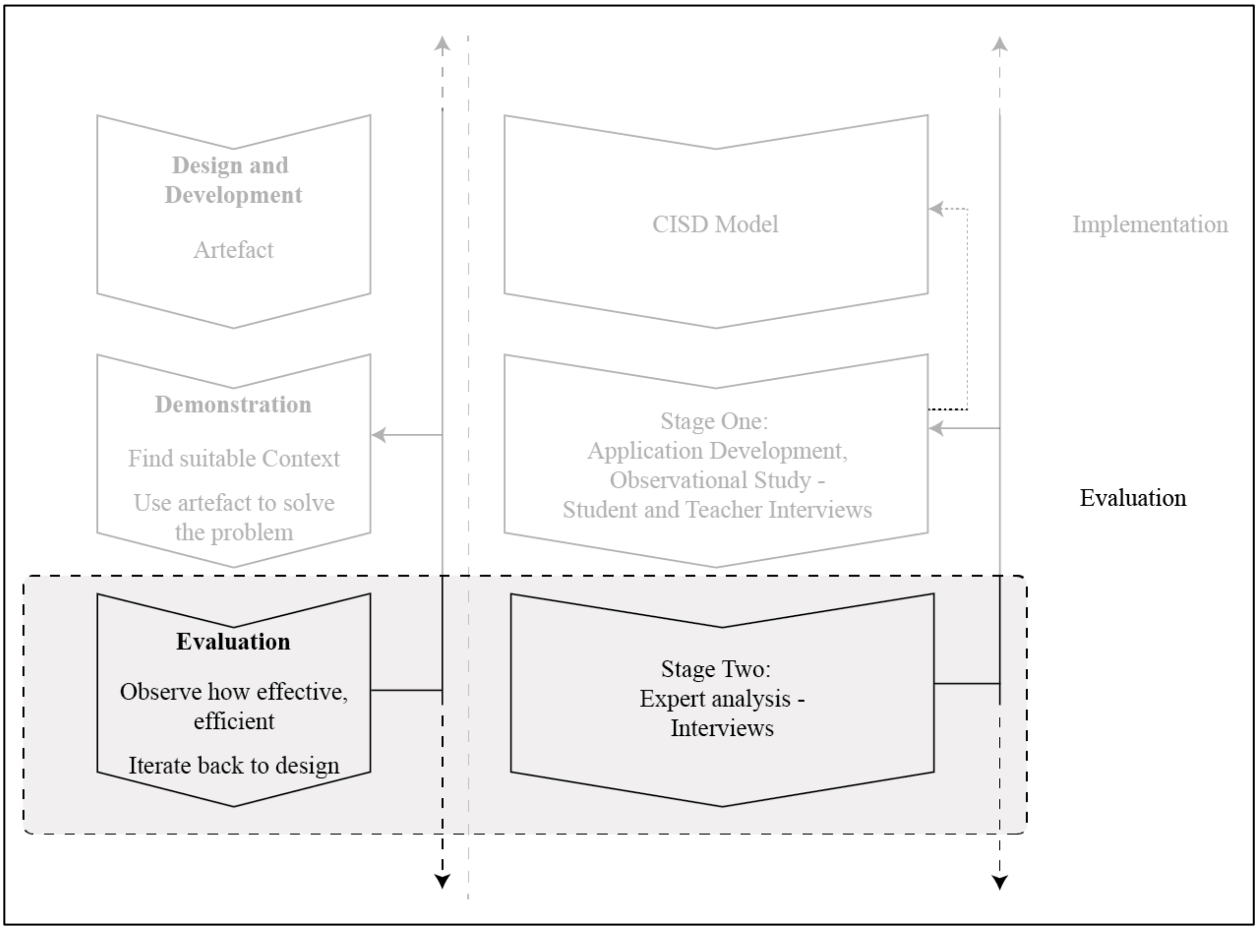


Figure 8-1: Stage Two: Expert evaluation of the Collaborative Instructional Systems Design model

Figure 8-1 puts into context the second stage analysis of the CISD model. In order to ratify the final outcome of the Stage One analysis, the revised CISD model, portions of video showing the students using the system were used in Stage Two: Experts Analysis, to explain how each phase of the CISD model was used to design the literacy application for the Large-Scale Shared Digital Space (LSSDS). Therefore, to help answer the primary research question, three sub-questions have been proposed:

S4. How can a model influence the structure of learning tasks in an application in order to facilitate effective collaborative learning activity in a large-scale shared digital space?

S5. How can a model guide the design of an interface on a shared digital space to facilitate effective collaborative learning activity?

S6. What is the perception of Instructional Systems Designers of the utility of a collaborative design model?

The focus of this stage of analysis was to bring together the experts opinions and to provide an analysis of the feedback they provided as to the validity and usefulness of the new model.

Expert opinion revolved around several issues: their general reaction to the new technology and the problem of developing collaborative learning applications for this technology; the need and structure of a collaborative model; a specific focus on the new Collaborative Taxonomies – Collaborative Instructional Strategies; using video from Stage One to demonstrate the students collaborating on the large-scale shared digital space to the CISD model and, finally, general questions on possible improvements to the CISD model.

8.2 Participants and Settings: Stage Two: The Experimental Context

Seventeen instructional design experts and academics from various Universities were invited via e-mail invitation to participate in the study, with contact information derived from publicly available information from University websites. Seven experts accepted the invitation. The seven participants have a broad range of specialist knowledge, skills and experience in instructional design, education design, development of educational resources for learning, and developers who have previously worked and designed applications for large-scale shared digital spaces.

The experts comprised of six participants from The Group of Eight Research Universities of Australia, and one participant from a high-ranking university in the United Kingdom. Four of the participants were specifically instructional designers. The remaining three have experience in designing educational resources, as well as previous experience and research in designing for large-scale shared digital spaces.

Table 8-1 below provides a summary of the participants involved in the qualitative analysis and their past experiences. The seven participants are referred to as Expert 1, Expert 2, etc., and will be represented as E1, E2, etc., in future discussions.

PARTICIPANT	PREVIOUS EXPERIENCE	ID[1]	TECH[2]
Expert 1 (E1)	Instructional Designer. E1 is part of STEM* faculty, is aware of touchscreen technology such as small touch devices and interactive whiteboards, but has no experience with horizontal large-scale shared digital spaces.	✔	
Expert 2 (E2)	Instructional Designer. E2 is aware of touchscreen technology and has seen them being used as information kiosks at conferences.	✔	
Expert 3 (E3)	Instructional Designer. E3 is aware of the technology, has heard of the technology, hasn't used the technology but sees some potential.	✔	
Expert 4 (E4)	Instructional Designer. E4 recalls working at an institution which purchased a Surface Table similar to the examples shown (see Appendix I), but it did not work very well as it was in the early days of the technology - 2007	✔	
Expert 5 (E5)	STEM* – E5 is an expert in Computer Science and has directly worked in HCI, Pervasive Computing research, where students completed a number of activities on interactive tabletops. Also, E5, completed a study comparing interactive tabletop technology with interactive walls. This expert has also had experience in developing lectures and tutorials. E5 did not consider that they would classify themselves as an expert in Instructional Design. Member of a STEM faculty*		✔
Expert 6 (E6)	STEM* – E6 has designed applications and has conducted research in Learning, Technology, and Design. Note: E6 has a PhD in Computer-Human		✔

	Adapted Interaction, which relates to multi-touch technology. E6 has not seen an instructional design model.		
Expert 7 (E7)	E7's career initially began as a Primary School Teacher, then moved to higher education working with teachers in CDP; Continuing Personal Development. CDP's used implicit instructional design, but when E7 moved to work with people in Computer Science, E7 found that a more formal framework in Instructional Design was used. E7 spent more than four years working with many different aspects of large horizontal table-based multi-touch surfaces.	✔	✔

[1] ID = Instructional Design experience.

[2] Tech = Technology experience – in particular, working with large-scale shared digital space.

***Science, Technology, Engineering and Mathematics (STEM) from two of the Group of Eight Universities.**

Table 8-1: The expert participants and their previous experience in touchscreen technology and in Instructional Design

8.2.1 Data Collection Protocols

The seven expert interviews took place at separate times. Six interviews occurred in different meeting rooms at various campuses and one international interview was conducted via Skype. The experts interviews were semi-structured and took approximately 1.5 to 2 hours each. The table below (see Table 8-2) presents the interview protocol for the experts interviews and their related appendices.

QUESTION THEMES	SUB-THEMES	RELATED MATERIALS PROVIDED AND APPENDICES
General Reaction	• Previous touchscreen experience • New Technology – Multi-touch • Learning Disabilities • Designing for Collaborative Design • The problem of Collaborative Design • Other Technologies	• **Appendix I:** Examples of Large-Scale Shared Digital Spaces
Comparison of ISD to CISD	• Instructional Systems Design • Designing for Collaboration	• **Appendix J:** ISD and CISD examples. • Selected video examples of the learners interacting with the LSSDS
CISD Model	• Phase One: Instructional Focus • Phase Two: Collaborative Analysis • Phase Three: Collaborative Instructional Strategies • Phase Four: Collaborative Application Design • Phase Five: Development, Release and Implementation • Phase Six: Learning Event Instance and Evaluation of Learning Outcomes • Phase Seven: Evaluation of Learning Outcomes • Phase Eight: Evaluation of Design Outcomes	• **Appendix K**: Instructional Focus – Decision Checklist • **Appendix L:** Collaborative Analysis – Scoping Document • **Appendix M:** Collaborative Instructional Strategies Specification Document • **Appendix N:** Design Phase – Design Document • **Appendix O**: Phonics Game – Student Log – A Complete Example • Selected video examples of the learners interacting with the LSSDS
Analysis of the Three New Collaborative Taxonomies	• Bloom's • Characteristics • Classification • Self-explanatory • Overall • The use in a real-world Context – Appropriateness – Effective Structure – Usefulness	• **Appendix P:** Taxonomies – Bloom's and Collaborative Instructional Strategies. • Selected video examples of the learners interacting with the LSSDS
Other	• Activity Structures • Collaborative Learning and Interactions • Communication Skills • Gestures • Learning Approaches	

Table 8-2: Second Thematic Analysis – Experts Interview Protocol: Question Themes, Sub-Themes, Recourses and related appendices

8.3 Description of the Expert Analysis data

Videos from Stage One showing the students interacting and collaborating on the large-scale shared digital space were used to demonstrate how the CISD model was used to assist in the design of the phonics literacy application. The experts were provided with detailed descriptions and with design process outputs of the stages as shown in Chapter 6 (Sections 6.3.1, 6.4.1,6.5.1, 6.6.1), and were presented with a video of the students using the system.

8.3.1 Observational Data: Video and Audio

A Go-Pro video camera was used as the video and audio capture source. The small camera was mounted on a tripod, focusing on the interview to accurately record the experts reactions and responses to the questions asked. At the same time, a Sony IC Recorder was used as a backup and, later, the audio was used for professional transcription. For the international Skype interview, a video capture tool called ShowMore (2016) was implemented at the time of the interview.

Figure 8-2: An example of the expert interview environment

8.4 Data preparation and Analysis Methods

The expert analysis data for Stage Two consisted of video, audio and transcribed audio. At the completion of the video and audio data collection, a series of steps were undertaken to prepare this data for analysis. Table 8-3 provides a summary of all the data collected for the Stage Two analysis.

PURPOSE	TOOL	PARTICIPANTS	VIDEO DATA HH:MM	AUDIO DATA HH:MM
Expert Interviews: Semi-structured Interviews	Go-Pro Video	1. Interview	1:56	1:55
		2. Interview	1:57	1:57
		3. Interview	2:27	2:09
		4. Interview	1:23	1:22
		5. Interview	2:15	2:24
		6. Interview	2:07	1:45
	Skype Video	7. Interview	1.45	1:46
Total video and audio time			12:30	11:58

Table 8-3: Stage Two Data Collection: A detailed activity summary

8.4.1 Observational Data: Video/Audio – Experts

The expert semi-structured interviews were recorded individually. The captured audio was transcribed via a transcription service, Go*Transcript* Australia (2017), and returned as a transcribed word document – no timestamps were recorded. The seven videos were imported into QSR Nvivo (Version 11.4.1.1064 (64bit)). Whilst watching the video, the transcribed interviews were systematically copied from the Go*Transcript* word document and pasted into the Detail View area in QSR Nvivo (see Figure 8-3). Any errors in the transcribed data were updated by the Researcher

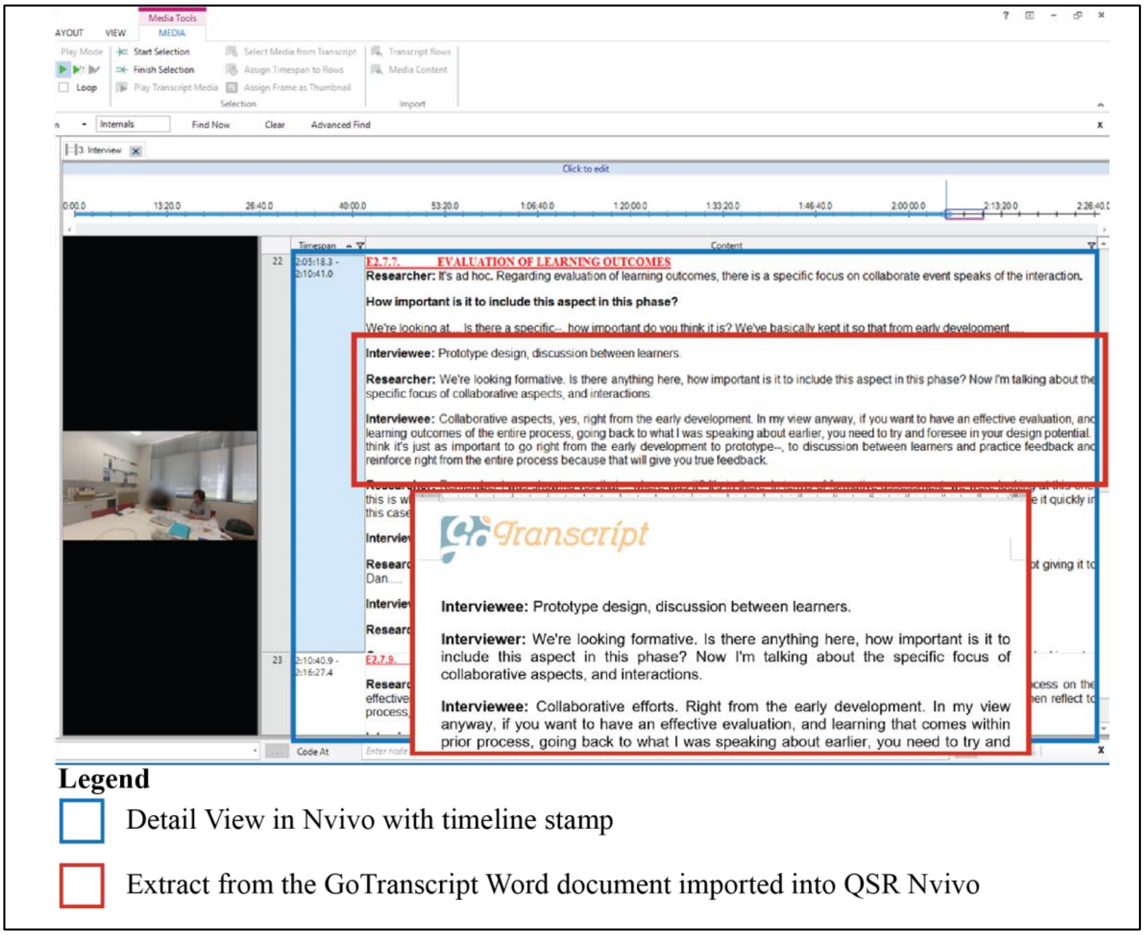


Figure 8-3: Sample of transferred data from GoTranscript to QSR Nvivo

Time-stamping of the data occurred when the transcribed interviews were merged with the video data and were then thematically coded and analysed.

8.5 Thematic Analysis

The aim of these interviews was to:

- gather the experts general reaction to the new LSSDS – touchscreen technology,
- gather the experts reaction to the problem of designing for collaboration,
- to look at the need for a new collaborative model,
- obtain the experts opinion by connecting the specific phase components of the CISD to the video of the students collaborating on the large-scale shared digital space with the CISD model,
- gather the experts reaction to the new Collaborative Taxonomies – *Collaborative Instructional Strategies.*

The thematic analysis will present the data and report the experts views using specific direct quotations to support the related discussion.

8.5.1 Thematic Analysis of the Experts Observational Data: An Overview

In coding the data, the first pass of the thematic analysis focused directly on the interview questions and interviewees' response (see Figure 8-4). Each question was numbered to maintain the correct sequence order of the research questions. The data was then combined and ordered by question sequence. This holistic form of coding was described by Saldana (2016, pp. 23-24) as a broad brush-stroke approach called *lumping*. Lumping all the data provided a complete view of the experts opinions, grouped and ordered by research questions.

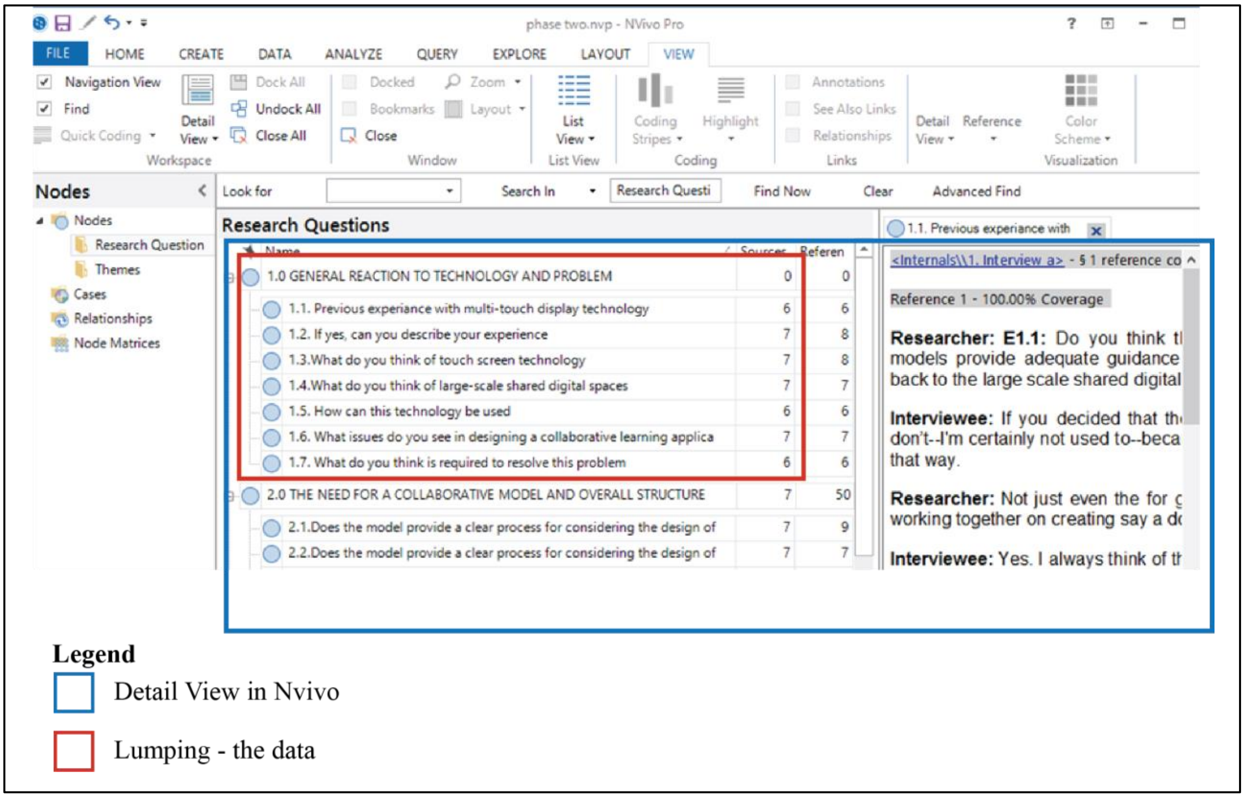


Figure 8-4: First Thematic pass of the video/audio data

On completion of this first pass of coding, the data was then refined by 'splitting' the large passages of text into smaller instances, then thematically organised into the five main question themes: General reaction, the Comparison of the ISD to the CISD model, the CISD Model as a whole, an analysis of three new Collaborative Taxonomies and finally, a category called, Other (see Figure 8-5).

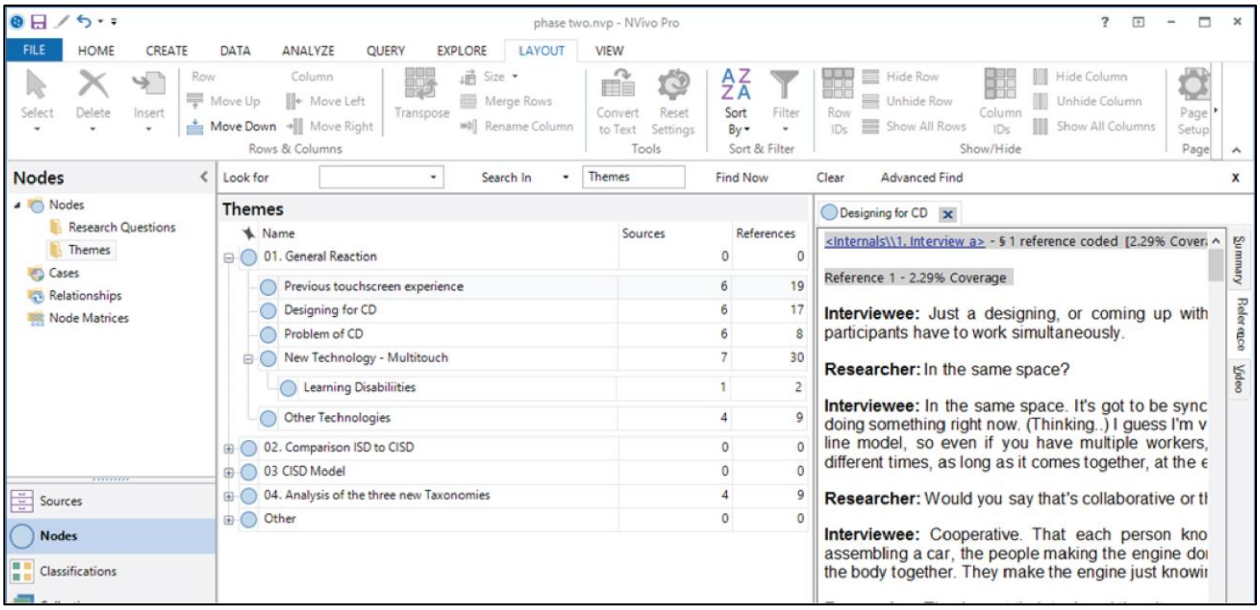


Figure 8-5: Second Thematic pass

8.6 Studies of the Collaborative Instructional Systems Design Model

This stage of the analysis delved into the opinions of educational experts and academics who work in Instructional Design and/or have developed their own classroom learning activities, and/or have worked predominantly with large-scale shared digital technologies.

The questions were designed to gauge the experts opinions on the purpose, clarity, and importance of each of the phases of the CISD model, and suggestions for improvements.

In summary, the five main key features that were examined in detail are:

- The CISD model as a whole, and its presentation of an alternate collaborative way of instructional design thinking by providing a series of systematic processes for collaborative design,
- Phase One of the model was examined and related to the formal decision-making process where choices are made as to whether it's appropriate for the application or idea to use the collaborative approach,
- Phase Two of the model was then examined and looked at the characteristics of the learners, of the content and the collaborative tasks, and the skills that need to be learned through a collaborative lens,
- Phase Three of the model was then explored, and presented the three new collaborative taxonomies specifically designed to cater to collaborative learning environments and, finally,

- Phase Four of the model was discussed and related to a holistic approach to interface design that adopted a multi-arrow form which points to five explicit design considerations for collaborative technologies.

The interview questions were very specific for five of the model components: Phase One, Two, Three, Four and Eight. For Phases Five, Six and Seven there was one question that looked at various aspects that may be problematic. Phase Seven also included two additional questions regarding the collaborative aspects of the learner's interactions, as well as any suggestions for inclusions or improvements. These three phases are necessary components of a complete CISD model, yet are similar to phases in other ISD models (see Section 2.7). They are not a focus of this current research.

8.6.1 General Response to the Overall Model

These interviews produced high volumes of qualitative data, and a number of strong themes emerged. These themes were based on the experts perception, opinions and response to the questions and have been categorised as follows:

- *General Response* **–** the intention, purpose and the impact of the model on the resulting design of the learning task and, finally, some suggested improvements to the model,
- *Comprehensibility* – relating to the transparency or the clarity of the model,
- *Structure* – as in, the relevance of the format and/or presentation of the phases within the model.

The analysed data is presented in the following sections: First, the data presents a holistic analysis of the experts opinions for the CISD model. This is followed by an analysis and a discussion of the key features for each of the phases, from Phase One through to Phase Four.

Based on the experts overall qualitative responses to the CISD model, the feedback was positive. They considered that the model provided the necessary support and that it was useful for designing collaborative learning applications for a large-scale shared digital space. E1 described the model as follows:

> I think very useful. It certainly gives you a lot of things to think about and breaks it down into the stages, which I guess would be more helpful than if you just went at it and sort of pieced it … ad hoc.

When asked if the experts had any thoughts about the suitability of the model, they all believed it could be used to design collaborative applications, using words to illustrate the usefulness, such as

E1 - “it’s groundbreaking in that context” and E2 – “it’s helpful”. This was not just for an LSSDS as E2 could also see the model being used in group workshops. E3 also found the model useful as it provided assistance for “different levels of design and learning”, and that the processes were not ambiguous, but very clear.

The experts really valued the break-down of the model, having phases, sub-phases, elements, and sub-elements. E2 stated that “it is a different way of thinking and you’re pulling in elements that you don’t normally think about,”, and that being specific was useful for “...group work and learning and collaboration.” E7 states, “There isn’t much out there on collaborative task design. It is a real problem, I think, in terms of CSCL [Computer Supported Collaborative Learning]”. E7 then went into more detail by acknowledging the practicality of the multiple layers of each phase, in that the different steps and stages provided a different perspective. One of the critical challenges in previous models was that they failed to concentrate on collaboration with the learning task, a task designed with technical design and learning outcomes. In terms of suitability and usefulness of the model, E7 states:

> I like the fact that it has layers. The different layers, which kind of simplify and then progressively made more complex as you go down. You can get people to buy into the simple model, and then when they need it…to…go down to the appropriate level of complexity to solve the particular problem that they've got.

The experts viewed the learners interacting and playing the phonics application on the LSSDS, and were shown correlating design documents with the CISD. When asked about the intention and purpose of the model, for example, relating elements of the model and the learners participating in a collaborative learning activity, a majority of the experts stated that they could identify elements of the CISD being applied to the phonics learning application in a real-world context. E4 said, “Yes, absolutely. Especially this group”, referring to a particular video. Then in reference to the design, “I can certainly see particular elements. In that regard, the shoulder to shoulder, so yes, I can see how some elements have come into play”.

8.6.1.1 Impact of the CISD on the Design of the Collaborative Learning Tasks

The following is an analysis of the response of the experts to the structure of the CISD model, as a whole, and the influence it has had as a working model. Also discussed is their response to the model as facilitating the analysis of the collaborative process and, for the designing of collaboration and collaborative learning tasks.

The experts comments were positive. They could see the specific phases and their related elements from within the CISD model and how they influenced and prompted the structure of the phonics learning task. Some experts simply said, “Yes”, whereas others were more detailed, stating that they could see the impact of the model and could see how each phase could be applied to their own work. For example:

> E3: Absolutely. It seems that they try to encourage, facilitate actual collaboration or going back to our taxonomies by promoting teamwork. Pass the letter to--, in that regards I can certainly see particular elements. In that regard, the shoulder to shoulder, so yes, I can see how some elements have come into play in that regard.

> E7: Yes, I could apply the model to the work that we did through [project name removed]. I can absolutely see the value of the model in working with multi-task services with collaboration.

and, E6: “It's nice to see how design thinking came to life.”

Interestingly, E1 stated that while he found the phases and elements of the model to be clear, he felt that it was not an easy process to put into context until he actually had a go at developing an application. This was also stated by E6, “It would be very nice to try it in a new development actually, from scratch …” While this research presents an initial validation of the model using expert feedback, further research could involve having a range of instructional design experts use the model. However, this is beyond the scope of the current thesis.

8.6.1.2 Suggested Improvements for the Model

At the conclusion of each phase, the experts were given the opportunity to suggest improvements pertaining to each particular phase. To begin with, E7 put forward a suggestion that,

> … you could break all of these down to a further set of stages, but that could make it overly complicated. I think the model works well because it has a sufficient level of complexity.

Given the complexity of the CISD model, in its current state, the proposed suggestions put forward were aimed at strengthening the model. In Phase One, E2 pointed out that in the initial checklist the questions currently jumped from the team objective directly to distribution of subtasks and suggested adding, in-between the two, an additional question, *“What's the learning goal for the collaborative task”*. E6 suggested that more clarification be made to checklist question four, “Can Peers contribute to the learning experience?” by adding the word ‘jointly’. In Phase Two: E2 suggests that at the conclusion of the Collaborative Analysis, a recommendation section should be added to determine whether the development of the application should continue or not. For Phase Three, E6 suggests a glossary to explain each of the elements and sub-elements of the taxonomies. Note: A glossary describing the taxonomies was developed at the conclusion of Stage One (see Appendix Q). This glossary was not presented to the experts during this stage of analysis as the Researcher wanted to determine if the fundamental aspects of the elements and sub-elements within the three taxonomies made sense.

These suggested improvements have been acknowledged and will be considered in future research.

8.6.1.3 Comprehensibility of the CISD Model

This theme relates to the experts reaction to the transparency and clarity of the processes involved within each of the main phases. In terms of each phase, the experts felt that the purpose, relevance and descriptions were comprehensive and clear.

Beginning with Phase One, the experts were shown a blank decision checklist—and a completed decision checklist—to determine if the learning task was collaborative or not (see Appendix K). E5 described the Instructional Focus as a good outline and starting point for collaborative design, and that the purpose of the checklist was useful as an appropriate guide to “how you plan to use it [the CISD] and why you want to use it [referring to LSSDS].” E3 also expressed the opinion that each step of the checklist was “absolutely” straightforward and easy to understand,

> This is clear, that's clear, that's sufficient to distribute. Yes, that's amongst the actual learners. Is there a communication coordination aspect amongst learners? Yes. I think in that regards, I have to have discussions, yes absolutely, that's clear for me.

The experts saw Phase One the same way E1 describes, as “very clear”, and a crucial building block providing the Instructional Designer with the foundation to develop a collaborative, multi-person/multiplayer learning task in a large interactive digital work area, helping to progress to Phase Two.

E1 states that once the Instructional Focus has been established, “…you've identified this is multiplayer. Now, you are getting down to what are the characteristics of each player. Which is what you have to do.” E1 relates this directly to the first element, which looks at the characteristics of the learners as individuals and as a group, “I’m designing this task, I’m thinking that they have to be two people there, and one of them has got to do this, and one of them has got to do that… ” E7 corroborates this, "I think it's absolutely essential, and one that's usually missed in other people's presentations of Instructional Design... "

E7 then discusses to the next element, Content Analysis, "That's one of my hobby horses", in that, Content Analysis is something that as Instructional Designer's "we're really bad at..." as "…it's important to think about - What is the nature of the collaboration? How does that relate to the task itself?"

Regarding the final element of this phase, Collaborative Task Analysis, E7 was, at first, not quite clear about the sub-element; Collaborative Theories. With further discussion, and using the Scoping Document example (see Appendix L), E7 then said, "…your explanation about Vygotsky's theory helped in terms of understanding the theoretical perspective. [The] Knowledge creation process relates very much to some of the theories of collaborative interaction CSCL. Yes, that makes a lot of sense". The experts recognised that Phase Two provided important structural elements, essentially suggesting that establishing the learners characteristics, the analysis of the content and the task analysis, was a necessary step resulting in a detailed Scoping Document. This detailed document provides the specific structure, learning goals and deliverables for Phase Three – *Collaborative Instructional Strategies*.

For this next phase, the experts were asked to provide an overall response to the three different *Collaborative Learning Strategies* (processes) and their related taxonomies. The experts were shown the overview of the model, then the in-depth view of this phase of the model, as well as a copy of the resulting output, the Specification Document. Their reaction towards this phase was summed up by E3 who considered that it provided important learning objectives, activity structure and measuring skills that assisted in analysis and interpretations of the specific *Collaborative Learning Strategies*:

> …You've broken it down to Collaborative Learning Strategies, Interaction Strategies in terms of the design elements based on not only coming up with the point of learning but more so, interest how to make that learning possible and the assessment is very clear in terms of -- yes.

E4 describes the way they could observe how "[t]he learners are working [together]" and by comparing the students interacting, could identify some of the behaviours exhibited by the students. At other times, while watching the students interact, the experts observed that the learners did not react or work together as was expected. Given the context, where the students were using a new application and interacting in a new environment for the first time, it is not surprising to see that at times they collaborated as intended, and sometimes they did not.

Overall, the experts were able to identify particular skills, such as *Coordination Skills* and collaborative skills, as well as identify the specific roles and the tasks of the learners. Finally, the experts were also able to identify explicit assessment metrics where the students self-corrected, or corrected their team member. Regarding the experts reaction to the Taxonomies, a further in-depth discussion is covered in the Section 8.6.4 - Phase Three: Analysis of the three new Collaborative Taxonomies.

Phase Four: *Collaborative Application Design* is the next phase to be discussed. To put this phase into perspective and to assist the experts to make an objective decision, layout concepts for each of the design elements (see Appendix N) were shown. E4, relating the elements of the phase to the images stated, "Yes, beautiful. I think it's a good start for that [the phonics application] design. We identify the different parts that we're going to have in your design… " And when asked about the clarity of this phase, "Yes, lots of nice detail. Pretty clear." E6 considered the description of this phase to be clear and that it "ask[ed] you to start thinking in terms of design decisions". In summing up, E7 stated, "I think it is almost a story-boarding in the design phase where you start to look at the pictures and functions of the environment, yes. Again, it is essential." Hence, the experts agreed that the individual elements in this phase were clear and comprehensible.

Regarding Phase Six: *Learning Event Instance Use of Artefact* and the penultimate phase of the CISD model, and also Phase Seven: *Evaluation of Learning Outcomes,* the experts were asked about their reaction to the collaborative aspects of the interactions, such as - How did the learners work together as a team? E6 stated:

> It's quite important to evaluate the collaboration as an indicator of learning outcomes. Yes, especially coming with my experience with classroom and analytics in the tabletop. It's something very important to do because collaboration does… and learning to collaborate is very crucial, and it's one of the 21st-century skills to be developed.

E7 stated, "As we talked about it in the beginning, it's absolutely essential because sometimes even when you design for collaboration, actually the learners end up working individually or sequentially."

At the completion of the entire process –Phase Eight – the Instructional Designer was given the opportunity to reflect on the instructional design effort and the design process. The experts felt that the purpose and description were "absolutely" clear. E7 believed that to reflect on the entire process and that without any question, this was also an important process:

> Did it work? Did the technology do what we want? What can we change? Were the kids actually working together or were they still working sequentially? How hard did the users find it in terms of doing what--?

E4 states that by using the word “reflection”, as well as the questions, it provides an excellent guide for the instructional designer to understand if the goals for the instructional design and the design process “worked or not.” E2’s comments summarise this phase;

> I think it is great that you actually separated the learning outcomes from the design outcomes because this gives you an opportunity to go deeper into how did we achieve the learning outcome based on your product that you designed, as opposed to just looking at, was the design effective. I think this is a good way of representing it.

The experts reaction and comments demonstrate that the way the phases were described was straight-forward and comprehensible. The next theme assesses the experts opinions on the general format of the CISD.

8.6.1.4 Structure of the Phases of CISD model

The format theme relates to the experts responses to the relevance and significance of the configuration of each of the five relevant phases. The experts response for each phase was highly supportive. Overall, the experts could see the goals and the objectives for each phase and how each phase had an interdependent relationship.

The general response for Phase One was that as it was the first step in the model, it was a vital decision-making process as to whether the design would move forward to become CISD, or if it would revert to a standard ISD. Experts comments for this phase were as follows: E1 states, “Well, it's critical. That step is the one that makes it one or the other.” E2, “It's the start, so it’s key, yes” and E6, “Yes. I think it is crucial...” and E3, “I think if you didn't have the focus (Instructional Focus) then you are running a very large risk of running into problems later down the track. I think it’s like buying a horse to fit a saddle, in that regard.” The above comments confirm that the experts supported and acknowledged that this phase was as an important fundamental decision-making process. In the model, if the process confirms that the learning application had a green light and was suitable for collaborative learning designs, the next phase can be initiated.

Again, the experts considered Phase Two to be essential. E2 said, “It's critical because you know you're analysing, all the content, the learner, the task, so it's very important.” E3 states,

> ...if we go back to audience purpose and form, I think, yes. Let's take a look at the purpose, Instructional Focus. I think if you don't have an understanding of your audience or the actual - the form, then you're not really - well, you might get to these later phases, but having those indications, I think it's highly critical.

Understanding the audience is something that was considered vital when matching the students for the phonics application (see Section 7.2), where the students were paired on specific characteristics such as personality traits, personality compatibilities, and level of learning capabilities.

Other experts focused on the collaborative aspect of the analysis. E4 expressed the following sentiments:

> Essential, I think. Collaboration is a huge learning... I'm trying not to say tool, but it's something that helps us clarify our own idea of what we know and check out understanding with others. We learn from others; you have to have this in here. Just because your students in the video I watched didn't do it properly, doesn't mean that they don't need to be doing it, because we need to learn how to learn it do it [collaborate] as well I think.

E4 reported that they believe that collaboration was something that was not innate, but that collaboration was something that needed to be taught. This sentiment supports a statement by T3 (see Section 7.7.4 — para. 3), where learners have an idea of how teams work, relating to teams and "footy and things like that", but when actually doing something together to create a result, which was specifically related to collaboration, these instructions need to be transparent. As mentioned in Chapter 7.1, the learners only participated and interacted with the LSSDS once, and this may have influenced how they interacted. Vygotsky's theory specifies that young learners begin to learn from social interaction with adults, beginning with their parents. In a traditional learning environment, these young learners have been socialised primarily as individual students. Therefore, it may take some time to encourage and foster discussion in learning tasks more collaboratively. In repeating these tasks, the learners would become more familiar with the interaction and the learning task.

E6 also saw this phase as being "…crucial because [it] is talking about analysis of collaboration, not only in one dimension but in three dimensions". The three dimensions to which E6 was referring are each element within this phase. E6 felt that this phase needed to be multifaceted, as it provides the Instructional Designer with the necessary means to analyse the users, the content and the theory for collaborative analysis. Once the collaborative analysis has been constructed, Phase Three is the next stage in the process.

E6 saw the *Collaborative Instructional Strategies* as "very important because it's more specific." E7 simply describes it as an "absolutely essential" part of the collaborative instructional design process. E2 explains this phase as being, "As important as the other processes. Equally important."

E3 found this phase "easy to read", and continues by stating that, "I think for the overall outcomes, look, I hate to sound like I'm saying the same thing. But for me, thus far, so far, the flow of it would be strange not to make those considerations." E3 was connecting this phase with the previous two phases, "Of course it's how you're predicting. You're looking at the potential paths and directions it can go. I would say it's just as important as the Instructional Focus, of course, is as fundamental as the analysis [Collaborative Analysis] is."

E4 also connects this phase with the previous two phases:

> I think it's really important because when you know what you're looking for, then you have a clear idea of really what you're trying to observe, and the behaviour you want to observe. Because it's not just about what they pick up on the phonics, it's more about how they collaborate and what to give them. This is great because this checklist puts in a whole lot of detail that you really want to try and watch for.

The experts were highly supportive of this phase as it provided a systematic approach and methodological planning. Also, the experts found the output,—Specification Document (see Appendix M)—to be valuable, and what E5 describes as a "concrete example that was more useful". The Specification Document is the resource that feeds into the next phase, as it provides a comprehensive description of the three elements and their related taxonomies. A more comprehensive analysis of the three taxonomies is discussed in Section 8.6.4.

On completion of the third phase, the experts were presented with Appendix N, which was the resulting output for Phase Four, the Design Document, of the Phonics Learning application. The examples were intended to enable the experts to visualise the connection to each element and be able to formulate ideas of the resulting output produced from the elements within this phase. Some experts used simple phrases when describing the importance and relevance of this phase, such as E2's comment, "Very important" and E7's comment, "Essential". Other experts expanded on these phrases with E5 stating, "Obviously, this is essential. This is the stuff that we usually start at, and then everybody knows what they've got to do." E4 agrees, referring to this phase as being "Absolutely [necessary], you can't do without that [relating to the whole design phase]. You can't just hand it [referring to the Specification Document from Phase Three] over and say, 'I want something like this.' You've got to say exactly what you want".

E3 describes the importance of this phase as it takes into consideration "potential issues" and "we shouldn't have to make our education adapt [to] machines nor should we--, it's not how media functions, it's how we function on media." E3 felt that if a design phase was not included, it would be like "building my barbecues or Ikea furniture without looking at the instructions." This notion was supported by E6, who sees this phase as being, "…crucial for everything. But this is much more crucial because this is the design itself and the scaffolding that is important." It was these comments that support the importance of having a design phase that incorporates the selection and, the analysis of the technology, to be used. Many essential design elements that guide the designer through the application design process are also crucial.

Finally, a discussion of Phase Eight was carried out. Phase Eight is a reflective process, where the designer sits back and contemplates the whole CISD design approach. The experts, again, believed this phase to be important and relevant. E5 states:

> Obviously, you want to go back and see whether it's the same reason with design. But I guess you want to also look at what you would recommend to improve? What are the shortcomings? Were some of the trade-offs the right decisions?

E6 states in a similar theme, "Yeah, I think that this phase is important because it makes a difference with the other method, the linear method", referring to the iteration, which takes the designer back to Phase Three: *Collaborative Instructional Strategies*. E6 continues with, "…this phase allows [you] to go over to perspective and go back to the design and revise it, update things. It's a way to inject information back to the design process from the beginning to modify and evolve too." The experts saw the importance of this phase as a way for the Instructional Designer to make or become better at contemplating the CISD process, as a whole, or individually phase by phase.

8.6.2 Phase One: Analysis of the Instructional Focus

The previous themes related to the experts responses to the overall CISD model. While it was important to discuss the model, and get the experts responses in their entirety, it was also important to pinpoint and discuss the most significant features for Phase One through to Phase Four, of the CISD model.

The key feature of this phase was a formal decision-making process used to evaluate if the learning task was appropriate for a collaborative approach or not. The decision checklist includes a series of generic Yes-No questions used to determine collaborative activities. The following are some comments:

> E1: That step is the one that makes it one or the other.
>
> E3: …without the initial focus I think a lot can go wrong, further down… without a clear direction then I would be worried…I wouldn't come back and write the introduction after I had completed the essay.
>
> E5: Well, it's not the solution looking for a problem. It's a problem it's supposed to be harnessing the right solution so obviously, we need to think these things through.

The experts identified this phase as being a unique step as it has not been used in past/previous instructional design models. They also saw that it was a crucial point of entry by providing clear direction in determining the collaborative process.

8.6.3 Phase Two: Evaluation of Collaborative Analysis

The key feature of this phase relates to the analysis of the learners and the granularity of the content, the tasks and skills, through a collaborative lens to ascertain if it was appropriate for the collaborative activity. The experts have responded as follows:

E2: “It's critical because you know you're analysing, all the content, the learner, the task, so it's very important.”

> E7: It is essential. Again, it’s knowing how much detail to provide. One of the things that I like about the way you presented it as there are different levels. You can go to the level that-- in terms of the details needed for a particular task. … I think there’s a scaffold to guide you into some a bit of problem-solving and thinking about, okay, like, "What’s actually required here?", but the balance of which you need to focus on different aspects of the model probably change for the nature of those different tasks.

E6 has also described this phase as being crucial and feels that it was important as it did not approach collaborative analysis as just having:

> …[o]ne dimension but three dimensions. The learner and learners is like the collective…and in terms of the content that is going to be shown is much more like task-oriented”, and then how it is “linked with the collaborative theory. For me … [t]hose three things are I think is [sic] very complex. By that this phase is very complicated and very [sic] needed.

E3 uses Moodle as an analogy to describe this phase:

> Learner Analysis is actually central to …an idea that's often overlooked in my experience…Moodle's trying to design a better practice in Moodle. Often the overall, "Who's your learner?" The learner is actually overlooked in the purpose of the construction…understanding who your learner is and what the specific elements are are highly central.

Without a doubt, the experts have expressed the significance and importance of the three elements within this phase. Understanding the characteristics of the learner/s, analysing the content to be used and, finally, understanding the Collaborative Task Analysis, are imperative. Also, at the conclusion of this phase, there was a Yes-No outcome where the recommendation points to the standard ISD, to produce a Scoping Document recommending that the project continue.

8.6.4 Phase Three: Analysis of Collaborative Instructional Strategies

Collaborative Instructional Strategies provides three categories. Each strategy has a specific focus and has been divided into sub-phases; Learning, Interaction, and Assessment. Within each sub-phase, there are specific taxonomies that provide a new way of thinking: Methods, Practice, and Indicators. These taxonomies have been created to assist the Instructional Designer in designing for a collaborative domain. The focus of each taxonomy begins at a co-operative level and ends at the collaborative level (see Section 5.5). A summary and the objectives for the three taxonomies are as follows:

- Taxonomy of Collaborative Learning Strategies (Methods) offers specific skills and strategies to be considered when designing learning strategies.
- Taxonomy of Collaborative Interaction Strategies (Practice) provides the instructional designer with a process to recognise specific activity structures and roles that can be assigned and distributed to each learner within the group.
- Taxonomy of Collaborative Assessment Strategies (Indicators) provides a guide to the types of assessment metrics and measuring skills to be included and expected of learners when working in their assigned group.

These taxonomies were designed to complement Bloom's taxonomies of educational objectives. Bloom's is discussed at the end of the following section.

8.6.4.1 Impact of the New Taxonomies

The aim of this section was to provide the experts response regarding the three new taxonomies and to gather suggestions for improvement. This also includes how the experts viewed the relationship of these new taxonomies compared to Bloom's taxonomy. During the course of the interviews, E7 referred to having extensive experience with analysing a range of taxonomies and offered a number of interesting insights into this aspect of the CISD model.

The experts were presented with two representations of the three taxonomies. The first was the linear overview of the taxonomies, which was presented as part of the complete model (Figure 5-6) in Chapter 5. The second representation was a detailed colour graphic (see Figure 8-6).

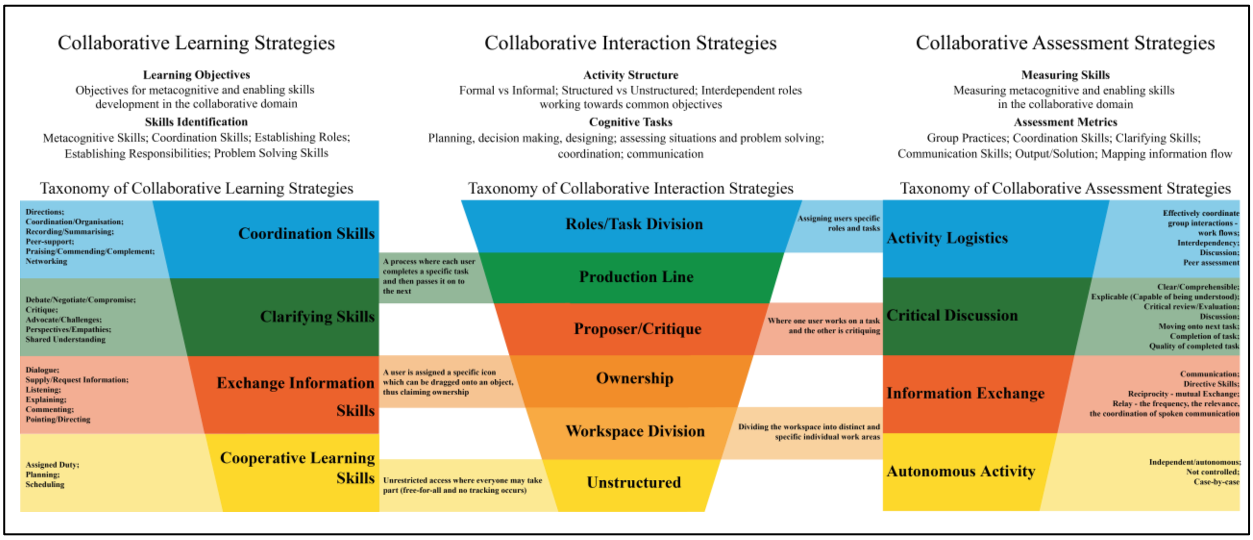


Figure 8-6: The coloured version of Phase Three: Collaborative Instructional Strategies

Each of the taxonomies has been arranged from being highly collaborative at the top down to a less collaborative, and more cooperative, at the bottom. *Collaborative Learning Strategies* identifies different learning methods and skills; Collaborative Interaction Strategies identifies different interaction practices and how the tasks are organised, and finally, Collaborative Assessment Strategies emphasises the learners behavioural indicator practices when working in groups. The experts were asked a series of questions relating to the taxonomies classification:

- Were the characteristics of each category easy to understand?
- Were the labels self-explanatory?
- Was the arrangement of items clear or unclear?

The overall response from the experts was positive. The experts considered the three new taxonomies provided the necessary classification systems to assist in the development of collaborative instructional applications for LSSDS. Some experts felt that the taxonomies provided an excellent foundation to analyse the nature of collaborative learning activities, while others believed that they were functional in supplying the labels and categories required to describe collaborative learning activities. E1 stated that “I think it's a good start and it's a good foundation.” E2 stated, “It helps you. It gives you some language in terms of trying to define what you want to do.” E6 believed that the new taxonomies provided a scaffold, or tool, which supplied many various aspects that need to be taken into consideration when designing for collaboration.

To help in understanding their train of thought, using the third taxonomy as an example, E3 verbalised a portion of the process:

> Absolutely, because I clearly point out what it is, and what it falls under, which makes it clearly between what is expected at each particular rung or level.
>
> Let's look at the Taxonomy of Collaborative Assessments we started to use; we have Critical Discussion. What is Critical Discussion? It's clear and comprehensible, it's critical review, and it's the completion of the task, for me it is clear.

E4, who worked many years ago in an institution which purchased Surface Tables, stated that for group work:

> [y]ou do need quite a bit of detail because there's a lot going on, in both the individuals and then the ways they interact with the group. Group work. You need something very detailed to cover all of that. It's [designing for collaboration] a great complex situation.

The experts recognised the benefits of the new taxonomies and how they assisted in identifying areas that provide support in essential collaborative situations and groups of learners. These new taxonomies propose unique processes when designing for collaboration and collaborative learning environments, as opposed to Bloom’s learning taxonomy that was aimed towards the individual learning environment.

The following sections provide further in-depth evaluation and discussion, examining the comprehensibility, the format of these new taxonomies, and the impact these taxonomies made on the resulting design of the collaborative learning task.

The experts were asked about the comprehensibility and transparency of the three new taxonomies and if there were any specific aspects requiring more clarification or were difficult to understand. A majority of the experts agreed that a user of the model would have to have some understanding of Bloom’s Learning Taxonomy. This was understandable, as the idea of these three new taxonomies was to supplement Bloom’s Taxonomy in collaborative situations. They have been designed to provide instructional designers with specific collaborative strategies for multi-user digital environments, such as the LSSDS, whereas Bloom's focuses on the learning activities of an individual learner without reference to their peers.

E7 explains:

> I found it harder to come to understand what you were meaning with these than I did with any of the other documents that we've seen... But then partly, that's because what you are presenting here is really new; the other [unintelligible] sequential breaking down a task and you can see and compare from other work. Because I think what you're getting here is genuinely new so, as a result, it does take a bit more getting your head around. That doesn't mean that it's not helpful or useful, if that makes sense.

E6 states that the description of each element and the related sub-elements was easy to read and understand, but also suggested that while the new taxonomies were self-explanatory, a better and more in-depth understanding of each element would be achieved if more information in the form of a "book or something", was provided. Given the complexity of the current model, the idea of a book would make room for the provision of a more detailed analysis and explanation of, not only the taxonomies but also a complete and thorough explanation of the overall processes of the entire CISD model. This concept can be considered in future research.

E2 felt that presenting the taxonomies as coloured visual representations tied them back to Bloom's, and helped clarify the relationships between the elements and their related sub-elements. When the Researcher pointed out that one was complementary to the other, E2's response was as follows:

> I think people will get it because the way it is visually presented with this [Bloom's] and this [new taxonomies], you already immediately see that there are supposed to be a relationship, it's just a matter of trying to understand what that relationship is. I can see that there is supposed to be a relationship, the visual way of presenting it is helpful.

In summing up, the experts were able to understand the classification system of the new taxonomies in their current form. However, some experts considered that an understanding of Bloom's Learning Taxonomy was important prior to using the new taxonomies. Finally, one expert put forward a suggestion that a more in-depth explanation of each element be provided in the form of a book to provide a better understanding of the taxonomies.

The experts were then asked to look at the way the three new taxonomies were classified and formatted. In terms of a classification process, the experts felt that three new taxonomies were helpful as they present a navigation structure for the different types of collaborative instructional strategies that could be used when designing a collaborative learning application.

E4, working through each element and sub-elements, described the taxonomies as having, "nice details in here". E2 describes the taxonomies as being "very comprehensive" and provides "some language, in terms of trying to define what you want to do". E2 was relating to the classification system that was in place and the way that the elements have been structured as a whole, being from a low cognitive level, co-operative, to the highest cognitive level, being collaborative.

When asked about the order of the sub-elements within the new taxonomies, E7 examined and discussed the format and structure of each taxonomy individually. E7 considered the hierarchy of the first Taxonomy; *Collaborative Learning Strategies*, to be straightforward, stating:

> In the first one, there's a hierarchy; you start from coordination through to cooperative, the complexity increasing…So clear about the relationship between the strategies in the central column that would be [Collaborative] Interaction Strategies. I can see they're all important components, but it was less clear what the relationship was between the components if that makes sense.

In the central column, Taxonomy of Collaborative Interaction Strategies, some experts sought further clarification regarding the alignment of specific tasks listed, and how they related to the two elements on either side. E2 asked if there was a meaning to the colours. The coloured model was a visual representation designed to complement Bloom's coloured model (see Figure 8-6). It was explained that the colours were interrelated and formed part of the same hierarchy, where *Unstructured* is at the lowest, cooperative, level and *Roles/Task Division* is at the highest collaborative level. E2 concluded, "Yes, it is a different way of looking at it … It'll take a little bit of time, but it's a good way of presenting and representing it."

E1 questioned the terminology to describe *Roles/Task Division* – Assigning users' specific roles and tasks. E1 interpreted the use of the word "users" as follows,

> [W]hen you use the words like, "assigning users specific roles," then that meant you have specific people in mind...to do this, rather than this role has to be fulfilled by somebody when the activity is in progress. So we got the activity, the phonics activity, we need two players, and that's what we're designing for. We don't know who they are, just player one and player two, and that's it. So there is no specific user.

E1 felt that the word *users* should be removed as this strategy should not relate to the "who's who", but should just define the tasks of a role so that each role has a specific task.

When analysing the third taxonomy, Collaborative Assessment Strategies, at first glance, E7 deliberated by actively working back through the processes:

> … [I] absolutely see … what you've got is the coordination of the Collaborative Learning Strategies is the hierarchy, and the others are dimensions of that hierarchy behind that makes sense.

While working through the elements and sub-elements, there was a point where E7 felt that the assessment strategies, 'Critical Discussion', to be of lower cognitive consequence than 'Exchange Information', stating:

> The Critical Discussion and Information Exchange jars a little bit because it looks like they're out of order because you've got this view of the hierarchy. But I absolutely see it's almost actually what you've got is the coordination of the Collaborative Learning Strategies is the hierarchy and the others are dimensions of that hierarchy behind that makes sense, map on to or map out of the Collaborative Learning Strategies.

When prompted to clarify the reasoning behind this thought process, E7 said:

> One of the problems is that the implicit collaboration around Information Exchange and Critical Discussion are quite interesting. Because you can exchange information with no intention to change your mind whereas Critical Discussion implies that you're trying to reach some kind of joint outcome by the way you buy into it. There is a that was part of the model that did gel with me as I want those to be the other way round in terms of the complexity, but I can see that the way you presented it you want to maintain the kind of horizontal connections between the different parts of the model.
>
> Once I got it, it kind of made more sense in being in that order, but the first time I saw it, I thought no they should be the other way round.

There were points where the interviewees requested clarification regarding some aspects of the taxonomies. Some aspects of the coloured model needed improvement, and there is the adjustment; the removal of the word "users" listed in the *Roles/Task Division* activity in the second taxonomy. The experts feedback is acknowledged and noted for future research. All in all, the experts understood that the order of the three taxonomies ranged from low cognitive level known as ‘cooperative’, to a high cognitive level being ‘collaborative’.

In view of this, the experts were asked to provide their opinion on Bloom’s Learning Taxonomy, specifically to comment on the relevance of Bloom’s Learning Taxonomy as a classification process when designing for collaboration on an LSSDS. What the majority of the experts agreed on was that Bloom’s taxonomy, on its own, primarily focused on the learners as individuals, not as a taxonomy for group learning. This is a reasonable assessment, as traditional classroom practices have revolved around the teacher as the controller of the learning environment, and the learner as an individual within this learning environment (see Section 2.5.1: Sociocultural Theory).

In relation to designing for collaboration, it was E6 who stated that Bloom’s Taxonomy (see Figure 8-7) was not the best option, in that collaboration as a learning domain was more complex than that of the individual learning domain. E3 believed, at first glance, that some of the early processes could, in some respects, be used in a collaborative sense, but when it came to the higher taxonomies such as Evaluation states, “how would you apply that necessarily to a collaborative experience versus an individual”, and that more rigorous systems and checks were required when it comes to collaboration.

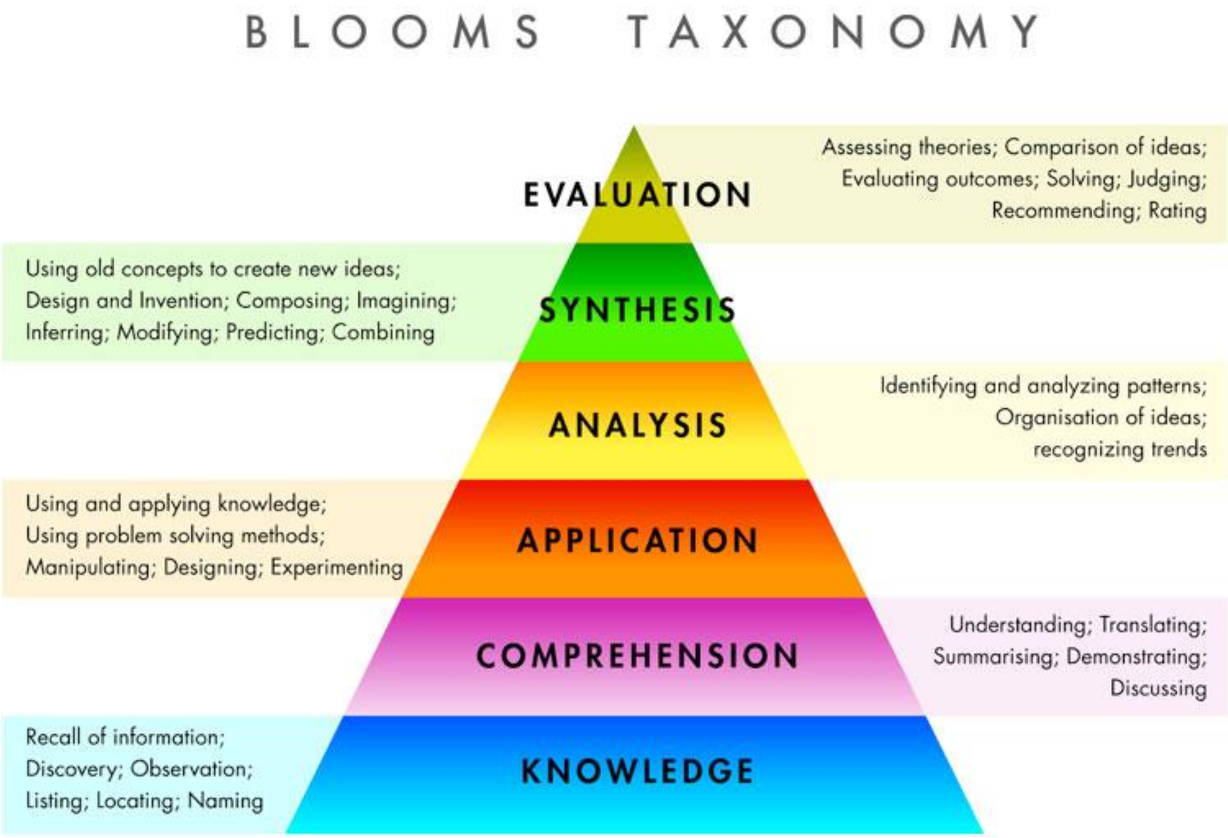


Figure 8-7: Bloom's Taxonomy (Cornwell, 2011)

Bloom’s was not considered an adequate classification process when focusing on groups of learners, as it did not focus on the relationship between what E7 describes as, “the collaboration and the outcome”. E7, who had in the past worked on various projects reviewing 45 different taxonomies, continues the argument by stating that “Taxonomies haven’t really caught up with Vygotsky”.

This is a strong point to make, as E7’s comment can be related back to Section 2.5.1: Sociocultural Theory, which discusses Vygotsky’s theory of how social interactions and people relate to each other in an interactive social context – in this case, the LSSDS. E7 recognised the benefit of the new taxonomies in how they help to identify problem areas, supported by essential collaborative strategies and groups of learners. The new taxonomies are unique in that they have been specifically designed for collaboration and collaborative learning environments, as opposed to Bloom’s Taxonomies, which are aimed towards the individual learning environment.

8.6.5 Phase Four: Analysis of the Collaborative Application Design

The experts discussion about this phase was general rather than specific. The key feature for Phase Four was a holistic interface/interaction design process that adopted a multi-arrow form which points to five specific design considerations for collaborative technologies. This design phase was relating collaborative technologies, such as the LSSDS, to human-computer interaction (HCI) and interface design.

The five elements are shown below (see Figure 8-8) are Shared Problem Space, Coordinated Interactions, Shared Interface Elements, Group Composition and Arrangement and finally, the new element, Induction to Interaction Strategies. These five elements are interrelated. This interrelationship was represented by the five-star arrow and needs to be thought of as a whole and not individually. For the instructional designer, the five elements act as prompts that enable and assist the designer to identify and create a design document that is specifically geared towards collaborative learning.

To begin, this phase of the model initially had four design elements, and became five as a consequence of the analysis of Stage One - Student/Teacher observational study (see Chapter 7).

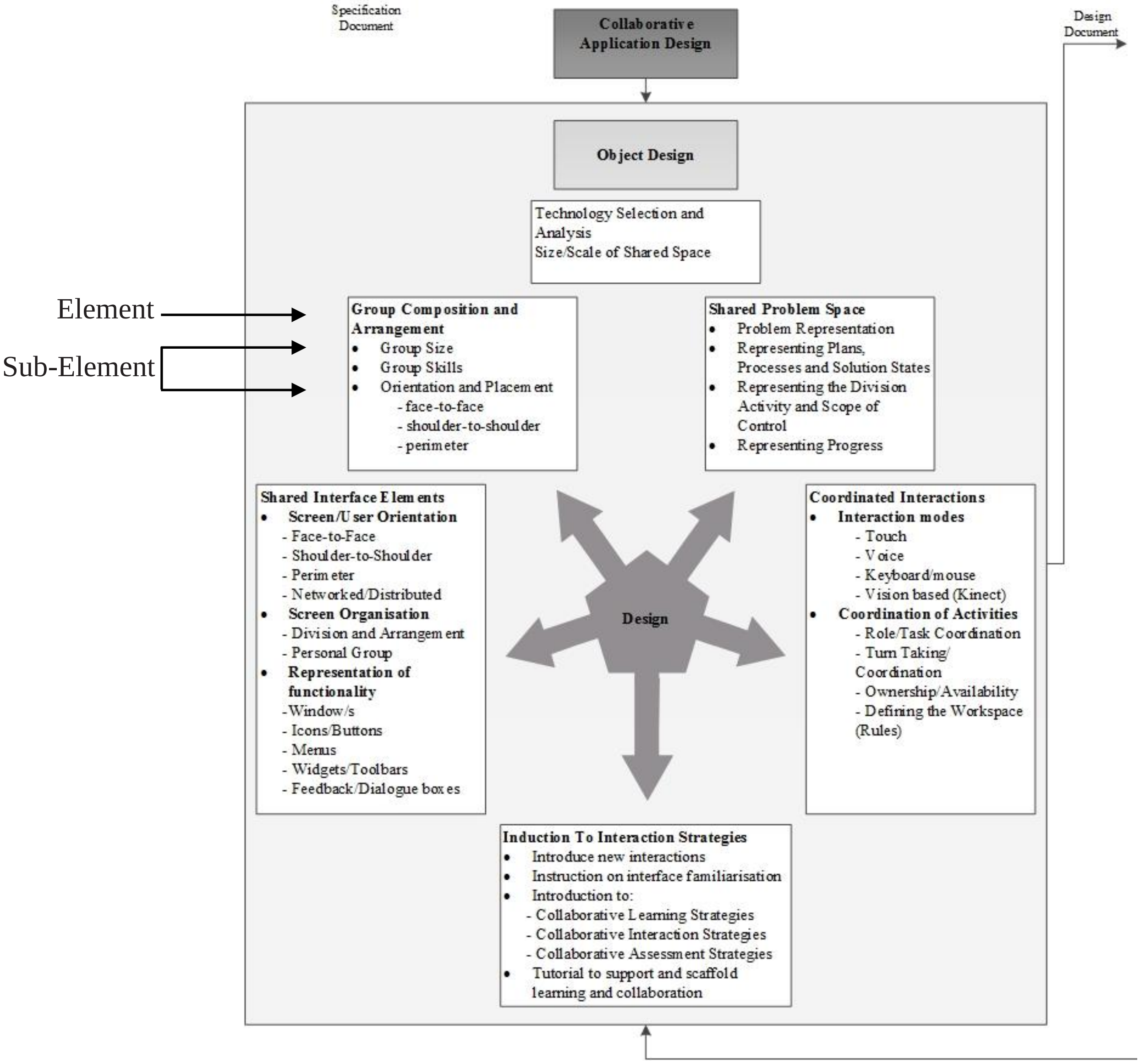


Figure 8-8: Collaborative Application Design, which includes new element - Induction to Interaction Strategies

The experts were presented with the phonics design document to provide context to the five design elements. In this regard, the experts response to the overall structure of each of the design elements was positive.

> E4: Yes, lots of nice detail. Pretty clear. Yes.

> E5: I think so. There’s a lot to it, but I don’t see of anything that I could throw out.

> E7: I thought that the model itself is pretty clear, to be honest…It was interesting to see what that looked like when you broke it down for your specific activity, but the model makes sense.

The phonics design document provided a valuable visual representation of the instantiations of the design elements. These design elements provided the instructional designer with a sufficient level of complexity for collaborative design.

E6 used a verbal form of the thought process when talking and comparing the phonics design examples to the elements:

> E6: Yes. These interfaces has [sic] a very good idea about design decisions based on what the different items that were considered into the process that make an impact on that, like deciding on your intention. That explains why the interface looks like this. We're talking about colours, the windows, interactions…

Through this process, E6 was able to then consolidate how the output, or phonics design document, provided a good explanation in relating back to the design elements.

When designing for multiple learners, group composition and how the groups are arranged around the screen requires consideration. For the phonics learning application, the learners were placed shoulder-to-shoulder. This gave them the opportunity to work closely together, allowing face-to-face discussion. While the learners interacted with the learning application as expected, there were times when some players would reach over and help themselves to the specific letter tile, or if there was a passive learner who allowed the dominant learner to take control. This was noted by a few of the experts whilst watching the video of the learners interacting. Learner dominance and frustration was a topic discussed in section 7.7.4 . In a social-constructivist learning environment, social interaction and discussion are important aspects of the learning process.

But in the design process, the Instructional Designer can plan for group size, skills, screen orientation and the learners placement around the screen. E4 stated, "I think it just would be hard to measure, even if you put in guidelines that ... look for frustration, look for dominance, I think it would be hard to measure unless you ask them [the students]." The process of matching students personality types that can lead to dominance or learner frustration is beyond the scope of this thesis. The process of matching learners is something that needs to be considered in situ and is a task that needs to be considered by the learner's instructor, who would understand the personalities of their students.

Finally, the discussion centred on the new element; Induction to Interaction Strategies, whereas an Expert in Instructional Design, one would need to bring about or induce certain interaction strategies and instruction on interface familiarisation. The experts recognised and agreed on the importance of adding this new element. E7 said:

> We started before the days when iPads were so prevalent. We didn't know exactly what kinds of gestures children would use. It's interesting now; you can already see culturally, young children pick up iPad gestures and try to use those on the multi-touch surface.

This idea (based on the original four elements) that children would pick up the gestures easily was also considered to be something that would come naturally. However, it was found that the learners, to begin with, did not intuitively understand about the gestures required to perform the expected tasks, even simple drag and drop. E6 noted that the "kids" modified the way they interacted and that when designing for LSSDS, one must not just assume that interaction would occur. When designing for touch, introducing learners to new interactions or even interface familiarisation required a more rigorous tutorial to support and scaffold learning and collaboration.

8.7 Summary

The key findings that have emerged from this chapter will now be highlighted. The majority of experts agreed that the overall CISD model provided guidance and would support instructional designers to develop a collaborative learning application. The experts overall sentiment towards the collaborative model was positive and supportive. The experts reactions and comments demonstrated that they understood that each phase was relevant to the surrounding phases, that they were straightforward, and provided an in-depth and logical design approach.

The experts responses regarding the four main phases were very specific. For Phase One, they saw this phase as a crucial decision-making process and that it was an important first step in the collaborative design process. The response for Phase Two was also positive. The experts saw the importance of how the three elements were interrelated as an essential analysis tool. For this reason, these elements would assist in determining the characteristics of the individual learner and those of a cohesive group, as well as the content and how the content and tasks are accomplished and, finally, the theory of the collaborative task analysis. The experts considered the third phase to be appropriate and helpful, and a highlight of the model. While they could draw strong correlations to Bloom's learning taxonomy, they observed that these three new taxonomies provided three new unique classification systems that are interrelated. The experts saw these new taxonomies to be supportive and would provide an important scaffold when designing for collaboration, as opposed to Bloom's taxonomy, which focused on designing for the individual learner. For Phase Four, the experts liked the level of details for each element, comparing this phase to the concept of storyboarding.

Suggestions for improvement were put forward and are noted for further research. Most suggestions related to the first three phases. For Phase One, an additional question was put forward relating specifically to the learning goal of the collaborative task, "Can Peers contribute to the learning experience?" and adding the word 'jointly' to the sentence, "Can Peers contribute [jointly] to the learning experience?" In Phase Two, a recommendation section was to be added to determine if the development of the application was to continue. Finally, regarding Phase Three, there was a number of suggestions put forward: the first was to have a glossary to explain each of the taxonomies, elements and sub-elements. This suggestion was identified and implemented in Stage One. Another consideration put forward was for the word 'user' to be removed from the Taxonomy of Collaborative Interaction Strategies, and as well as having aspects of the coloured version improved. Lastly, there was a suggestion to produce a "book or something", and that this book could provide a full explanation of the overall processes of the entire CISD model.

On the whole, all the experts were supportive of the design. No expert rejected the model outright. A number of suggested areas of improvement were highlighted and will be considered for further research. Therefore, the feedback of the experts has helped validate the utility and comprehensibility of the CISD model

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9 Conclusion and Recommendations

9.1 Introduction

This research began with the idea of developing a synchronous learning application for a Large-Scale Shared Digital Space (LSSDS). The application was to facilitate multiple learners, encourage collaborative interaction, discussion, and collaborative learning. The idea itself was simple enough. But as time progressed, with a more in-depth investigation of the literature, it was found that the standard instructional systems design model that was used so readily when designing instructional learning materials, would not work for designing collaborative learning applications for the interactive space.

Much of the background literature, such as Piper et al., (2006) and Sluis et al., (2004) demonstrated the LSSDS technology itself and its usability. But what was found was that these studies did not look at the necessary collaborative learning strategies and user interface strategies required to create and develop a learning application for multiple, co-located learners to work collaboratively in the same digital environment. Other aspects of this early research, such as Higgins et al., (2011), Piper et al., (2006) and Sherry et al., (2005), did not look at what was needed to understand the characteristics of multiple learners and how they are influenced by the learning activity. For example, it was unclear how the content of the learning tasks would be divided and how these divided tasks would be distributed amongst the learners. Another aspect that was not previously explored was the notion that planning, teamwork, and how learners communicate, are important skills, especially when working in a co-located interactive workspace. And finally, when designing and arranging learners around a large interactive environment such as the LSSDS, design, layout, interfaces, and affordances were important considerations. Clearly, the standard instructional systems design process was not well suited to this context.

Therefore, when designing a learning application for collaboration on an LSSDS, a systematic structure for designing learning applications was required. The planned approach that forms the main contribution of this research is in the form of a new model that provides the Instructional Designer with specific analysis and design strategies. This new model was titled—Collaborative Instructional Systems Design (CISD).

This research then validated the CISD model in two stages. Stage One of the methodology described the development of a game instantiation, as the phonics learning application, based on the CISD model, in order to show a sample of the output of the new instructional design process. This included an observational study where five pairs of students, supervised by three teachers, were observed interacting with the phonics learning application on the LSSDS. These observations and the follow-up interviews highlighted the collaborative nature of the resultant learning activity, which was the prime objective of the CISD model. Based on the lessons learned at this stage of the research, the model was revised and updated. A summary of the students/teachers findings is discussed in Section 9.5.

Stage Two of the methodology presented the updated CISD model to experts in the field of Instructional Design and/or in Educational Technology and sought their feedback on the utility and format of the new CISD model. Seven experts were presented with the CISD model, including an overview version of the model, a detailed version and the associated collaborative learning taxonomies. Also included in the resources presented to the experts were examples from the learning application design process and videos of the learners interacting with the learning application on the LSSDS. The experts were then interviewed regarding their response to the model. Overall, the reaction of the experts to the model was very positive, and they recognised the utility and relevance of specific elements of the model and the general approach. A summary of the experts findings is discussed in Section 9.5. Suggested improvements to the CISD model are documented in Section 9.5: Recommendations for Further Research.

9.2 Addressing the Research Questions.

To answer the main research question, a two-stage research approach was implemented. The primary research question to be addressed by this thesis is as follows:

> P1. How can an instructional design model assist in the design of collaborative learning environments based on large-scale shared digital spaces?

The results of this research indicated:

- that a model can be built to complement the current standard ISD model and assist Instructional Designers in designing collaborative learning applications in the context of LSSDS.
- that the output of the new CISD model produced a learning application that provided a face-to-face environment which encouraged learners to work collaboratively with a boost to verbal interaction.

- that the feedback from expert Instructional Designers was that this new design approach provided the foundation for developing collaborative learning applications for this type of shared learning environment

Part of the process of answering the main research question was to answer the following sub-questions. The first two sub-questions were addressed by the literature review.

S1. What are the educational affordances of large-scale shared digital spaces?

S2. What educational issues need to be considered when designing a Collaborative Instructional Systems Design model for large-scale shared digital spaces?

Relating to the educational affordances of LSSDS and, unlike desktop computing which focused on what Scott et al., (2003, p. 220) describes as "one-person/one computer paradigm", the LSSDS can accommodate multiple users to work synchronously in a face-to-face learning environment. To accommodate multiple users, a number of aspects needed to be addressed, such as, (1) group composition and arrangement, (2) the incorporation of specific collaborative strategies to encourage user interaction, (3) the shared workspace, itself, in designing for the large co-located workspace and design of the application, (4) the shared interface elements, which should encourage users to interact in order to facilitate effective collaborative learning interactions and, finally, (5) the coordination of the interactions using specific interaction modes such as touch, gestures and dialogue. All these points have been addressed by including a Design phase into the model. The Design phase was a key element absent from the standard ISD.

The main educational issues identified in the literature review focused on the standard ISD model, where it was identified that this model only focused on the notion of the individual learner/one computer paradigm. To understand the needs and requirements of multiple learners, the Literature Review explored and analysed Collaborative Learning, Computer Supported Collaborative Learning, Interactive Technologies and Collaborative Learning Theories.

The analysis of these theories enabled the design of the CISD model, consisting of a number of distinct phases, which is the main contribution of this research. Each of the phases in the CISD is incremental and provides the Instructional Designer step-by-step design processes. Examples of the learning theories related to the design of the CISD include Section 2.5.1: Sociocultural Theory, Section 2.5.2: *Activity Theory* and Section 2.5.3: Distributed Cognition Theory. These three domains of educational theory can be related directly to the design of Phase Two of the CISD, Collaborative Analysis. A range of theories, philosophies, and models was considered when designing a CISD model for large-scale shared digital spaces. More of these influences on the design of the CISD have been described in Chapters 4 and 5.

This was then followed by a two-stage research design. Stage One was to validate the CISD model by developing a research instrument; a phonics learning application presented to young learners at a local primary school. Stage One of the methodology focused on the following sub-question.

> S3. For a learning application designed using the Collaborative Instructional Systems Design model, what is the experience of the students and teachers in the classroom?

Whilst using the learning application, there were numerous times where the learners demonstrated that they could work together collaboratively. This supports the objective of the collaborative application design, in that the learners demonstrated many of the intended collaborative behaviours designed into the application. Given additional opportunities to familiarise themselves with the collaborative learning process on the LSSDS could have produced improved collaborative activity by the learners. As a consequence, an outcome of this analysis was to introduce an Induction to Interaction Strategies component to the CISD model. This would then introduce the learners to the specifics of the interface and teach them the new interactions required to use the collaborative learning application.

The teachers response was positive. The teachers saw the learning application to be an effective learning tool and that the learners interacted with the learning application in a collaborative manner. What they also observed was that as the levels of the learning application became more difficult, the learners interacted as well as discussed the task at hand more, and worked together collaboratively.

The next sub-question relates to Stage Two, where seven experts with instructional design and technology experience were shown a breakdown of the CISD and their related outputs, such as reports and design specification documents. At the same time, the student videos from Stage One (using the research instrument resulting from the CISD model) were presented to the experts. Stage Two addressed the following sub-questions:

> S4. How can a model influence the structure of learning tasks in an application in order to facilitate effective collaborative learning activity in a large-scale shared digital space?

How the model influenced the structure of the learning task to facilitate effective collaborative learning activity in an LSSDS was discussed in Section 8.6.1. In summary, the experts responses related to three main themes. The first was a general response to the model where the intention, purpose and the impact of the model relating to the design of the learning task were discussed. In a holistic sense, the experts were positive. They could see how the step-by-step processes of the model influenced the structure of the phonics learning tasks, as well as the resulting outputs from each phase. The experts agreed that the comprehensibility and structure of the model, phases, elements, and sub-elements influenced the phonics learning application. The experts agreed that the interdependent relationship and the objectives of each phase influenced the structure of the phonics learning application.

> S5. How can a model guide the design of an interface on a shared digital space to facilitate effective collaborative learning activity?

Including a design phase into the CISD model, Phase Four, provides the Instructional Designer with the necessary support to guide the design of an interface. Phase Four (see Figure 9-1) included a multi-arrow form, which points to five design considerations created explicitly for collaborative technologies.

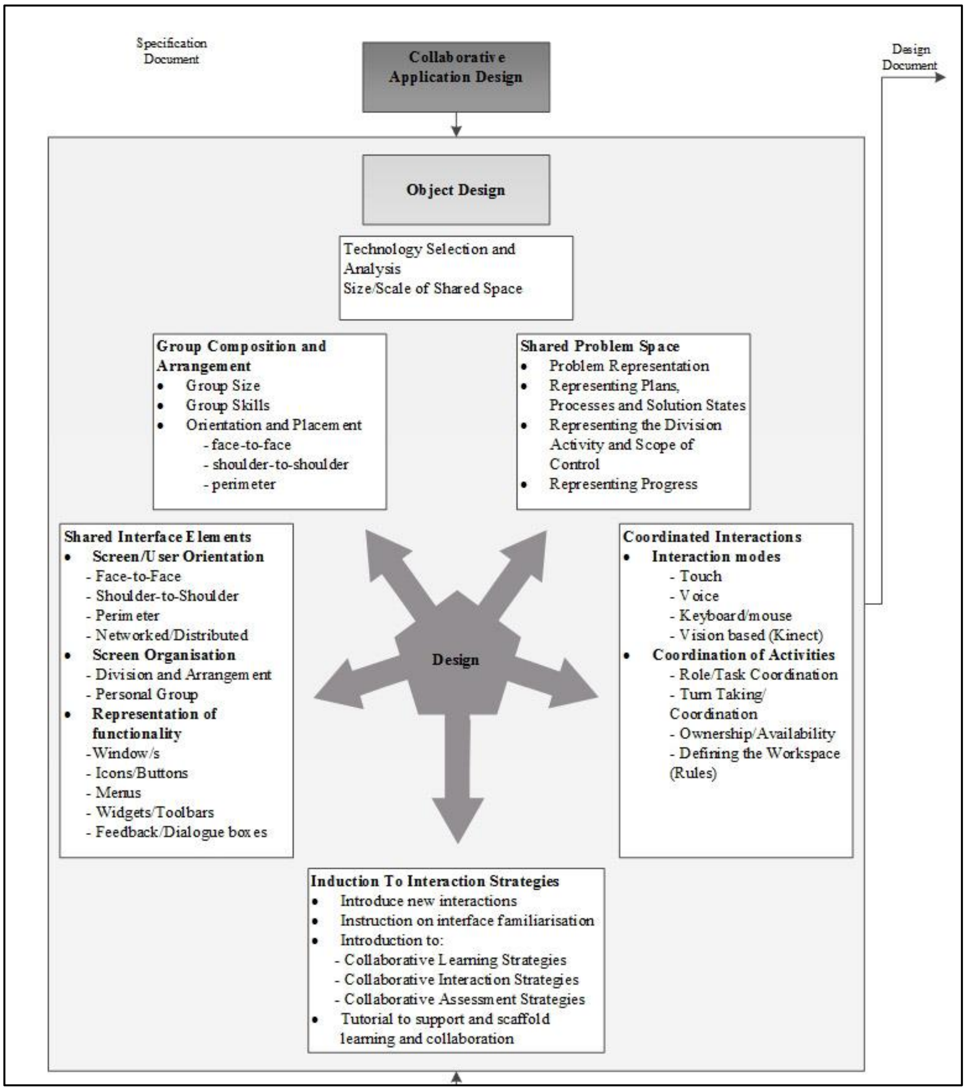


Figure 9-1: Example of Phase Four: Collaborative Application Design

Expert response to each of the design elements within this phase, and the output, or phonics design specification document (see Appendix M), was positive. The experts considered the design specification document to be a valuable report, providing examples of instantiations for each of the design elements. A comprehensive discussion relating to the experts feedback of this phase is in Section 8.6.5.

> S6. What is the perception of Instructional Systems Designers of the utility of a collaborative design model?

This question asked the experts to look at the whole CISD model and the sequence of each process to assess the functionality of each process and if the scope of each one was considered manageable. The experts were supportive of the CISD model and agreed that, in terms of design processes, this model provided a solution for Instructional Designers when creating a collaborative application, which catered for multiple users in a co-located interactive space such as the LSSDS. The experts also put forward a number of suggested improvements for the CISD model, but no expert rejected the model outright.

9.3 Research Contributions

The contributions of this research relate to the five key features.

- The first contribution is the CISD model itself.

The new instructional design model has added value and contributed to the following three domains: Instructional Systems Design (ISD), Interactive Technologies - the LSSDS, and the domain of using technology in education - Educational Technology. The CISD model is unique as it provides Instructional Designers with a new way of thinking by providing a detailed, rich and multifaceted series of systematic processes to assist in developing collaborative applications.

One example is Phase One of the CISD model. This phase, Instructional Focus, is the introduction of a decision-making process to assess the appropriateness of the collaborative learning approaches for the specific learning task. This is the first time that such a decision-making process has been incorporated into an ISD model. This process is important in that it is the initial step in determining if the proposed learning application is appropriate for the collaborative approach, and for implementation on an LSSDS.

Another example is Phase Two – Collaborative Analysis, which incorporates three elements: the analysis of the learners, the content analysis from a collaborative perspective and, finally, a collaborative task analysis. These three elements provide a series of steps that produce a detailed documentary outcome in the form of a scoping document to support the CISD in designing the learning application.

Finally, another unique aspect of the CISD model is Phase Four – Collaborative Application Design. This design process is distinctive as it provides the specific design support for creating collaborative learning applications. In the past, instructional designers have had access to many different processes for designing applications, but none that really focus on or make the designer think deeply about the collaborative aspects. A design process, specific to interactive technologies, was not previously included in the standard ISD model. This design phase will prompt and guide the Instructional Designer with essential elements and metaphors to assist in making necessary design decisions. Phase Four relates to HCI, Usability, and User Interface design domains.

In relation to the LSSDS technology, this model is exclusive to specifically supporting the design of collaborative learning applications for collaborative interactive technologies. The contribution to Educational Technology is what Higgins et al. (2011) refer to as the design relationship between the technological characteristics of the LSSDS and the learning possibilities in a classroom environment.

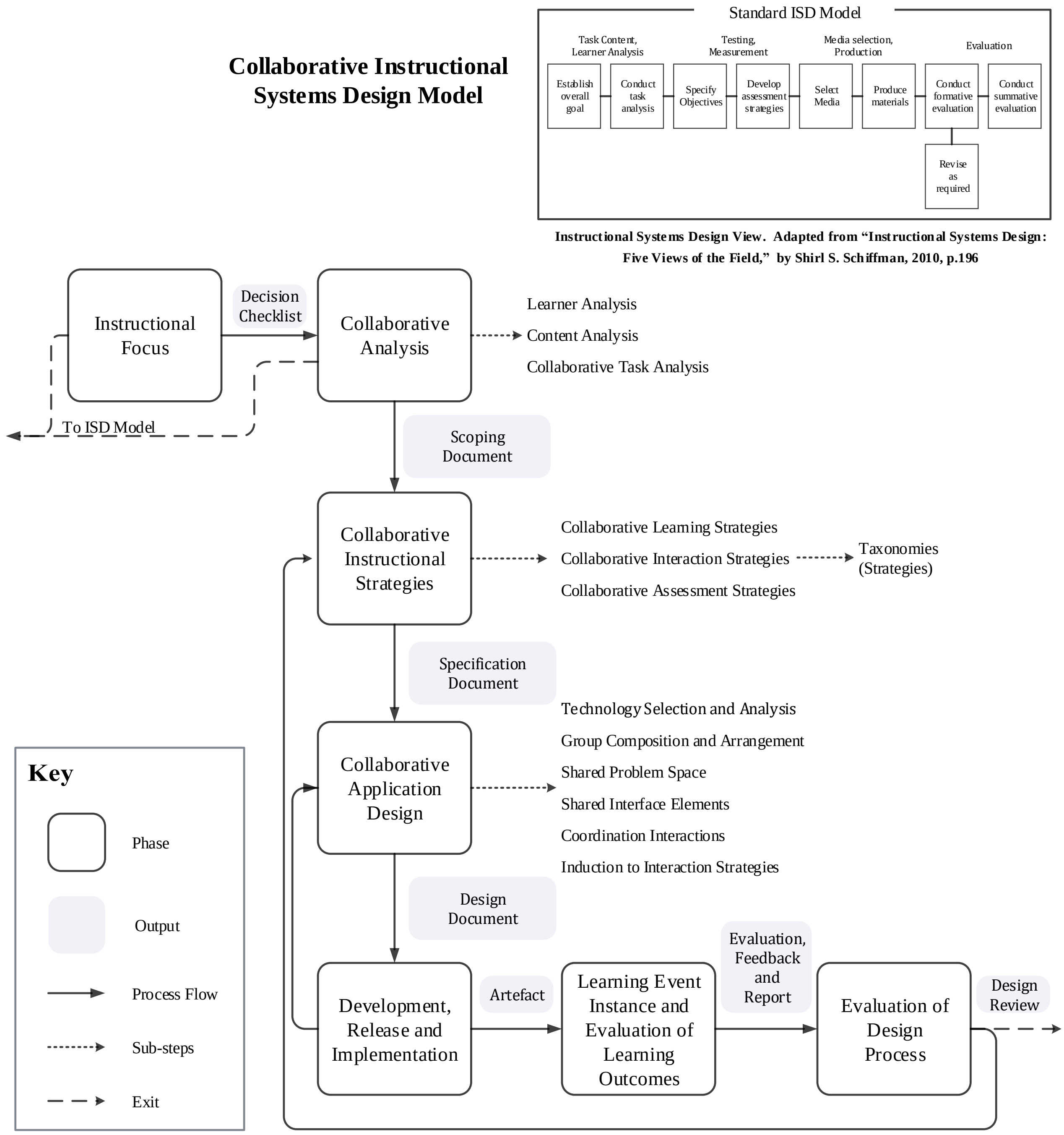


Figure 9-2: Revised Collaborative Instructional Systems Design Model with standard Instructional Systems Design Model inset

Figure 9-2 demonstrates the first level of the revised CISD Model and, inset is the standard ISD model. The change that is evident at this level of the CISD model is the addition of the Induction to Interaction Strategies. Figure 9-3 is the revised and updated version of the multi-layered CISD model. A legend has been inset to show the updated areas discussed and to relate back to the above Research Contributions. Stage One revision is shown in violet and Stage Two revision is in blue.

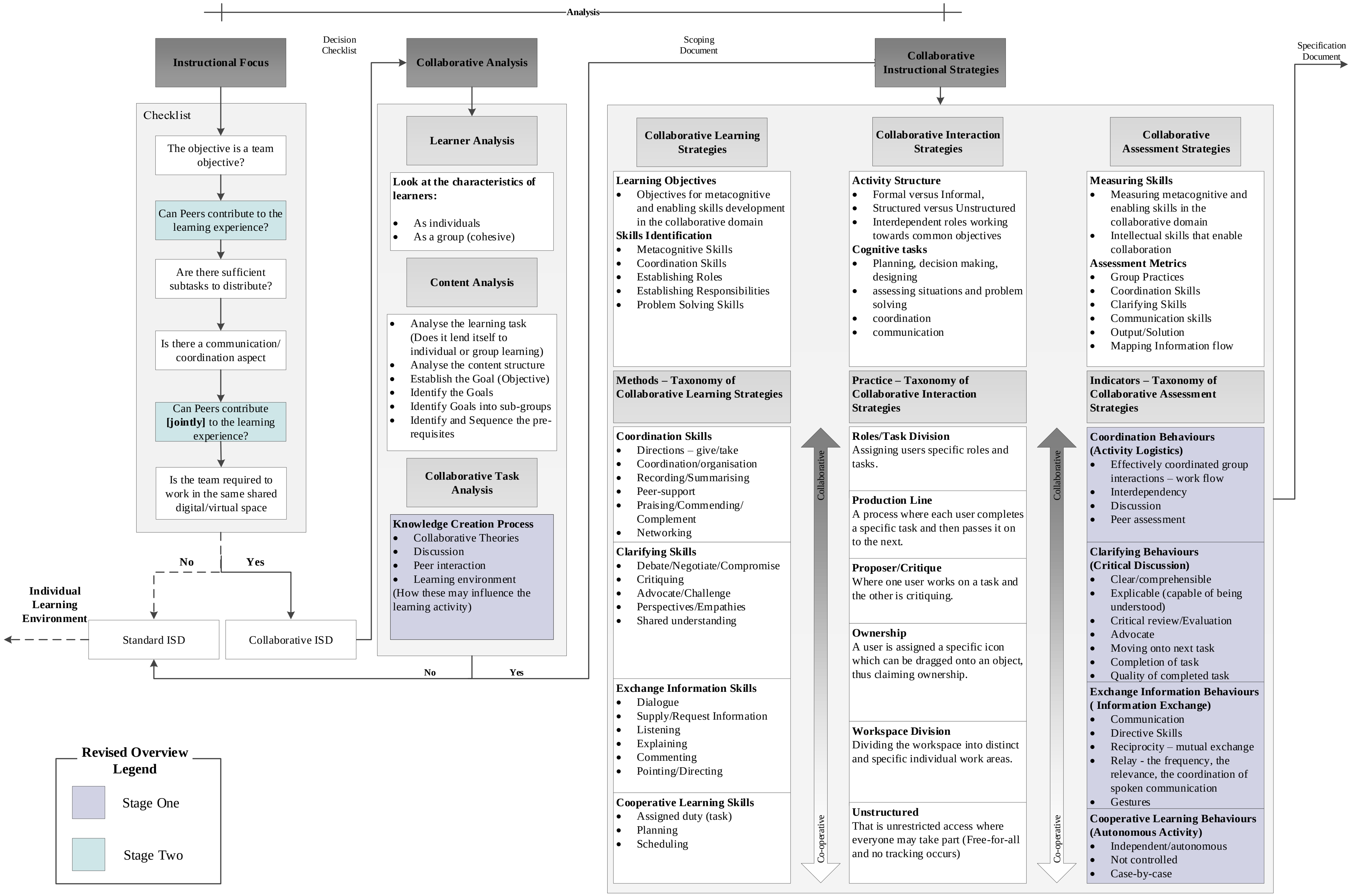
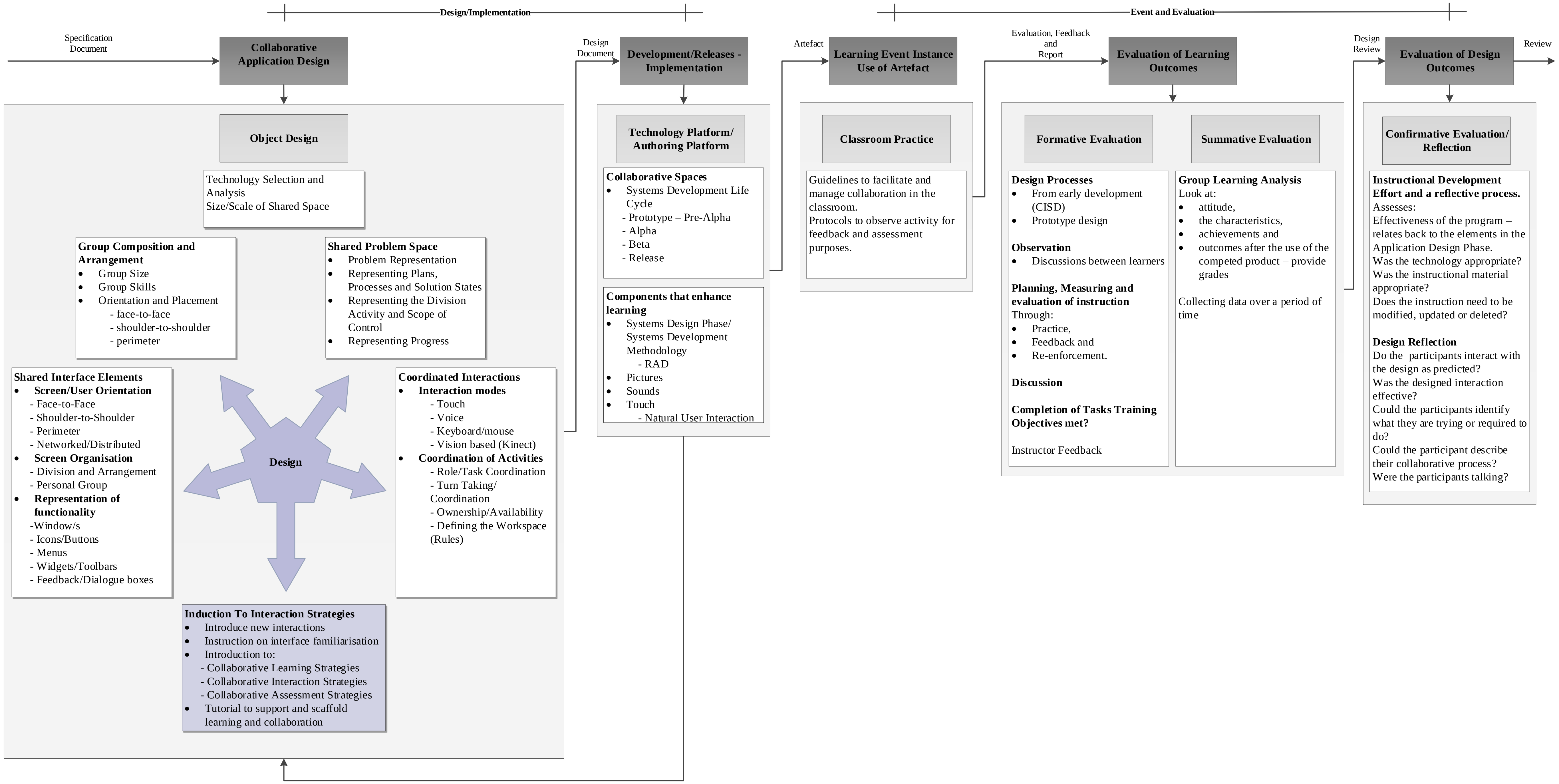


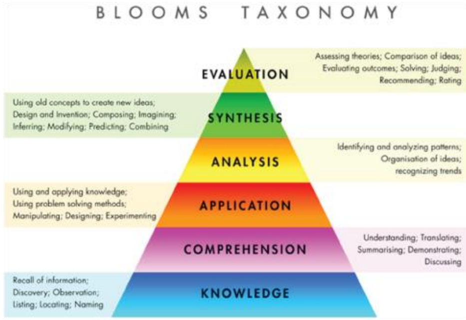
Figure 9-3: Revised and updated Collaborative Instructional Systems Design Model


Design/Implementation
Event and Evaluation
Specification Document
Collaborative Application Design
Design Document
Development/Releases - Implementation
Artefact
Learning Event Instance Use of Artefact
Evaluation, Feedback and Report
Evaluation of Learning Outcomes
Design Review
Evaluation of Design Outcomes
Review
Object Design
Technology Selection and Analysis
Size/Scale of Shared Space
Group Composition and Arrangement
• Group Size
• Group Skills
• Orientation and Placement
- face-to-face
- shoulder-to-shoulder
- perimeter
Shared Problem Space
• Problem Representation
• Representing Plans, Processes and Solution States
• Representing the Division Activity and Scope of Control
• Representing Progress
Shared Interface Elements
• Screen/User Orientation
- Face-to-Face
- Shoulder-to-Shoulder
- Perimeter
- Networked/Distributed
• Screen Organisation
- Division and Arrangement
- Personal Group
• Representation of functionality
-Window/s
- Icons/Buttons
- Menus
- Widgets/Toolbars
- Feedback/Dialogue boxes
Design
Coordinated Interactions
• Interaction modes
- Touch
- Voice
- Keyboard/mouse
- Vision based (Kinect)
• Coordination of Activities
- Role/Task Coordination
- Turn Taking/ Coordination
- Ownership/Availability
- Defining the Workspace (Rules)
Induction To Interaction Strategies
• Introduce new interactions
• Instruction on interface familiarisation
• Introduction to:
- Collaborative Learning Strategies
- Collaborative Interaction Strategies
- Collaborative Assessment Strategies
• Tutorial to support and scaffold learning and collaboration
Technology Platform/ Authoring Platform
Collaborative Spaces
• Systems Development Life Cycle
- Prototype – Pre-Alpha
- Alpha
- Beta
- Release
Components that enhance learning
• Systems Design Phase/ Systems Development Methodology
- RAD
• Pictures
• Sounds
• Touch
- Natural User Interaction
Classroom Practice
Guidelines to facilitate and manage collaboration in the classroom.
Protocols to observe activity for feedback and assessment purposes.
Formative Evaluation
Design Processes
• From early development (CISD)
• Prototype design
Observation
• Discussions between learners
Planning, Measuring and evaluation of instruction
Through:
• Practice,
• Feedback and
• Re-enforcement.
Discussion
Completion of Tasks Training Objectives met?
Instructor Feedback
Summative Evaluation
Group Learning Analysis
Look at:
• attitude,
• the characteristics,
• achievements and
• outcomes after the use of the competed product – provide grades
Collecting data over a period of time
Confirmative Evaluation/ Reflection
Instructional Development Effort and a reflective process.
Assesses:
Effectiveness of the program – relates back to the elements in the Application Design Phase.
Was the technology appropriate?
Was the instructional material appropriate?
Does the instruction need to be modified, updated or deleted?
Design Reflection
Do the participants interact with the design as predicted?
Was the designed interaction effective?
Could the participants identify what they are trying or required to do?
Could the participant describe their collaborative process?
Were the participants talking?

- The second contribution is the three new Collaborative Instructional Strategies and their related new taxonomies.

These three new taxonomies are unique as they were designed specifically with collaboration and collaborative learning in mind. Each taxonomy is explicit, as they have specific interdependent elements that provide the instructional designer with an indication and explanation of what is a collaborative approach and what is a cooperative approach to learning. Like Bloom's taxonomy, these elements utilise a hierarchical approach arranged from high-level skills, being a collaborative approach, to low-level skills being of a co-operative nature. These three taxonomies were designed to complement Bloom's Learning Taxonomy, just as Bloom has provided educators and instructional designers with a learning classification system which provided a scaffold to assist in designing classroom learning activities for individual learners so that higher level activities are included where appropriate. These three new taxonomies will provide the Instructional Designer with an ordered classification system of elements to incorporate into a learning activity, which covers all bases from what is collaborative in nature and what is cooperative.

Several changes have been made to the three new taxonomies: the colour of the three new taxonomies have been updated and aligned for consistency to Bloom's Learning Taxonomy (see Figure 9-4), the names have been aligned with the first Taxonomy of Collaborative Learning Strategies, and finally, a glossary has been created (see Appendix Q) to describe each of the terms in the taxonomy.



Bloom's Taxonomy (Cornwall, 2011)

Collaborative Learning Strategies

Learning Objectives
Objectives for metacognitive and enabling skills development in the collaborative domain

Skills Identification
Metaognitive Skills; Coordination Skills; Establishing Roles; Establishing Responsibilities; Problem Solving Skills

Collaborative Interaction Strategies

Activity Structure
Formal vs Informal; Structured vs Unstructured; Interdependent roles working towards common objectives

Cognitive Tasks
Planning, decision making, designing; assessing situations and problem solving; coordination; communication

Collaborative Assessment Strategies

Measuring Skills
Measuring metacognitive and enabling skills in the collaborative domain

Assessment Metrics
Group Practices; Coordination Skills; Clarifying Skills; Communication Skills; Output/Solution; Mapping information flow

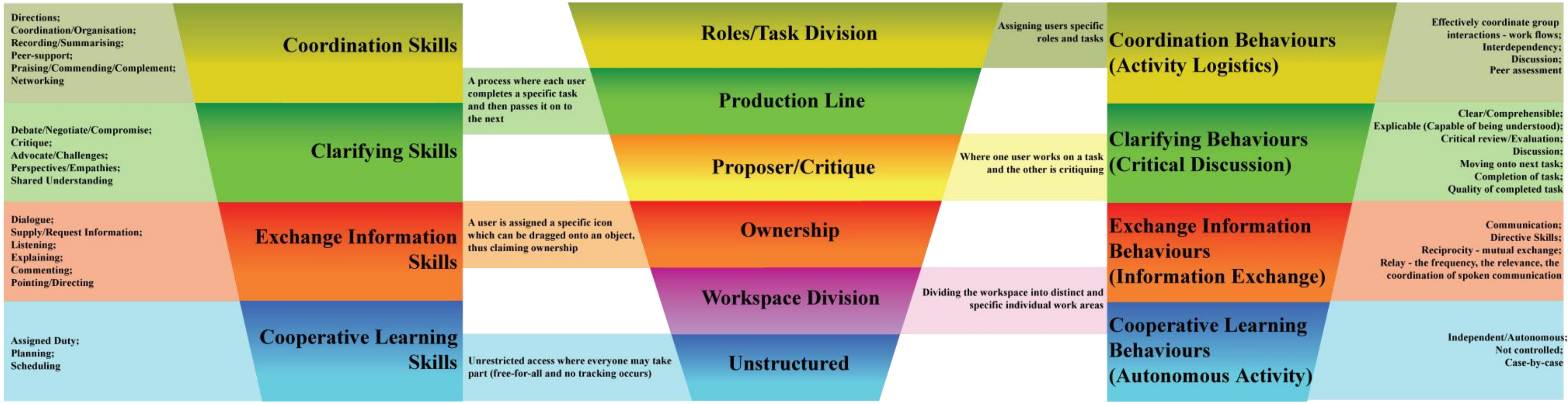


Figure 9-4: Updated Taxonomies with Bloom's Learning Taxonomy inset

9.4 Limitations

In this thesis, there were several limitations:

The evaluation did not seek to test student learning gains and outcomes resulting from the collaborative learning application that was developed. There is a large body of literature which supports how collaboration leads to good learning outcomes, whereas, the focus of this thesis was to design and to validate the CISD model.

In relation to how the students interacted and collaborated, the experimental learning activity was performed only once. Giving the students a second opportunity to interact and collaborate on the LSSDS using the same application may have resulted in more examples of collaborative learning activities, as would perhaps be choosing a different group of participants.

Only one learning application was developed. The focus of this thesis was not to develop many collaborative learning applications. The learning application developed is viewed as being sufficient to validate the model and to see if the program enabled collaboration.

The research sought feedback from experts in the field of instructional design and educational technology. It was beyond the scope of the research to have Instructional Designers use the CISD model to develop real-world collaborative learning applications on LSSDS, due to the funding and time required. The application developed as part of this research provided the examples and outputs required to seek feedback from the experts.

9.5 Recommendations for Further Research

The first recommendation would be to place emphasis on the investigation of the entire model, from beginning to end, by developing a learning application in a different instructional domain, such as Maths, Geography, and Physics. The purpose of this examination would be to reinforce the CISD model in order to validate its reliability, and/or to put forward further necessary modifications.

The second recommendation relates to the three new taxonomies and supports further research to explore the taxonomies across a range of different kinds of activities. This will help to further validate the three taxonomies in their current state or may result in further changes to fine-tune them in order to make them more effective and usable.

The third recommendation relates to the design process. It is important to further investigate whether the elements within this phase provide the necessary design support for the Instructional Designer.

This investigation would be achieved by the development of a new learning application in a different domain and would further strengthen and/or support the design phase in its current state.

The subsequent recommendations for further research focuses on the CISD model and how it was used to develop an application for one face-to-face collaborative learning environment. E7 suggested, “I could see it being used in similar situations where the participants were remote but had a shared space that they will be working on together.” Future research would examine how the CISD model would work in other interactive environments, such as shared virtual learning spaces. One example could be students collaborating on other large interactive environments, such as an interactive whiteboard, or with multiple interactive environments such as LSSDS or interactive whiteboard and tablets – locally or virtually, with a shift to a different pedagogy, such as blended learning. The CISD model could be used to develop a learning application that promotes a mix of traditional classroom practices that are generally teacher centred but can also be mixed with virtual, e-learning practices.

Explore ways to best present the CISD model, allowing an Instructional Designer to adopt the processes most easily. One example put forward was to produce a book or an e-book to fully explain each of the phases and processes of the model, and for an Instructional Designer to develop their own collaborative learning application. Another aspect could be to include Bloom’s pyramid in the taxonomies and/or include the standard ISD in the material for the CISD model.

Finally, it would be useful to test the student learning gains from a collaborative learning application developed using the CISD model. Up to now, there has been a considerable amount of the data analysis focused on the first four phases of the CISD model. Further research could emphasise, investigate and validate the model in its entirety by including the final three phases. This could further strengthen the CISD model.

9.6 Concluding Statement

For an Instructional Designer to develop a collaborative learning application for LSSDS using the standard ISD model can be a challenging task. One of the key challenges is the integration of collaboration with the learning task. It cannot be assumed that positioning learners around a large device will automatically facilitate them working together collaboratively as a team. To enable learners to work together collaboratively in a face-to-face environment takes planning and preparation. Processes and structures need to be put in place so that there is an effective and interactive workflow. As one teacher, T3, stated:

> …if you know your role is to collaborate and help that person then that would alleviate some of the frustration and it becomes a more positive experience if they both think...Ok, we together, have got to do this.

This thesis adopted the Design Science Research approach. This methodology demonstrated that a model, the CISD model, can facilitate collaborative learning in the context of LSSDS. To design and develop this new collaborative research artefact it was necessary to research and incorporate specific educational theories such as sociocultural theories, as well as collaborative learning theories, to assist in designing new collaborative learning activities for LSSDS. This was followed by a demonstration of a working learning application to establish that the model worked. Finally, the CISD model was analysed and validated by experts in instructional design and in technology.

The experts evaluation and feedback have shown that the CISD model equips Instructional Designers by providing a multi-layered method to guide and assist in the development of a collaborative learning application. Further use and re-testing of the CISD model in other learning domains would only strengthen and further validate this model.

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Appendices

Appendix A: Phase One: Student Research Questions

PHASE ONE
Group One: Student/Teacher

Students are required to play the phonics literacy application for 15 minutes on the large-scale shared digital space. At the end of the gameplay the students will participate in a 5-minute discussion to talk about their experience. The teachers roles during these sessions are in an observational capacity and are only to intervene when necessary.

Group One: Student

ST1. What did you have to do in the game?

ST2. Where you able to help your friend in the game?

ST3. Was your friend able to help you in the game?

ST4. How did playing on the table make you feel?

ST5 What did you like about the phonics game?

ST6. What didn't you like about the phonics game?

Appendix B: Phase One: Teacher Research Questions

PHASE ONE
Group Two: Teachers

At the end of all the student sessions, the teachers will participate in a 30-minute semi-structured interview.

T1. The children interacting

T1.1. What types of interactions did you see?

T1.2. Did you feel that students discussed the task at hand?

T1.3. Do you feel that there was a needed for the students to make shared decisions?

T2. The design influence on the interaction

T2.1. Do you feel that the structure of the learning tasks enabled the students to interact more effectively? In what way?

T2.2. Did you feel that the group dynamics, where students working alongside each other, encouraged collaboration and discussion?

T2.3. Did you feel the interface guided the student interaction effectively? If so why or why not?

T2.4. Do you feel that the visual and audio cues supported the interaction?

T3. Specific collaboration aspects

T3.1. Did the application lend itself to encouraging effective group interactions?
In what way?

T3.2. Did the structure of the learning tasks enabled the students to work together more effectively? If so how?

T3.3. Did the screen layout guide the student collaboration effectively?

T3.4. Did you find the interactions in the learning application were intuitive and easy to use?

T3.5. Do you feel that the students were able to work together without you providing help?

T4. The technology influence on the interaction

T4.1. Did you feel that the technology encouraged discussion? Why?

T4.2. Did the digital shared workspace allow the students to coordinate their interactions?

T4.3. Do you feel that this technology effectively facilitate collaborative learning?

T5. Suggestions

T5.1. Can you suggest any improvements in this design?

T5.2. How do you think this technology could be used to facilitate collaborative learning in the classroom?

T5.3. Are there any other issues that you would like to raise?

Appendix C: Phase Two: Expert Research Questions

PHASE TWO

Group Three: Expert Analysis

On completion of Groups 1 & 2, an information video will be created to demonstrate how the CISD model was used to assist in the design of the Phonics application and, demonstrate how students have interacted and collaborated on the large-scale shared digital space.

The experts will watch the video of the students using the systems and participate in a semi-structured interview. This video is divided into four sections:

Questions about their general reaction to technology and problem.

1. Questions about the need for a collaborative model and overall structure
2. Questions about the new Collaborative Taxonomies - Collaborative Instructional Strategies
3. The following questions connect the video of students collaborating on the large-scale shared digital space to the CISD model.

Expert Analysis

E1. QUESTIONS ABOUT THEIR GENERAL REACTION TO TECHNOLOGY AND PROBLEM.

In this section the information video will present the experts with:

- An Overview of the technology- large-scale digital spaces
- An introduction to the problems of collaborative design
- The phonics application with some children using it

E1.1. You may be aware of touch screen technology such as iPods, iPads, Information kiosks and interactive whiteboards. Were you aware or have you ever used multi-touch display technology such as the horizontal large-scale shared digital space?

E1.2. If yes, can you describe your experience?

E1.3. What do you think of touchscreen technology?

E1.4. What do you think of large-scale shared digital spaces?

E1.5. How can this technology be used?

Multiple people can use this technology at one time; one of the problems identified was to design collaborative interactions so that people can use this technology.

E1.6. What issues do you see in designing a collaborative learning application for a large-scale shared digital space where more than one user can interact at the same time?

To establish a need in how they would go about designing for this technology

E1.7. What do you think is required to resolve this problem?

E2. QUESTIONS ABOUT THE NEED FOR A COLLABORATIVE MODEL AND OVERALL STRUCTURE

In this section the information video will present the experts with:

Steps of each process by:

- Demonstrating, with examples, how each phase of the CISD model was used in the design process of the Phonics literacy application and
- the related outputs of each phase.

Comparing the ISD model to the CISD model.

E2.1. Does the model provide a clear process for considering the design of collaborative learning in a large-scale shared digital space?

Re: ISD Model

E2.2. Does this standard ISD model provide adequate guidance when designing for collaboration on a large-scale shared digital space?

E2.3. What specific features do you think need to be added to this model to assist in designing for collaboration on a large-scale shared digital space?

Re: Overview of CISD Model

E2.4. Does this overview of the model provide you with more guidance in designing for collaboration on a large-scale shared digital space?

E2.5. Is there a particular step in the overview that is unclear or that you don't understand?

E2.6. Is the order of the steps appropriate?

E2.7. Do you think that this model is self-explanatory?

The following questions are on each phase of the model.

E2.7.1. Instructional Focus

- Is the purpose of this phase clear?
- Is the way this phase is described clear?
- Did the example provided help you understand this phase of the model?
- Is the resulting output from this phase of the model, the checklist, useful?
- How important is it to include this phase in the model?
- Can you suggest any improvements in this phase?
- Any other comments?

E2.7.2. Collaborative Analysis

- Is the purpose of this phase clear?
- Is the way this phase is described clear?
- Did the example provided help you understand this phase of the model?
- Is the resulting output from this phase of the model, the scoping document, useful?
- How important is it to include this phase in the model?
- Can you suggest any improvements in this phase?
- Any other comments?

E2.7.3. Collaborative Instructional Strategies

- Is the purpose of this phase clear?
- Is the way this phase is described clear?
- Did the example provided help you understand this phase of the model?
- Is the resulting output from this phase of the model, the specification document, useful?
- How important is it to include this phase in the model?
- Can you suggest any improvements in this phase?
- Any other comments?

(Note: Section 3 will further investigate the taxonomies for Collaborative Instructional Strategies)

E2.7.4. Collaborative Application Design

- Is the purpose of this phase clear?
- Is the way this phase is described clear?
- Did the example provided help you understand this phase of the model?
- Is the resulting output from this phase of the model, the design document, useful?
- How important is it to include this phase in the model?
- Can you suggest any improvements in this phase?
- Any other comments?

E2.7.5. Development, Release and Implementation (output: the application)

E2.7.6. Learning Event Instance and

E2.7.7. Evaluation of Learning Outcomes

- Are there any aspects of these phases that are problematic?

E2.7.8. Evaluation of Learning Outcomes

- There is a specific focus on the collaborative aspects of the interaction. How important is it to include this aspect in this phase?
- Can you suggest any inclusions or improvements?

E2.7.9. Evaluation of the Design Outcomes

- This phase is a reflective process on the effectiveness of the program.
- Is the purpose of this phase clear?
- Is the way this phase is described clear?
- How important is it to include this phase in the model?
- Can you suggest any improvements in this phase?
- Any other comments?

E3. QUESTIONS ABOUT THE NEW COLLABORATIVE TAXONOMIES - COLLABORATIVE INSTRUCTIONAL STRATEGIES

In this section the information video will present the experts with:

- An overview of Bloom's Taxonomy and
- Discuss how the new taxonomies complement Bloom's by focusing specifically on collaborative aspects.

Re: Bloom's Taxonomy

E3.1. Do you think that Bloom's taxonomy offers an adequate classification of processes when designing for collaboration on a large-scale shared digital space?

The following are the three new Taxonomies

- Methods: Taxonomy of Collaborative Learning Strategies,
- Practice: Taxonomy of Collaborative Interaction Strategies,
- Indicators: Taxonomy of Collaborative Assessment Strategies,

E3.2. Do these new taxonomies provide you with an adequate classification process when designing for collaboration on a large-scale shared digital space?

E3.3. Is there a particular part of these new taxonomies that are unclear or that you don't understand?

E3.4. Is the order of the characteristics listed within these new taxonomies appropriate?
E3.5. Do you think that these taxonomies are self-explanatory?
Overall question relating to the taxonomies
E3.6. Do you feel that these multi-tiered taxonomies provide the necessary *classification systems,* to assist in defining effective collaborative strategies for large-scale shared digital spaces?

E4. THE FOLLOWING QUESTIONS CONNECT THE VIDEO OF STUDENTS COLLABORATING ON THE LARGE-SCALE SHARED DIGITAL SPACE TO THE CISD MODEL.

In this section the information video will present the experts with:

- students collaborating on the large-scale shared digital space and
- how the Phonics learning application was based on the CISD model

E4.1. Can you see how elements of the CISD model have been applied to the application, in a real-world context?
E4.2. Can you see the effects of designing for collaboration on a large-scale shared digital space?
E4.3. Based on what you have seen, how useful do you think the CISD model would be for designing collaborative learning application?

4. FINALLY, A GENERAL AND OVERALL QUESTION:

E5.1. Do you have any other thoughts about the suitability and usefulness of the CISD model?

Appendix D: MUHREC Low Risk Application Form

MONASH University

Human Research Ethics Committee

Low Risk Application Form

For low risk research or projects involving the use of existing non-health data or previously collected human tissues

Application Information

This is a dynamic PDF form. Depending on your answers, more questions will appear for you to complete and text boxes will expand. Completing both parts of the checklist below is required and is important to avoid delays in reviewing the application.

Submission Requirements

Email the following to muhrec@monash.edu:

- One e-copy of the application submitted from the Chief Investigator's Monash email account. Hard copies are not required.
- If electronic signatures are not available, print, sign and scan the signature page(s) and attach with the application.
- Explanatory Statement(s), Consent Form(s) and if relevant, advertisement, survey/interview/instrument questions, etc...

Does this project include any of the following? *If you answer YES to any of the questions in this section, your research may not meet the low risk criteria or may require full HREC review.*		
Any physical/psychological/social/economic or legal risks greater than inconvenience or discomfort, in either the short or long term, resulting from participation, or use of data in this project.	☐ Yes	☒ No
Use of identifiable/coded health information without consent *e.g. medical records, data linkage*	☐ Yes	☒ No
Focus on Aboriginal and Torres Strait Islander issues and /or participants	☐ Yes	☒ No
Interventions and therapies *e.g. administration of drugs, clinical or psychological treatments*	☐ Yes	☒ No
People with a cognitive impairment, an intellectual disability, or a mental illness	☐ Yes	☒ No
Human genetics	☐ Yes	☒ No
Pregnant women and the human foetus	☐ Yes	☒ No
Research intended to study/expose illegal activity	☐ Yes	☒ No
People highly dependent on medical care who may not be able to give consent	☐ Yes	☒ No
Persons considered to be forensic patients, involuntary patients or security patients	☐ Yes	☒ No
Radioactive substances / Ionising radiation *e.g. DXA, X-ray*	☐ Yes	☒ No
Sensitive / contentious issues *e.g. suicide, eating disorders, body image, trauma, violence*	☐ Yes	☒ No
Assisted reproductive technology	☐ Yes	☒ No
Use of human embryos	☐ Yes	☒ No
Derivation of human embryonic stem cells	☐ Yes	☒ No
Please answer all of the questions below. This will not affect the assessment of this research but further action is required on your part.		
Does this project involve the Monash MBBS Curriculum or its students? *If YES, you must register this project with the MBBS Executive.*	☐ Yes	☒ No
Does this project involve international travel? *Please confirm you have read the University travel policy.*	☐ Yes	☒ No
Does this project involve collecting data off campus or in rural settings? Please confirm that an OHS risk assessment has been prepared. Please contact your faculty OHS consultant for assistance or enquiries.	☐ Yes	☒ No
Is this a student research project from the Faculty of Law? *If YES, the project must be reviewed by the Law Advisory Panel on Empirical Research prior to submission for ethical review.*	☐ Yes	☒ No

Section 1 - Project details

1.1 Project Title

Evaluating the validity and suitability of the Collaborative Instructional Systems Design model in order to Facilitate Collaborative Learning in the Context of Large-Scale Shared Digital Spaces

1.2 Investigator Details

- The first investigator listed must be the Chief Investigator who is responsible for the research.
- For student research projects, the main Monash supervisor should be listed as the Chief Investigator.

1

Investigator Role Chief Investigator

Title	Given Name(s)	Last Name	Staff/Student ID
Dr	Michael	Morgan	01029079

School/Department	Faculty	Campus
Caulfield School of IT	Information Technology	Caulfield

Email Address	Preferred Phone Number(s)
michael.morgan@monash.edu	99031066

Please note that Monash staff and students MUST use their Monash email address.

Please describe your experience relevant to the proposed research. *(max 100 words)*

Various PhD supervisions to completion.

Add Investigator | Remove Investigator

2

Investigator Role Student

Title	Given Name(s)	Last Name	Staff/Student ID
Mrs	Daniela	McGivern	19209037

School/Department	Faculty	Campus
Caulfield School of IT	Information Technology	Caulfield

Email Address	Preferred Phone Number(s)
daniela.mcgivern@monash.edu	99034113

Please note that Monash staff and students MUST use their Monash email address.

Please describe your experience relevant to the proposed research. *(max 100 words)*

Conducted research, during my Honours, using observation and focus groups with adults and university students using multi-touch tabletop devices.

Add Investigator | Remove Investigator

1.3 In plain language, provide a succinct description of the background and the potential significance of the research project. *(max 250 words)*

Large-scale multi-touch technology is a new class of an interactive learning environment where multiple learners, up to eight participants, can interact on a single large digital display at the same time. In order to accommodate many users in one shared

digital space I have devised and developed a Collaborative Instructional Systems Design (CISD) Model to facilitate the design of collaborative learning applications/materials for large-scale shared digital spaces. This model has been designed to replace the current standard Instructional Systems Design (ISD) model that was created to assist the design of individual learning materials, and therefore will assist in the design of synchronous collaborative face-to-face learning environments.

1.4 Clearly state the aims and/or hypotheses of the research project. *(max 250 words)*

A Collaborative Instructional Systems Design model will assist Instructional Systems Designers create/design/develop learning applications for collaborative learning environments based on large-scaled shared digital spaces. This research project aims to prove the hypothesis by examining: i)ways in which learning tasks can be effectively structured to take advantage of the large-scale digital space; ii) the structuring of an effective interface to support a collaborative approach and finally iii) the benefits of large-scale digital learning spaces in which all participants can be active in an educational environment.

1.5 Please outline the benefits to participants and /or to the community as a result of this research being conducted.

Instructional designers will benefit from the development of the Collaborative Instructional Systems Design model as it specifically assists them design and develop synchronous collaborative learning applications for large-scale shared digital spaces such as multi-touch table technology. Student participants will benefit from better designed collaborative learning activities.

1.6 Please outline the risks involved in this research and clarify how participation will result in nothing more than discomfort.

Primary School students will be required to play an interactive phonics literacy game on a large-scale shared digital space. There are no risks or discomfort for participants.

1.7 Is this project related to other Monash University human ethics applications?

☐ Yes ☒ No

1.8 Will this project be submitted to other Human Research Ethics Committees (HRECs)?

☒ Yes ☐ No *Projects already approved by other HRECs can be registered with MUHREC using the other HREC Registration Form.*

Please provide details in the table below. You must inform all other HRECs that you are applying to MUHREC for approval.

HREC name	HREC approval obtained	HREC approval pending	Add/Delete row
Application to Conduct Research in Catholic Schools	☐	☒	+ -

1.9 Please indicate the type of research.

☐ Staff research ☒ Student research ☐ Unit project

Please provide the full title of the degree, e.g. PhD, Masters, Honours etc...

Doctor of Philosophy

1.10 Does your research involve recruiting participants or collecting data at other organisations?

☒ Yes ☐ No

Please provide details in the table below. The Chief investigator is responsible for obtaining permission from each organisation before advertising the research or starting data collection.

Organisation name	Contact name	Position	Add/Delete row
[redacted]			+ -

1.11 Do any of the investigators have a personal or financial interest in this research or in any of the organisations involved in this project?

☐ Yes ☒ No

1.12 Has funding been obtained for this project?

☐ Yes ☒ No

Section 2 - Research Scope

To avoid delays in processing your application, you must tick at least one of the two boxes below and complete the subsequent questions.

What does this project involve? *(tick all that apply)*

☒ Direct involvement or participation of human participants *Please complete Section 2a for each group of participants, and Section 2b*

☐ Use of existing identifiable non-health data or previously collected human tissues

Section 2a - Participant Recruitment and Consent Details

This is a repeating section and you can add extra groups by clicking the button at the end of this section. Please answer all the questions (2a.1 - 2a.11) for each group of participants and attach an Explanatory Statement and Consent Form for each group, if relevant.

Group

1

2a.1 Participant group title - *e.g. students.*

Primary School Students

2a.2 How many participants will be recruited in this group?

4 students per group, 5-10 groups in total.

2a.3 Are the participants children under 18 years of age?

☒ Yes ☐ No

Please outline how you will obtain parental consent. If you are not seeking parental consent, please describe the potential risks and the ability of the children to understand and voluntarily consent to participate in this research.

Parental consent will be gained through a consent form and explanatory statement distributed through the school.

2a.4 Describe who the participants in this group are and where they will be recruited from.

The participants are primary school students, grade 4-5. These students will be recruited from one Catholic School.

2a.5 Is there a pre-existing (unequal) relationship between the participants and anyone involved in recruiting and/or collecting data from this group of participants? *e.g. teachers/students, doctors/patients.*

☐ Yes ☒ No

2a.6 Do these participants have any cultural needs? *e.g. specific consent arrangements or sensitivities*

☐ Yes ☒ No

2a.7 Do you have any criteria for exclusion from this participant group?

☐ Yes ☒ No

Group	
	2a.8 Explain how you will recruit this group of participants and invite them to participate, including how you will obtain their contact details. *Please provide a copy of the advertising/invitation material, if relevant.*
	Permission sought from teacher and school principle and Catholic Education Office. Letter provided to the primary school to distribute to the grade 4-5 students. Students are to return the letter via the school or in the envelope provided direct to the researcher.
	2a.9 Will you be offering payment or any other incentives to this group of participants? ☐ Yes ☒ No
	2a.10 Will you use a written Explanatory Statement to inform the participants about this project? ☒ Yes ☐ No *Please include the Explanatory Statement when submitting this application. Refer to the MUHREC website for the template and details of what to include.*
	2a.11 Please clarify how you will obtain informed consent from this group of participants? ○ Implied Consent *e.g. return of an anonymous survey* ◉ Consent Form *Must be attached with this application* ○ Other *Please explain the process by which the participants will give consent and how will they return the consent form to the researchers.*
	Consent form, both parent and primary school child, to be completed and returned with authorising signatures, via the reply paid envelope or in person.
	Add another Group Remove this Group
2	**2a.1 Participant group title** - *e.g. students.*
	Teachers
	2a.2 How many participants will be recruited in this group?
	2 teachers
	2a.3 Are the participants children under 18 years of age? ☐ Yes ☒ No
	2a.4 Describe who the participants in this group are and where they will be recruited from.
	The teachers in this phase will be recruited from the school.
	2a.5 Is there a pre-existing (unequal) relationship between the participants and anyone involved in recruiting and/or collecting data from this group of participants? *e.g. teachers/students, doctors/patients.* ☐ Yes ☒ No
	2a.6 Do these participants have any cultural needs? *e.g. specific consent arrangements or sensitivities* ☐ Yes ☒ No
	2a.7 Do you have any criteria for exclusion from this participant group?

Group	
	☐ Yes ☒ No **2a.8 Explain how you will recruit this group of participants and invite them to participate, including how you will obtain their contact details.** *Please provide a copy of the advertising/invitation material, if relevant.* Teachers are members from the school and will be given an explanatory statement. Teachers will be recruited through e-mail invitation with contact information derived from publicly available information from school web sites. **2a.9 Will you be offering payment or any other incentives to this group of participants?** ☐ Yes ☒ No **2a.10 Will you use a written Explanatory Statement to inform the participants about this project?** ☒ Yes ☐ No *Please include the Explanatory Statement when submitting this application. Refer to the MUHREC website for the template and details of what to include.* **2a.11 Please clarify how you will obtain informed consent from this group of participants?** ○ Implied Consent *e.g. return of an anonymous survey* ◉ Consent Form *Must be attached with this application* ○ Other *Please explain the process by which the participants will give consent and how will they return the consent form to the researchers.* Participants will provided consent via the school or in reply paid envelope. Add another Group Remove this Group
3	**2a.1 Participant group title** - *e.g. students.* Instructional Design Experts **2a.2 How many participants will be recruited in this group?** Approximately 10 Experts in Instructional Systems Design and educational learning **2a.3 Are the participants children under 18 years of age?** ☐ Yes ☒ No **2a.4 Describe who the participants in this group are and where they will be recruited from.** The participants are experts in Instructional Systems Design and educational learning. They will be recruited from publicly available domains in the education sector, e.g. Primary School, Universities. **2a.5 Is there a pre-existing (unequal) relationship between the participants and anyone involved in recruiting and/or collecting data from this group of participants?** *e.g. teachers/students, doctors/patients.* ☐ Yes ☒ No **2a.6 Do these participants have any cultural needs?** *e.g. specific consent arrangements or sensitivities* ☐ Yes ☒ No **2a.7 Do you have any criteria for exclusion from this participant group?**

Group	
	☐ Yes ☒ No **2a.8 Explain how you will recruit this group of participants and invite them to participate, including how you will obtain their contact details.** *Please provide a copy of the advertising/invitation material, if relevant.* Instructional Experts will be invited via E-mail. University academics will be recruited via e-mail invitation with contact information derived from publicly available information derived from publicly available information from University web-sites. **2a.9 Will you be offering payment or any other incentives to this group of participants?** ☐ Yes ☒ No **2a.10 Will you use a written Explanatory Statement to inform the participants about this project?** ☒ Yes ☐ No *Please include the Explanatory Statement when submitting this application. Refer to the MUHREC website for the template and details of what to include.* **2a.11 Please clarify how you will obtain informed consent from this group of participants?** ○ Implied Consent *e.g. return of an anonymous survey* ◉ Consent Form *Must be attached with this application* ○ Other *Please explain the process by which the participants will give consent and how will they return the consent form to the researchers.* Participants will provided consent via return email. Add another Group Remove this Group

Section 2b - Data Collection Procedures

2b.1 Please indicate how the data will be collected?

☐ Questionnaires / Surveys - *attach a copy with this application*

☒ Interviews or focus groups - *attach a list of topics or questions*

☒ Observations

☐ Photography or videography

☐ Non Diagnostic Psychological inventories - *attach the instrument(s)*

☐ Other

Please provide details about the interviews or focus groups, e.g. will this include audio or video recording?

Phase One will begin with an observational study where primary school students are required to interact on a large-scale shared digital space using a phonics literacy application. The Teachers are required to observe how the students interact and collaborate in the learning activity and possibly assist the students with the learning activity, if necessary. Phase One will include audio and video recording of each session and at the conclusion the students will be asked to describe their experience. This will be followed by a concluding session with the teachers who will be interviewed in a semi-structured interview.
Phase Two includes interviews with experts in Instruction Systems Design and educational learning. These will also be audio and video recorded.

Please provide details about the observations, e.g. with or without the knowledge of participants and will this involve audio or video recording.

Phase One: 4-5 sessions involving teachers and students. These sessions will be audio and video recorded. Teachers and students will have prior knowledge and be aware, that these sessions are being recorded and video taped. This information will be included

on the Explanatory Statement and consent form from both students and parents will be obtained.
Phase Two: An information video, including samples of student collaboration from phase 1, will be created demonstrating how the phonics application was developed based on the new Collaborative Instructional Systems Design model. Experts are asked to view this video demonstration and be interviewed regarding the suitability of the Collaborative Instructional Systems Design model. The experts interviews will also be audio and video recorded for analysis and evaluation. This information will be included on the Explanatory Statement and a consent form will be obtained from each member.

2b.2 Please list in the table below which method(s) indicated in Q2b.1 will be used for each group of participants.

Group no./title	Relevant data collection method(s)	Add/Delete row
Group One: Student/ Teacher	4-5 sessions of 2 or 4 students per group for 15 minutes each of game play as an Observational Study, and a 5 minutes discussion with each group of students to gauge their experience.	+ -
Group Two: Teachers	At the end of all the student sessions the teachers will participate in a 30 minute semi-structured interview.	+ -
Group Three: Expert Analysis	Interviews	+ -

2b.3 Please provide details about what you are asking participants to do or what is to be done to them.
Include a step-by-step description of what participants will experience if they choose to take part in this project.

Group One/Group Two: A phonics literacy application has been developed based on the Collaborative Instructional Systems Design Model.
1. Students are required to play the the phonics literacy application for 15 minutes on the large-scale shared digital space. After which, the students will then participate in a 5 minute discussion to talk about their experience.

2. Teachers will be asked to observe how the students interact with the phonics literacy application on the large scale shared digital space. Teachers will observe 4-5 sessions of student interacting with the application and be present for the 5 minutes discussion. At the end of all sessions the teachers will participate in a 30 minute semi-structured interview and provide feedback of what happened in the sessions.

Group Three:
3. On completion of 1 & 2, an information video will be created for Phase Two to explain: (i) how the Collaborative Instructional Systems Design model was used to assist in the design of the Phonics application and, (ii) demonstrate how students have interacted and collaborated on the large-scale shared digital space. The experts will watch the video of the students using the systems and participate in a semi-structured interview.

2b.4 How much time are you asking of participants in this group and when will the time be required? *e.g. 30 min after class.*

Group One: a 20 minutes session.
Group Two: 4-5 20 minute sessions plus a 30 minute interview. Total Time: 2 hours 10 minutes.
The time will be required during class time at the school.
Group Three: A semi-structured interview of 1 hour.

2b.5 Where will the data be collected and by whom? *eg. Public library, University meeting room*

The data will be collected at the school.
Expert analysis will be collected in a University meeting room or my office via an in person interview or via Skype.

Section 3 - Privacy and confidentiality

3.1 Does this research involve the collection, use or disclosure of IDENTIFIABLE or CODED personal (excluding health) information within Australia? *e.g. names, contact details.*

☐ Yes ☒ No

Section 4 - Data access and security

4.1 Describe the security arrangements for the storage of the data. Include details of where the data will be stored and who will have access to the information?
You should consult the University's [Research Data Planning Checklist] to ensure that your data is managed securely and effectively.

The storage of the data collected will adhere to the University regulations and will be retained in a secure, locked cupboard/filing cabinet and electronic data will be stored on a password protected University computer for a period of 5 years after submission of the thesis.

4.2 Will a non-Monash third party have access to the data during this research?
e.g. using online survey tools such as Survey Monkey, translators or external data analysis/processing.

☐ Yes ☒ No

4.3 Will some or all of the research data be shareable at some time in the future?

☒ Yes ☐ No

Please explain how and what will be shared.

The research data may be included in my PhD research thesis in a non-identifiable form and the data may also be used for other research publications such as conference proceedings, journal articles or book chapter. All the data will remain anonymous and confidential. Anonymity of the video data will be addressed by ensuring that any reference to names will be bleeped, for audio, and any identifying titles, such as screen names will be blurred.

4.4 Are the data access and security arrangements detailed in the Explanatory Statement and consent form?

☒ Yes ☐ No

4.5 How will the data be disposed of if it is no longer required?

Hard copies will be shredded. Storage devices will be erased.

Section 5 - Communication of research outcomes

5.1 Please indicate in what format(s) the research will be published and/or communicated?

☒ Thesis
☒ Journal article
☒ Book / Book chapter
☒ Conference
☐ Report to organisation
☐ Dataset
☐ Other

5.2 Please describe how you will share the results with participants and / or organisations and how you will protect participants' identities? *e.g. summary, oral presentation, copy of journal article, report to organisation etc...*

The results will be presented in a oral presentations, such as the pre-submission seminar, or in at a conference, in a journal article and/or in a book chapter.
A copy of the results will be given to the participating school.

Declarations and Signatures

I/We, the undersigned, declare that I/We:

- accept responsibility for the ethical conduct of the research detailed above in accordance with the principles outlined in the National Statement and the Australian Code for the Responsible Conduct of Research.
- undertake to conduct this research project in accordance with the protocols and procedures outlined in this proposal as approved by MUHREC.
- inform MUHREC of any changes to the protocol after the approval of the Committee has been obtained using a Request for Amendment form.
- have read and agree to comply with the Monash Research Data Management Policy and have a plan for managing and/or sharing Research Data securely.
- understand and agree that study files and documents and research records and data may be subject to inspection by MUHREC, research governance officer, the sponsor or an independent body for audit and monitoring purposes.

If you do not have signature images, please add all investigators to this table, print the page to obtain their signatures and then submit the scanned signature page with your application.

Investigator full name	Signature of investigator	Date
Dr Michael Morgan	[redacted] *Click the space above to insert signature image*	18/09/2014
Mrs Daniela McGivern	[redacted] *Click the space above to insert signature image*	18/09/2014

MONASH University

EXPLANATORY STATEMENT

CHILDREN PARTICIPATION GROUP

Project: Evaluating the validity and suitability of the Collaborative Instructional Systems Design model in order to Facilitate Collaborative Learning in the Context of Large Scale Shared Digital Spaces

Dr Michael Morgan	**Mrs Daniela McGivern**
Faculty of Information Technology, Caulfield	Faculty of Information Technology, Caulfield
[redacted]	[redacted]

You are invited to take part in this research study. Please read this Explanatory Statement in full before deciding whether or not to participate in this research. If you would like further information regarding any aspect of this project, you are encouraged to contact the researchers via the phone numbers or email addresses listed above.

What does the research involve?

My name is Daniela McGivern, I am a PhD student from Monash University. I am studying how to make educational applications for learners. I have developed a model to help teachers create learning games. Based on this model, I have made a phonics literacy game that will help you learn how to recognise letter shapes and letter sounds. You will be working in a group of 2 or 4 players and are required to play this phonics game on a large touch table that looks like a big iPad. What I need you to do is play the game for 15 minutes. To teach you how to play the phonics game you will need to watch a small video. After the game we will have a short 5 minute discussion about the game. What you do, while playing the game, is important to my research.

How much time it will take?

You will play the phonics game for 15 minutes and then there will be a short 5 minute talk at the end of your session.

Why were you chosen for this research?

The phonics game is aimed at young students to help you to learn how to recognise letter shapes and letter sounds using a new technology, the large touch table.

Consenting to participate in the project and withdrawing from the research

For you to participate in this activity you need to sign the consent form. You can choose not to participate at any time and up to 14 days after you have taken part in this activity If you have signed the consent form and don't want to participate just speak to your parents or one of your teachers and they will let me know.

Possible benefits and risks to participants

The Phonics activity is simple to play and your teacher is there to help you. Some of the video material will be used to create an information video.

Confidentiality

While the use of the data is primarily for inclusion on the research thesis, data may also be used for other research publications such as conference proceedings and journal articles. All data will remain anonymous and confidential. This means that in the video, when someone says or calls your name, this will be bleeped out and your screen name will be blurred.

Storage of data

Storage of the data collected will follow the University regulations and kept on University premises in a locked cupboard/filing cabinet for 5 years. Electronic data will be stored on a password protected University computer for 5 years. A report of the study may be submitted for publication, but you will not be identifiable in this report.

Results

The findings will be accessible in a newsletter that will discuss the results of the research. Speak to your parent or teacher and they can explain these results.

Complaints

Should you have any concerns or complaints about this research, speak to your parent or your one of your teachers and they can contact the Executive Officer, Monash University Human Research Ethics (MUHREC):

Executive Officer
Monash University Human Research Ethics Committee (MUHREC)
[redacted]

Thank you,

[redacted]
Dr Michael Morgan
Monash University, Caulfield Campus
[redacted]

[redacted]
Mrs Daniela McGivern
Monash University, Caulfield Campus
[redacted]

MONASH University

EXPLANATORY STATEMENT

PARENT GROUP

Project: Evaluating the validity and suitability of the Collaborative Instructional Systems Design model in order to Facilitate Collaborative Learning in the Context of Large Scale Shared Digital Spaces

Dr Michael Morgan	**Mrs Daniela McGivern**
Faculty of Information Technology, Caulfield	Faculty of Information Technology, Caulfield
[redacted]	[redacted]

Your child has been invited to take part in this study. Please read this Explanatory Statement in full before deciding whether or not you will allow your child to participate in this research. If you would like further information regarding any aspect of this project, you are encouraged to contact the researchers via the phone numbers or email addresses listed above.

What does the research involve?

My name is Daniela McGivern. I am a PhD student from the Caulfield School of Information Technology. My research relates to education and technology. I have developed a new Collaborative Instructional Systems Design (CISD) model to facilitate instructional designers in the design of collaborative learning applications for large-scale shared digital spaces also known as multi-touch tables, tabletop technology. Using this model I have created a phonics learning application for classroom learning and young students. This application focuses on matching letter shapes and letter sounds in one co-located work space. In order for me to verify the Collaborative Instructional Systems Design model, I am asking for your permission to allow your son/daughter to participate in this learning activity. Your son/daughter will be in a group of 2 or 4 students. They are provided with a short tutorial and are then asked to play the phonics game on a large-scale shared digital space. Two teachers from your school will be present at all times to provide the students with assistance, if required. Each session is audio and video recorded to assist me in data analysis. Also, a few scenes will be included in an information video. This video will be presented to explain/demonstrate to Instructional Design experts, from University, Schools how the model has assisted in the creation/development of the phonics literacy application. The group of students including your son/daughter will be asked to discuss their experience of playing the game for five minutes at the end of the session.

How much time it will take?

20 minutes.

Your son/daughter are asked to interact (play) with the phonics learning game on the large-scale shared digital space for 15 minutes and then be part of a short 5 minute discussion at the end of their session.

Why were you chosen for this research?

The phonics game is aimed at young students to help you to learn how to read using a new technology, the large touch table.

Consenting to participate in the project and withdrawing from the research.

Could you please sign and return the attached consent form. You and your child have the right to withdraw from further participation at any stage during the participation process and up to 14 days after the completion of the participation process. No names will be used in reporting the data. Once collected and analysed this data will become part of this research.

Possible benefits and risks to participants.

The benefit of the CISD model is that it is a tool designed to assist Instructional Designers, such as teachers, develop learning applications for collaborative, face-to-face learning environments such as the large-scale shared digital space. The Phonics literacy game has been designed based on the set guidelines of the CISD model and will encouraged the students to connect with one another, working together, collaboratively, sharing their knowledge as well as problem sharing in a co-located environment. This student engagement will lead to deeper learning and understanding of their subject area as they are working in a team environment.

There is NO known potential level of inconvenience or discomfort for your child as a participant.

Confidentiality

No names will be used in reporting of the data. Privacy can be assured as the video will only be seen by a small number of experts who will not be made aware of the identity of the students involved. Any audio reference to your child's name will be bleeped, and any identifying titles, such as screen names, will be blurred in order to preserve their anonymity.

Storage of data

Storage of the data collected will adhere to the University regulations and kept on University premises in a locked cupboard/filing cabinet for 5 years. Electronic data will be stored on a password protected University computer for 5 years. A report of the study may be submitted for publication, but individual participants will not be identifiable in such a report.

Use of data for other purposes

While the use of the data is primarily for inclusion on the research thesis, data will also be used for other research publications such as conference proceedings and journal articles. All data will remain anonymous and confidential.

Results

If you would like to be informed of the aggregate research finding, please email **Daniela McGivern** at **daniela.mcgivern@monash.edu or Dr Michael Morgan** at **michael.morgan@monash.edu**. I will provide you with a brief article that will discuss the outcomes/results of this research.

Complaints

Should you have any concerns or complaints about the conduct of the project, you are welcome to contact the Executive Officer, Monash University Human Research Ethics (MUHREC):

Executive Officer
Monash University Human Research Ethics Committee (MUHREC)
[redacted]

Thank you,

[redacted]

Dr Michael Morgan
Monash University, Caulfield Campus
[redacted]

[redacted]

Mrs Daniela McGivern
Monash University, Caulfield Campus
[redacted]

MONASH University

EXPLANATORY STATEMENT

TEACHER PARTICIPANT GROUP

Project: Evaluating the validity and suitability of the Collaborative Instructional Systems Design model in order to Facilitate Collaborative Learning in the Context of Large Scale Shared Digital Spaces

Dr Michael Morgan
Faculty of Information Technology, Caulfield
[redacted]

Mrs Daniela McGivern
Faculty of Information Technology, Caulfield
[redacted]

You are invited to take part in this study. Please read this Explanatory Statement in full before deciding whether or not to participate in this research. If you would like further information regarding any aspect of this project, you are encouraged to contact the researchers via the phone numbers or email addresses listed above.

What does the research involve?

My name is Daniela McGivern and I am conducting a research project at the Monash University, Caulfield School of Information Technology towards my Doctor of Philosophy. My research relates to education and technology. I have developed a new Collaborative Instructional Systems Design (CISD) model to facilitate instructional designers in the design of collaborative learning applications for large-scale shared digital spaces also known as multi-touch tables, tabletop technology. Large-scale multi-touch technology is a new class of an interactive learning environment where multiple learners can interact on a single large digital display at the same time. The CISD model has been designed to replace the current standard Instructional Systems Design (ISD) model used by Instructional Designers. The ISD model was created to assist in the design of individual learning materials, whereas the CISD model will assist instructional Designers in designing applications for synchronous, collaborative, face-to-face learning environments. Using this model I have created a phonics learning application for classroom learning and young students. This application focuses on matching letter shapes and letter sounds in one co-located workspace.

In order to verify the Collaborative Instructional Systems Design model, I am asking for your permission to allow your students to participate in this learning activity. Your students will be in a group of 2 or 4 and will be provided with a short tutorial. They will then be asked to play the phonics literacy game on a large-scale shared digital space. You, as teachers, will be present at all times to provide the students with assistance, at all times. Each session is audio and video recorded to assist me in data analysis. Also, a few scenes will be included in an information video. This video will be presented to explain/demonstrate to Instructional Design experts, from University, Schools how the model has assisted in the creation/development of the phonics literacy application. Your students will be asked to discuss their experience of playing the game for five minutes at the end of the session. After all the sessions are completed you are asked to participate in a 30 minute interview about your student's experience and collaborative learning interactions.

How much time it will take?

The session will consist of approximately 4 to 5 20 minute sessions plus a 30 minute interview. Total time: 2 hours and 10 minutes.

Why were you chosen for this research?

As Teachers your name has been put forward by your school Principal/Learning co-ordinator to give your opinion and feelings relating to how your students interacted with the collaborative learning application and the technology they used. Your insight in this regard is important to this stage of research.

Consenting to participate in the project and withdrawing from the research

The consent process requires that you sign and return the consent form via email. As a participant, you have the right to withdraw during and up to 14days after participation. After the 14 day time frame the data collected will be analysed and become part of this research. Furthermore, parts of the the video and audio data collected will be used for further data collection, in a demonstration video, to be presented to experts in Instructional Design.

Possible benefits and risks to participants

The benefit of CISD model is that it is a tool designed to assist Instructional Designers develop learning applications for synchronous, collaborative, face-to-face learning environments such as the large-scale shared digital space. This will encourage students to connect with one another, working together, collaboratively, sharing their knowledge as well as problem sharing in a collocated environment. This student engagement will lead to deeper learning and understanding of their subject area as they are working in a team environment.
There is NO potential level of inconvenience or discomfort for you as the participant.

Confidentiality

No names will be used in reporting of the data. Privacy can be assured as the video will only be seen by a small number of experts who will not be made aware of the identity of the students or teaching staff involved. Anonymity of the video data will be addressed by ensuring that any reference to all names will be bleeped, for audio, and any identifying titles, such as screen names will be blurred.

Storage of data

Storage of the data collected will adhere to the University regulations and kept on University premises in a locked cupboard/filing cabinet for 5 years. Electronic data will be stored on a password protected University computer for 5 years. A report of the study may be submitted for publication, but individual participants will not be identifiable in such a report.

Use of data for other purposes

While the use of the data is primarily for inclusion on the research thesis, data may also be used for other research publications such as conference proceedings and journal articles. All data will remain anonymous and confidential.

Results

If you would like to be informed of the aggregated research finding, please email **Daniela McGivern** at **daniela.mcgivern@monash.edu** or **Dr Michael Morgan** at **michael.morgan@monash.edu.** I will provide you with a brief article that will discuss the results of this research.

Complaints

Should you have any concerns or complaints about the conduct of the project, you are welcome to contact the Executive Officer, Monash University Human Research Ethics (MUHREC):
Executive Officer
Monash University Human Research Ethics Committee (MUHREC)
[redacted]

Tel: [redacted]

Thank you,

[redacted]

Dr Michael Morgan

[redacted]

[redacted]

Mrs Daniela McGivern

[redacted]

MONASH University

EXPLANATORY STATEMENT

Plain Language Statement - Principal

Project: Evaluating the validity and suitability of the Collaborative Instructional Systems Design model in order to Facilitate Collaborative Learning in the Context of Large Scale Shared Digital Spaces

Dr Michael Morgan
Faculty of Information Technology, Caulfield
Phone: [redacted]
email: [redacted]

Mrs Daniela McGivern
Faculty of Information Technology, Caulfield
Phone [redacted]
email: [redacted]

You are invited to take part in this study. Please read this Explanatory Statement in full before deciding whether or not to participate in this research. If you would like further information regarding any aspect of this project, you are encouraged to contact the researchers via the phone numbers or email addresses listed above.

What does the research involve?

My name is Daniela McGivern and I am conducting a research project at the Monash University, Caulfield School of Information Technology towards my Doctor of Philosophy. My research relates to education and technology. Under the supervision of Dr Michael Morgan, I have developed a new Collaborative Instructional Systems Design (CISD) model to facilitate instructional designers in the design of collaborative learning applications for large-scale shared digital spaces also known as multi-touch tables, tabletop technology. Large-scale multi-touch technology is a new class of an interactive learning environment where multiple learners can interact on a single large digital display at the same time. The CISD model has been designed to replace the current standard Instructional Systems Design (ISD) model used by Instructional Designers. The ISD model was created to assist in the design of individual learning materials, whereas the CISD model will assist instructional Designers in designing applications for synchronous, collaborative, face-to-face learning environments.
Using this model I have created a phonics learning application for classroom learning and young students. This application focuses on matching letter shapes and letter sounds in one co-located workspace.
In order to verify the Collaborative Instructional Systems Design model, I am asking for your permission to allow your teachers and students to participate in this learning activity. Your students will be in paired groups and will be provided with a short tutorial shown at the beginning of each session, on the large-scale shared digital space. They will then be asked to play the phonics literacy game on a large-scale shared digital space.
I will require 2 teachers and 4-5 paired groups students for approx. 20min each group session, this will conclude with a half hour session at the end with the teachers. The teachers are required to be present at all times to provide the students with assistance. Each session will be audio and video recorded to assist me in data analysis. Also, a few scenes will be included in an information video. This video will be presented to explain/demonstrate to Instructional Design experts, from university and/or schools how the model has assisted in the creation/development of the phonics literacy application. Your students will be asked to discuss their experience of playing the game for five minutes at the end of the session. After all the sessions are completed the teachers are asked to participate in a 30 minute interview about your student's experience and collaborative learning interactions.

How much time it will take?

The student/teachers sessions will consist of approximately 4 to 5 20 minute sessions plus a concluding 30 minute interview with the teachers involved. Total time: 2 hours and 10 minutes.

Why were you chosen for this research?

Your teachers have been selected to give their opinion and feelings relating to how your students interacted with the collaborative learning application and the technology they used. Your teacher's insight in this regard is important to this stage of research.

Consenting to participate in the project and withdrawing from the research

The consent process requires that you sign and return the enclosed permission letter either by mail or via email. You and/or your teachers have the right to withdraw from this research during and up to 14 days after participation. After the 14 day time frame that data collected will be analysed and become part of this research. Furthermore, parts of the video and audio data collected will be used for further data collection, in a demonstration video, to be presented to experts in Instructional Design.

Possible benefits and risks to participants

The benefit of CISD model is that it is a tool designed to assist Instructional Designers develop learning applications for synchronous, collaborative, face-to-face learning environments such as the large-scale shared digital space. This will encourage students to connect with one another, working together, collaboratively, sharing their knowledge as well as problem sharing in a collocated environment. This student engagement will lead to deeper learning and understanding of their subject area as they are working in a team environment.
There is NO potential level of inconvenience or discomfort for you as the participant.

Confidentiality

No names will be used in reporting of the data. Privacy can be assured as the video will only be seen by a small number of experts who will not be made aware of the identity of the students or teaching staff involved. Anonymity of the video will be addressed by ensuring that any reference to all names will be bleeped, for audio, and any identifying titles, such as screen names be blurred.

Storage of data

Storage of the data collected will adhere to the University regulations and kept on University premises in a locked cupboard/filing cabinet for 5 years. Electronic data will be stored on a password protected University computer for 5 years. A report of the study may be submitted for publication, but individual participants will not be identifiable in such a report.

Use of data for other purposes

While the use of the data is primarily for inclusion on the research thesis, data may also be used for other research publications such as conference proceedings and journal articles. All data will remain anonymous and confidential.

Results

If you would like to be informed of the aggregated research finding, please email **Daniela McGivern** at **daniela.mcgivern@monash.edu** or **Dr Michael Morgan** at **michael.morgan@monash.edu.** As per the agreement with the Catholic Education Office, I will provide you with a summary report of the findings of this research.

Complaints

Should you have any concerns or complaints about the conduct of the project, you are welcome to contact the Executive Officer, Monash University Human Research Ethics (MUHREC):

Executive Officer
Monash University Human Research Ethics Committee (MUHREC)
[redacted]

[redacted]

Thank you,

[redacted] [redacted]

Dr Michael Morgan
Monash University, Caulfield Campus
[redacted]

Mrs Daniela McGivern
Monash University, Caulfield Campus
[redacted]

MONASH University

EXPLANATORY STATEMENT

INSTRUCTIONAL DESIGN EXPERT PARTICIPANT GROUP

Project: Evaluating the validity and suitability of the Collaborative Instructional Systems Design model in order to Facilitate Collaborative Learning in the Context of Large Scale Shared Digital Spaces

Dr Michael Morgan
Faculty of Information Technology, Caulfield
Phone [redacted]
email: [redacted]

Mrs Daniela McGivern
Faculty of Information Technology, Caulfield
Phone [redacted]
email: [redacted]

You are invited to take part in this study. Please read this Explanatory Statement in full before deciding whether or not to participate in this research. If you would like further information regarding any aspect of this project, you are encouraged to contact the researchers via the phone numbers or email addresses listed above.

What does the research involve?

My name is Daniela McGivern and I am conducting a research project at the Monash University, Caulfield School of Information Technology towards my Doctor of Philosophy. My research relates to education and technology. I have developed a new Collaborative Instructional Systems Design (CISD) model to assist instructional designers develop collaborative learning applications for large-scale shared digital spaces also known as multi-touch tables, tabletop technology. Large-scale multi-touch technology is a new class of an interactive learning environment where multiple learners can interact on a single large digital display at the same time. The CISD model has been designed to replace the current standard Instructional Systems Design (ISD) model used by Instructional Designers. The ISD model was created to assist in the design of individual learning materials, whereas the new CISD model will assist Instructional Designers in designing applications for synchronous, collaborative, face-to-face learning environments for a co-located workspace such as the large-scale shared digital space.

Prior to seeking your input and to test this model, I created a phonics learning application for classroom learning and presented it to teachers and students at a school in an audio and video recorded session. This phonics application focused on matching letter shapes and letter sounds in one co-located work space.

From the previous data collection, an information video has been created demonstrating how the phonics application was developed based on the new Collaborative Instructional Systems Design model and showing how the students collaborated when using the application.

As an Instructional Systems Design expert you will be asked to view this video demonstration and be interviewedregarding the suitability of the Collaborative Instructional Systems Design model. This interview will take place in a University meeting room or my office via an in person interview or via Skype and will be audio and video recorded.

How much time it will take?

The demonstration video and interview will take approximately 60 minutes, approximately 10 minutes to view the demonstration video and 50 minutes in a semi-structured interview.

Why were you chosen for this research?

As experts in Instructional Design you have been selected to give your opinion and feelings relating to the Collaborative Instructional Systems Design model and how this model may support Instructional designers develop collaborative applications/learning materials. Your contact details have been obtained from publicly available educational web sites and/or as authors of relevant scholarly papers/journals.Your insight in this regard is important to this stage of research.

Consenting to participate in the project and withdrawing from the research

The consent process requires that you sign and return the consent form via email As a participant, you have the right to withdraw during and up to 14days after the data collection process. After the 14 day time frame the data collected will be analysed and become part of this research.

Possible benefits and risks to participants

The benefit of CISD model is that it is a tool designed to assist Instructional Designers develop learning applications for synchronous, collaborative, face-to-face learning environments such as the large-scale shared digital space. This will encourage students to connect with one another, working together, collaboratively, sharing their knowledge as well as problem sharing in a collocated environment. This student engagement will lead to deeper learning and understanding of their subject area as they are working in a team environment.

There is NO potential level of inconvenience or discomfort for you as the participant.

Confidentiality

No names will be used in reporting of the data.

Storage of data

Storage of the data collected will adhere to the University regulations and kept on University premises in a locked cupboard/filing cabinet for 5 years. The storage of digital/electronic data will be stored on a password protected university computer. A report of the study will be submitted for publication, but individual participants will not be identifiable in such a report.

Use of data for other purposes

While the use of the data is primarily for inclusion on the research thesis, data may also be used for other research publications such as conference proceedings and journal articles. All data will remain anonymous and confidential.

Results

If you would like to be informed of the aggregated research finding, please email **Daniela McGivern** at **daniela.mcgivern@monash.edu** or **Dr Michael Morgan** at **michael.morgan@monash.edu**. The findings will also be accessible in my PhD thesis.

Complaints

Should you have any concerns or complaints about the conduct of the project, you are welcome to contact the Executive Officer, Monash University Human Research Ethics (MUHREC):

Executive Officer
Monash University Human Research Ethics Committee (MUHREC)
[redacted]

Thank you,

[redacted]

[redacted]

Dr Michael Morgan
Monash University, Caulfield Campus

Mrs Daniela McGivern

[redacted]

[redacted]

MONASH University

CONSENT FORM

CHILD PARTICIPATION

Project: Evaluating the validity and suitability of the Collaborative Instructional Systems Design model in order to Facilitate Collaborative Learning in the Context of Large Scale Shared Digital Spaces

Chief Investigator: Dr Michael Morgan

I have been asked to take part in the Monash University research project specified above. I have read and understood the Explanatory Statement and I hereby consent to participate in this project.

I consent to the following:	Yes	No
Participate in the phonics learning game	☐	☐
Allow audio/video recording during the game play and the discussion at the end of the game.	☐	☐
I understand that some parts of my audio/video recording may be used in a 10 minute demonstration video that will be shown to teachers who make learning games and that my name will not be mentioned.	☐	☐
I understand that the information the researcher takes from me during the time of game play and the discussion may be printed in University papers or in a book but my name will not be mentioned	☐	☐
I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw up to 14 days after the completion of the project participation without being penalised or disadvantaged in any way.	☐	☐

Name of Participant ____

Participant Signature ______________________________ Date ____________

MONASH University

CONSENT FORM

PARENTAL

Project: Evaluating the validity and suitability of the Collaborative Instructional Systems Design model in order to Facilitate Collaborative Learning in the Context of Large Scale Shared Digital Spaces

Chief Investigator: Dr Michael Morgan

My daughter/son, ___________________________ has been asked to take part in the Monash University research project specified above. I have read and understood the Explanatory Statement and I hereby consent for her/him to participate in this project.

I consent to the following:	Yes	No
My daughter/son to take part in playing a phonics literacy learning application	☐	☐
Agree to allow my daughter/son to be audio and video recorded during the game play and the short discussion at the conclusion of his game session.	☐	☐
I understand that parts of the audio and video recorded may be used in a 10 minute demonstration video to be shown to Instructional Design experts. Also any reference to names will be bleeped, for audio, and any identifying titles, such as screen names will be blurred.	☐	☐
I understand that any data that the researcher extracts from the students group session may be used in reports or published findings and will not, under any circumstances, contain names or identifying characteristics	☐	☐
I understand that the participation of my daughter/son is voluntary, that they or I can choose not to participate in part or all of the project, and that they or I can withdraw up to 14 days after completion of the project participation without being penalised or disadvantaged in any way.	☐	☐

Name of Participant ____

Participant Signature ______________________________ Date ____________

MONASH University

CONSENT FORM

Teacher

Project: : Evaluating the validity and suitability of the Collaborative Instructional Systems Design model in order to Facilitate Collaborative Learning in the Context of Large Scale Shared Digital Spaces

Chief Investigator: **Dr Michael Morgan**

I have been asked to take part in the Monash University research project specified above. I have read and understood the Explanatory Statement and I hereby consent to participate in this project.

I consent to the following:	Yes	No
I agree to take part in the Monash University research project specified above. I have had the project explained to me, and I have read the Explanatory Statement, which I keep for my records.	☐	☐
I agree to be involved in an interview at the conclusion of all the phonics sessions that will be audio and video recorded	☐	☐
I agree to allow the audio and video recorded of myself during the phonics activity sessions	☐	☐
I agree to allow the concluding interview to be audio and video recorded	☐	☐
The data that I provide during this research may be used by the researcher in future research projects.	☐	☐
I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw up to 14 days after completion of the project participation without being penalised or disadvantaged in any way.	☐	☐

Name of Participant ______________________________

Participant Signature ______________________________ Date ____________

MONASH University

CONSENT FORM

Experts in Instructional Systems Design and Educational Learning

Project: : Evaluating the validity and suitability of the Collaborative Instructional Systems Design model in order to Facilitate Collaborative Learning in the Context of Large Scale Shared Digital Spaces

Chief Investigator: Dr Michael Morgan

I have been asked to take part in the Monash University research project specified above. I have read and understood the Explanatory Statement and I hereby consent to participate in this project.

I consent to the following:	Yes	No
I agree to take part in the Monash University research project specified above. I have had the project explained to me, and I have read the Explanatory Statement, which I keep for my records.	☐	☐
I agree to be involved in an interview at the after viewing the information video	☐	☐
I agree to allow the interview to be audio and video recorded during the interview session.	☐	☐
The data that I provide during this research may be used by the researcher in future research projects.	☐	☐
I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw up to 14 days after completion of the project without being penalised or disadvantaged in any way.	☐	☐

Name of Participant ______________________________

Participant Signature ______________________________ Date __________

Appendix E: Response to the Human Research Ethics Committee

Monash University Human Research Ethics Committee (MUHREC)
Research Office

Response to the Committee

Please address each of the Committee's comments in the provided area. If the Committee has requested changes to supporting documents, please attach the revised documents to your response email. Please use track changes when revising supporting documents (i.e. Explanatory Statement, Consent Form or Form P etc.) to facilitate the review process.

CF14/3310 - 2014001761 - Evaluating the validity and suitability of the Collaborative Instructional Systems Design model in order to Facilitate Collaborative Learning in the Context of Large-Scale Shared Digital Spaces

1. Please provide further details of CI Morgan's relevant experience.

I have a PhD in Education, over 20 peer reviewed research papers in the field of educational technology and pedagogy, several Honour, Masters and PhD supervisions in educational research topics.

2. Please provide MUHREC with the necessary permission letters from both the Catholic Education Office and the School Principal prior to commencing your research project.

A permission email was sent to the [redacted], see Q18. If and when interim approval is received from MUHREC, an Application to Conduct Research in Catholic Schools form is ready to be sent to the Catholic Education Office.

3. Please comment on whether the researchers will require a Working with Children check.

see enclosed file: McGivern_WorkingWithChildren.pdf

4. In Q2a.4 (for Group 1), you state that "These students have been recruited from one Catholic school. Other sections also discuss recruitment in the past tense. Please confirm that recruitment has NOT been conducted as this project does not yet have ethical approval. Please clarify the extent of your contact with this school.

No recruitment has been conducted. The extent of the contact with the school was to contact the Principal and the Enhancement Centre Coordinator to ask if the school was interested in the research project.

5. For Group 1 in Q2a.11, please clarify to whom the consent forms are returned when submitted in person.

To the student's teacher.

6. In regards to Q2a.8 for Group 2, please provide further details where the contact details for the teachers are publically available. This information is not obvious in a scan of the [redacted] website.

The principal's contact details are listed at: [redacted]

In a document describing a new project called the Nationally Consistent Collection of Data on School Students with [redacted] is listed as the [redacted]

Contact with the appropriate teachers has been organised through the Principal and [redacted].

7. In Q2b.1, you state that you will be video recording interviews with experts in instruction design. Please comment on why video recording is required and how this data will be used in reporting the research.

The video record is preferred because they are discussing diagrams of an instructional design process and videos of classroom activities. The video will allow the researcher to understand the context of points raised and to create transcripts of comments if needed.

8. In Q2a.1, you state that there will be 10 sessions but in Q2b.2 there will only be 4-5 sessions. Please clarify.

The researcher intends to run 4 to 5 sessions of 2 students per session.

9. Your observational study will be conducted in class time and will be done serially in 4-5 sessions. Please explain how the class will be organised for those students not participating in a specific session. This is particularly important as the classroom teacher is also involved in all the sessions.

Further, in your Explanatory Statement, you indicate that students will learn about the phonics game through a video. When will this video be shown, where will students who are not participants in this research be at this time, and what will these students be doing?

The researcher will consult the [redacted] and the classroom teachers about the classroom activity and supervision arrangements for all the students in the [redacted]. These are generally small class groups with intensive learning activities conducted by more than one teacher/teacher's aide. The Researcher will work with the teachers to develop a lesson plan that ensures all the students will be accommodated and that only the students participating in the phonics game will need to view the tutorial video shown on the large-scale shared digital space.

10. In Q4.3, you state that data will be anonymous. Please explain how you will ensure this anonymity with video data. This issue will also need to be addressed in the Explanatory Statement with a revised Confidentiality section.

Anonymity of the video data will be addressed by ensuring that any reference to names will be bleeped, for audio, and any identifying titles, such as screen names, will be blurred.

Please provide the Committee with a revised copy of this document, using track changes.

11. Please revise your Results section in the Explanatory Statement. A PhD is not an appropriate form to communicate results to grade 4-5 students.

    The Researcher will provide a brief article expressed in an audience appropriate language. This article will discuss the results of the research for the students, parents and teachers involved.

    Please provide the Committee with a revised copy of this document, using track changes.

12. All the Explanatory Statements should be signed by the student researcher or both researchers. Please amend.

    Both researchers signatures are now included in the Explanatory Statement.

    Please provide the Committee with a revised copy of this document, using track changes.

13. Explanatory Statement for Experts:

    a. Please specify how you obtained their contact details in the "Why you were chosen" section.

    The following clause has been added:
    Your contact details have been obtained from publicly available educational web sites and/or as authors of relevant scholarly papers/journals.

    b. In the Withdrawal section, please clarify what you mean by the phrase " along with any implications of withdrawal".

    The above mentioned clause has been ammended and includes the issues raised in Q14:
    As a participant, you have the right to withdraw during and up to 14days after the data collection process. After the 14 day time frame the data collected will be analysed and become part of this research.

    c. Additionally, this statement makes no mention that the interviews will be audio and video recorded and does not nominate a place where the interview will be held. Please revise.

    The following statement has been added to the end of the final paragraph in "What does the research involve?"

This interview will take place in a University meeting room or my office via an in person interview or via Skype and will be audio and video recorded.

d. Please include a statement about storage of digital/electronic data in this Statement.

The following has been included in the paragraph:

The storage of digital/electronic data will be stored on a password protected university computer.

e. Please clarify the last sentence of section "What does the research involve", as it implies that the teacher will be interviewed for 30 minutes after each session.

The final sentence has been adjusted to read:

After all the sessions are completed you are asked to participate in a 30 minute interview about your student's experience and collaborative learning interactions.

f. Please include a statement about how the teachers were selected and how you got their contact details.

The sentence has been ammended to read:

As Teachers your name has been put forward by your school Principal/Learning co-ordinator....

Please provide the Committee with a revised copy of this document, using track changes.

14. In all of the Statements, you have a blanket statement about the right to withdraw at any stage. This seems to be misleading, as you will be progressively making use of data and using it as input in subsequent stages. Further, with video recording of group activity, it does not seem feasible to remove a participant's appearance in the video if they withdraw.

a. Please amend all the Statements to ensure there are appropriate and realistic comments about what withdrawal entails and at which point participants can withdraw.

All statements have been amended to include a clause stating that withdrawals can be made at any time during participation and up to 14 days after the completion of the participation process. This time frame is required as the process involving the students, parents and teachers will be used to develop a demonstration video to be used with Experts in Instructional design.

Additionally, please revise the statement that "privacy can be assured …"., as showing images to the experts breaches privacy.

This statement has been revised for each explanatory statement to read as follows

Child:

This means that in the video, when someone says or calls your name, this will be bleeped out and your screen name will be blurred.

Parent:

Any audio reference to your child's name will be bleeped, and any identifying titles, such as screen names, will be blurred in order to preserve their anonymity.

Teachers:

Anonymity of the video data will be addressed by ensuring that any reference to all names will be bleeped, for audio, and any identifying titles, such as screen names will be blurred.

Please provide the Committee with revised copies of these documents, using track changes.

15. In all Consent forms, the clause about withdrawal might require revision depending on your response to the question above.

The following clause have been added to the consent forms:

Child:

I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw up to 14 days after the completion of the project participation without being penalised or disadvantaged in any way.

Parent:

I understand that the participation of my daughter/son is voluntary, that they or I can choose not to participate in part or all of the project, and that they or I can withdraw up to 14 days after completion of the project participation without being penalised or disadvantaged in any way.

Teacher:

I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw up to 14 days after completion of the project participation without being penalised or disadvantaged in any way.

Please provide the Committee with a revised copy of this document, using track changes, if revisions need to be made.

16. In the Child and Parental Consent Form, please include a clause that would allow the video to be shown to other people. This clause should be very specific about who the

images are being shown to, and if appropriate for what length of time.

The following clause have been added to the consent forms:

Child:
I understand that some parts of my audio/video recording may be used in a 10 minute demonstration video that will be shown to teachers who make learning games and that my name will not be mentioned.

Parent:
I understand that parts of the audio and video recorded may be used in a 10 minute demonstration video to be shown to Instructional Design experts. Also, any reference to names will be bleeped, for audio, and any identifying titles, such as screen names will be blurred.

Please provide the Committee with a revised copy of this document, using track changes.

17. The Teacher Consent Form does not have a clause for recording the interview at the end of the sessions. Please amend to be consistent with the application.

Amended to read:

I agree to be involved in an interview at the conclusion of all the phonics sessions that will be audio and video recorded

Please provide the Committee with a revised copy of this document, using track changes.

18. Please provide the explanatory statements you will send to the School Principal and the Catholic Education Office, which is the basis for their permissions to conduct the research.

School Principal [redacted]
I have contacted [redacted] **via email, requesting if** [redacted] **would be a willing participant for my research prior to submitting their name in the Monash Ethics application, see McGivern_email_to_Principal.pdf, and also prior to formalising it by sending the letter of permission, see permission-letter-**[redacted]**.docx.**
A copy of the email, McGivern_email_to_Principal.pdf, is enclosed. This email also includes an email from [redacted] **I have also enclosed is an explanatory statement for the school Principal to sign.**

Catholic Education Office (CEO)
I have the form, Application to Conduct Research in Catholic Schools, to apply to the CEO to conduct the research in their schools. If MUHREC consents to provide an interim approval for this research, I will submit the form to the CEO's, with the letter from the Principal, the Explanatory statements, Consent forms, copy of all research instruments – research questions, for their approval. If approved by the CEO, I will submit this approval number to MUHREC for full approval.

Appendix F: Working with Children Check

Appendix G: Application to conduct research in Catholic Schools

Researchers in Catholic Schools and
Access to Data on Catholic Schools

CEOM POLICY 2.8
Appendix 2

APPLICATION TO CONDUCT RESEARCH IN CATHOLIC SCHOOLS

Instructions to applicants:

- Please complete ALL (applicable) questions, using the spaces provided and/or attaching additional pages/documents where necessary.
- Please refer to the CEOM Policy 2.8 – Procedures for Obtaining Approval to Conduct Research in a Catholic School whilst completing your application. http://www.ceomelb.catholic.edu.au/publications-policies/policy/policy-2.8-researchers-in-catholic-schools-and-access-to-data/

Section 1: General Details

1. Details of Principal Researcher					
Title:	Dr	Given Name:	Michael	Family Name:	Morgan
Phone:	[redacted]				
Address:					
Suburb:		State:		Postcode:	
*This is the email address to which a letter of approval (if granted) will be sent					
Name of organisation / university:			Monash University		
Are you currently employed in a Catholic school?			☐ Yes		☒ No
If yes, which school(s)					

2. Student Researcher Details:	
Complete this section if your research is contributing to the award of a degree.	
Qualification:	Bachelor of Information Technology (Honours)
Name of Institution:	Monash University, Caulfield School of IT
Address of Institution:	[redacted]
Suburb:	

3. Details of Associate Researcher					
Provide details for one Associate Researcher only. If you are a student researcher, please provide your research supervisor details.					
Title:	Mrs	Given Name:	Daniela	Family Name:	McGivern
Faculty/Department:	Faculty of Information Technology				
Name of Institution/Organisation:	Monash University				
Phone:	[redacted]				
Address:					
Suburb:	Caulfield East	State:	Vic	Postcode:	3145

Section 2: Details of Research Project

4. Title of Research Project
Evaluating the validity and suitability of the Collaborative Instructional Systems Design model in order to Facilitate Collaborative Learning in the Context of Large-Scale Shared Digital Spaces

5. Please give a brief summary of your research question and project. (max 250 words)
Large-scale multi-touch technology is a new class of an interactive learning environment where multiple learners, up to eight participants, can interact on a single large digital display at the same time. In order to accommodate many users in one shared digital space I have devised and developed a Collaborative Instructional Systems Design (CISD) Model to facilitate the design of collaborative learning applications/materials for large-scale shared digital spaces. This model has been designed to replace the current standard Instructional Systems Design (ISD) model that was created to assist the design of individual learning materials, and therefore will assist in the design of synchronous collaborative face-to-face learning environments.

6. Proposed dates for research				
Anticipated start date:	February	Month	2015	Year
Anticipated end date:	April	Month	2015	Year

7. Proposed research sample					
No. of Schools:	Primary: 1	Secondary:		Other:	
Researchers wishing to approach schools outside the Archdiocese of Melbourne will need to seek approval from the Directors of Catholic Education of the dioceses involved (Ballarat, Sandhurst or Sale).					

8. Categories & number of research participants to be sought	
Students (year level and number):	years 4 to 6, 4-5 pairs of students
No. of Parents:	0
No. of Teachers:	2
No. of Principals:	0
Other:	

9. Participant Recruitment Strategies

Describe how you intend to recruit participants and include details for specific participant populations.

Students:
A consent form and an explanatory statement will be provided to the primary school to distribute to the grades 4-6 students. As this research involved minors, a consent form and explanatory statement is provided for both the students and parents. The Students/Parents can return the signed consent forms via the school or in the provided reply paid envelope to be mailed directly to the researcher
Teachers:
Teachers will be recruited through the school. The teachers are also provided with a consent form and an explanatory statement to be returned to the researcher by hand or by mail in the reply paid envelope.

10. Methods of Data Collection

Please list the method(s) by which you intend to collect your data.

This research is an observational study where primary school students are required to interact on a large-scale shared digital space, for approximately 15 minutes, using a phonics literacy application. The teachers are required to observe how the students interact and collaborate in the learning activity and possibly assist the students with the learning activity, if necessary. All these sessions will be audio and video recorded. At the conclusion of each session there will be a 5 minute semi-structured interview with the students, who will be asked to describe their experience. Total student/teacher time is 20 minutes. At the end of all the student sessions there is one 30 minute semi-structured interview with the teachers.

11. Instruments for Data Collection

Please attach copies of all data collection instruments (surveys, questionnaires, interview questions, observation techniques etc.)

Attached: A copy of the students and teachers semi-structured interview questions are attached:
GroupOne_Student_Research Questions,
GroupTwo_Teacher_Research Questions

11a. Demands on participants Include a time allocation and other commitments for students, schools and other participants	
Students:	4-5 pairs of students, 20 minute session. Students are required to play the the phonics literacy application for approximately 15 minutes on the large-scale shared digital space. After which, the students will then participate in a 5 minute discussion to talk about their experience.
Parents:	
Teachers:	Observe 4-5 pairs of students, 20 minute sesstions with students plus one 30 minute interview. Total Time: 2 hours 10 minutes. Teachers are asked to observe how the students interact with the phonics literacy application on the large scale shared digital space. Teachers will observe 4-5

	sessions of student interacting with the application and be present for the 5 minutes discussion. At the end of all sessions the teachers will participate in one 30 minute semi-structured interview to provide feedback of what happened in the sessions.
Principals:	
Others *(specify)*:	
11b. Inducements: Are participants or schools to be offered any inducements to participate in research?	
☐ Yes	☒ No
If 'Yes', please give details	

12. Consent of participants
Indicate how consent will be sought
Student: Consent form and explanatory statement is to be distributed to parent and primary school child, to be completed and returned with authorising signatures, via the reply paid envelope or in person. Teacher: Teachers are members from the school and will be given an consent form and explanatory statement. Teachers will be recruited through e-mail invitation with contact information derived from publicly available information from school web sites.
Where appropriate, please attach copies of your documents for obtaining consent.

13a. Intrusiveness
Identify any parts of the research with the potential to be intrusive, upsetting or incriminating to participants.
The students are required to play a phonics literacy application on a large-scale shared digital space. No parts of this research will be intrusive, upsetting or incriminating to the participants.
13b. Follow-up support
Indicate what support will be made available for participants should it be required.

14. Approval by Human Research Ethics Committee (HREC)	
a. Name of the HREC which is reviewing the proposal	
Monash University Human Research Ethics Committee	
b. Has HREC approval been obtained?	
☒	Yes (attach copy of approval letter)
☐	No (forward copy of approval when available)
c. If no approval has been sought, please give reasons	

15. Confidentiality
Provide outline of arrangements for protecting confidentiality of data and ensuring privacy of participants.*
The storage of the data collected will adhere to the University regulations and will be retained in a secure, locked cupboard/filing cabinet and electronic data, audio and video recordings will be stored on a password protected University computer for a period of 5 years after submission of the thesis. Re: Audio If the student names are mentioned this will be bleeped out and their screen name will be blurred as required.

*Refer to NHMRC *Australian Code for the Responsible Conduct of Research 2007.*

16. Reasons for wanting to involve Catholic schools in the proposal

Catholic Schools are committed to social justice principles of educational excellence, equity of opportunity and participation for all students.

The developed phonics learning application is an innovative educational tool that encourages collaborative learning which could lead to improved educational outcomes.

By targeting remedial literacy this phonics application should provide students with an opportunity in the sharing of knowledge in a collaborative learning environment, on the large-scale shared digital space and should provide an understanding of basic literacy skills which promotes educational excellence and equity.

17. Contribution of research to the priorities for Catholic Education in Melbourne **Please select the priorities that most align with your research** (for further information please see 2011-2015 Directions for Catholic Education in Melbourne http://www.ceomelb.catholic.edu.au/about-catholic-education/2011-2015-directions/)	
1. Attract, develop and retain the very best teachers and staff	☐
2. Develop Catholic schools as core community centres	☐
3. Increase the active engagement of parents in their child's learning	☐
4. Enhance our Catholic identity	☐
5. Promote and develop shared, visionary and inspirational leadership	☐
6. Plan and provide safe, contemporary and effective learning environments	☒
7. Promote a culture of creativity and innovative practice	☒
8. Other (please specify)	☐

18. Agreement to provide reports and to grant the Catholic Education Office Melbourne the right to publish a summary report	
I agree to provide the Catholic Education Office Melbourne with a summary of the findings of the research described in this application.	
I further agree to provide participating schools with a suitable report.	
I grant the Catholic Education Office Melbourne the right to publish an edited summary of the research findings using either the print or electronic media.	
[redacted] collected during this project and to ensure privacy of all	
	Date: 19 / 12 / 2014

19. Declaration: [redacted]	
I declare that the a [redacted] ***ect.***	
M. Morgan [redacted]	Date: 19/ 12/ 2014.
Signature of Applic [redacted]	

Please complete th [redacted] **list before submitting your application**		
☒	Letter of reques [redacted]	☒ if attached
☒	Plain Language Statement (PLS) describing research – for principal	
☒	PLS – for participants (written in a style appropriate to their age)	
☒	PLS – for parents (if applicable)	
☒	Copy of all research instruments (e.g. surveys, interview questions)	
☒	Consent Form for participants	
☒	Consent Form for parents (if students are participants)	
☒	Notification of approval from the HREC (if applicable*)	
☒	Any additional information to support the application (optional)	
***If HREC notification is not yet available, it must be sent to the CEOM before schools are approached.**		

This application and attachments must be emailed to: km@ceomelb.catholic.edu.au

Enquiries:
Policy & Research, Catholic Education Office Melbourne
Phone (03) 9267 0228

Appendix H: Approval Letter from Catholic Education Office

Catholic Education Office
Archdiocese of Melbourne

GE14/0009
22/12/2014

Project #2062 Morgan

Dr Michael Morgan
Monash University
[redacted]

Dear Dr Michael Morgan

I am writing with regard to your research application received on 19/12/2014 concerning your forthcoming project titled *Evaluating the validity and suitability of the Collaborative Instructional Systems Design model*. You have asked approval to approach a Catholic school in the Archdiocese of Melbourne, as you wish to involve teachers and students.

I am pleased to advise that your research proposal is approved in principle subject to the eight standard conditions outlined below.

1. The decision as to whether or not research can proceed in a school rests with the school's principal, so you will need to obtain approval directly from the principal of the school that you wish to involve. You should provide the principal with an outline of your research proposal and indicate what will be asked of the school. A copy of this letter of approval, and a copy of notification of approval from the organisation's/university's Ethics Committee, should also be provided.

2. A copy of the approval notification from your institution's Ethics Committee must be forwarded to this Office, together with any modifications to your research protocol requested by the Committee. You may not start any research in Catholic Schools until this step has been completed.

3. A *Working with Children* (WWC) check – or registration with the Victorian Institute of Teaching (VIT) – is necessary for all researchers visiting schools. Appropriate documentation must be shown to the principal before starting the research in the school.

4. No student is to participate in the research study unless s/he is willing to do so and informed consent is given in writing by a parent/guardian.

1 of 2

James Goold House [redacted]

5. Any substantial modifications to the research proposal, or additional research involving use of the data collected, will require a further research approval submission to this Office.

6. Data relating to individuals or the school are to remain confidential.

7. Since participating schools have an interest in research findings, you should consider ways in which the results of the study could be made available for the benefit of the school community.

8. At the conclusion of the study, a copy or summary of the research findings should be forwarded to the Catholic Education Office Melbourne. It would be appreciated if you could submit your report in an *electronic format* using the email address provided below.

I wish you well with your research study. If you have any queries concerning this matter, please contact Ms Shani Prendergast of this Office.

The email address is [redacted]

Yours sincerely

[redacted]

Anna Rados
MANAGER ANALYSIS, POLICY & RESEARCH

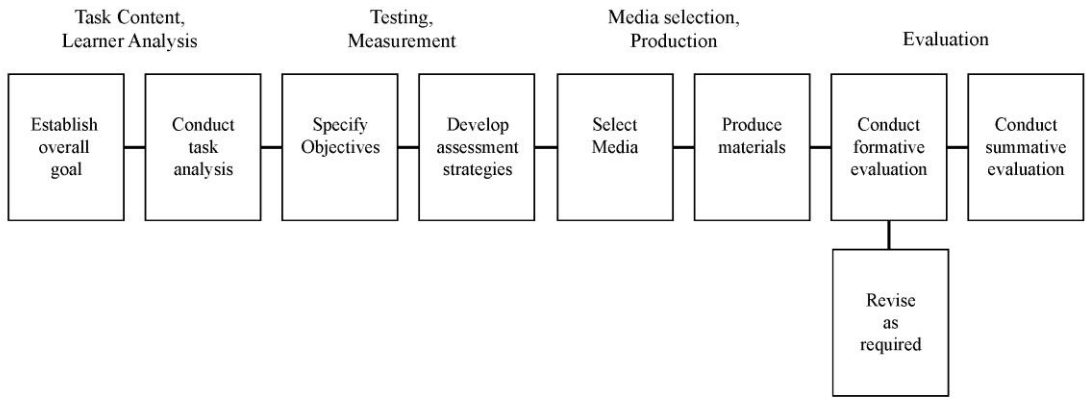
Appendix I: Examples of Large-Scale Shared Digital Spaces

Source: SynergyNet: integrating multi-touch technology in classrooms at Durham University
http://www.naace.co.uk/1705

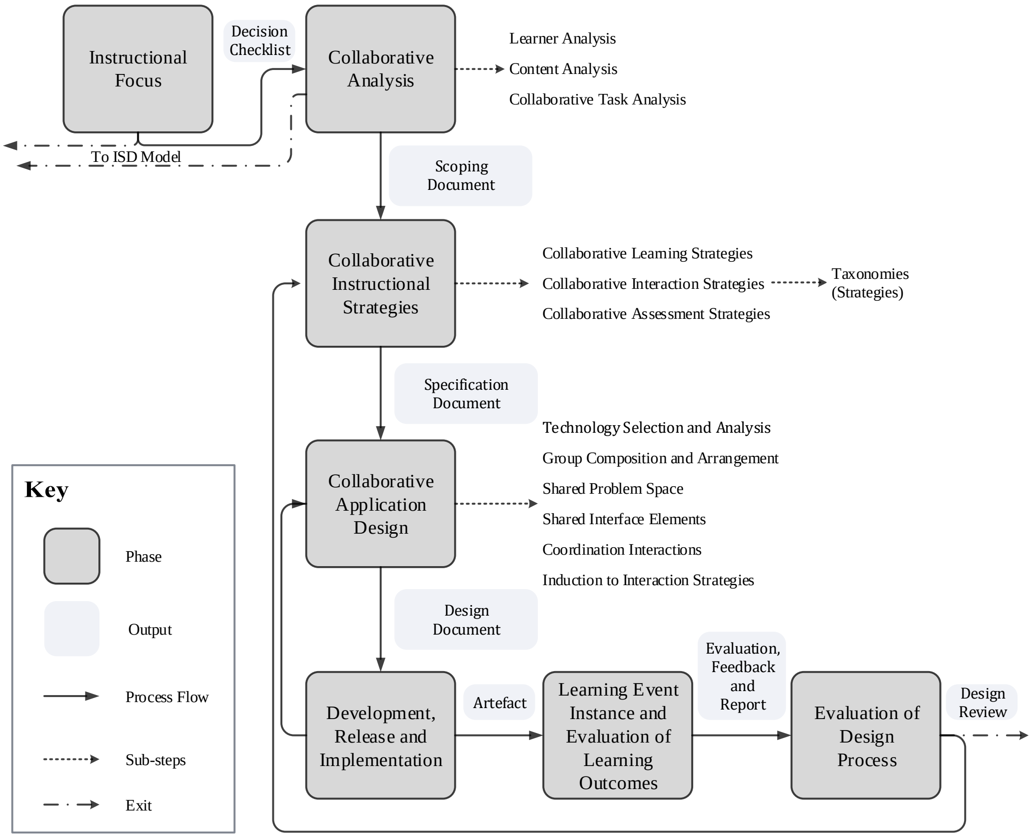
http://multimedia.3m.com/mws/media/844414P/3mtm-multi-touch-display-c4667pw-with-hands.jpg?boundedSize=310

http://www.bitrebels.com/wp-content/uploads/2013/01/ideum-pano-touchscreen-desk-4.jpg

Appendix J: ISD and CISD Examples



ISD View. Adapted from "Instructional Systems Design: Five Views of the Field", by Shirl S Schiffman, 2010, p.196



Appendix K: Instructional Focus – Decision Checklist

Instructional Focus Decision Checklist		
Instruction Type:		
	Yes	**No**
Is the objective a team objective?	☐	☐
What are the team objectives?		
Are there sufficient subtasks to distribute?	☐	☐
Describe the subtasks?		
Is there a communication/coordination aspect?	☐	☐
Describe possible communication/coordination aspects?		
Can Peers contribute to the learning experience?	☐	☐
Is the team required to work in the same shared digital/virtual space?	☐	☐
Recommendation to continue?	☐	☐
Notes:		

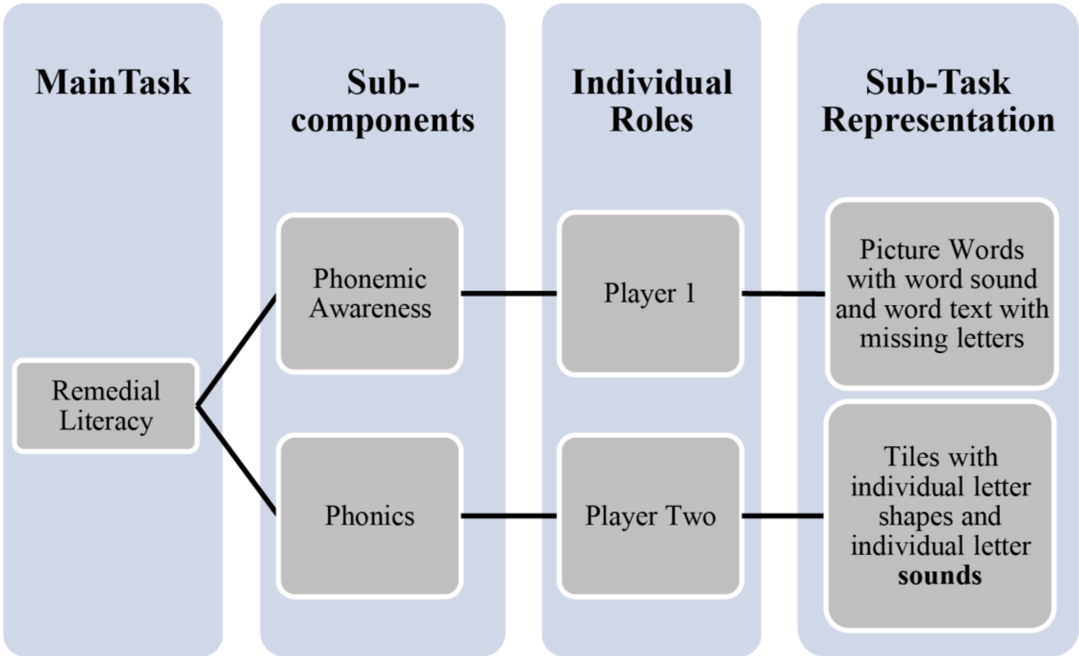
Instructional Focus Decision Checklist		
Instruction Type: Phonics Application		
	Yes	**No**
Is the objective a team objective?	☑	☐
What are the team objectives? exchange information using dialogue, understanding letter shapes & sounds.		
Are there sufficient subtasks to distribute?	☑	☐
Describe the subtasks? phonemic awareness, phonics, vocabulary development, reading fluency/comprehension strategies.		
Is there a communication/coordination aspect?	☑	☐
Describe possible communication/coordination aspects? Verbal, haptic.		
Can Peers contribute to the learning experience?	☑	☐
Is the team required to work in the same shared digital/virtual space?	☑	☐
Recommendation to continue?	☑	☐
Notes: Components to assist in providing basic literacy skills.		

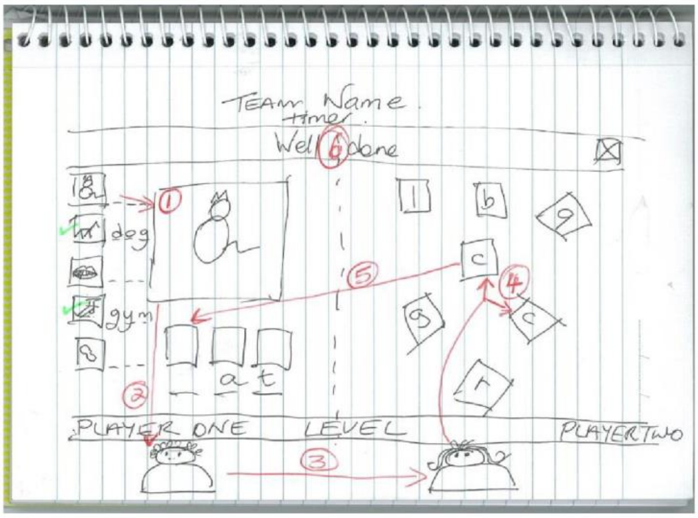
Appendix L: Collaborative Analysis – Scoping Document

Collaborative Analysis
Learner Analysis Look at the Characteristics of learners:
• **As Individuals**
• **As a Group (cohesive)**
Description of Learner Analysis:
Content Analysis
1. Analyse the learning task (Does the task lend itself to individual/group learning)
2. Analyse the content Structure
3. Establish the Goal (Objective)
4. Identify the Goals

5. Identify Goals into sub-groups
6. Identify and sequence the prerequisites
Collaborative Task Analysis Knowledge Creation Process
1. Collaborative Theories
2. Discussion
3. Peer Interaction
4. Learning Environment – How these may influence the learning activity

Collaborative Analysis
Learner Analysis Look at the Characteristics of learners:
As Individuals
As a Group (cohesive)
Description of Learner Analysis: The Phonics Learning Application. The target audience for the phonics learning application is primary school students – Foundation to Level 4. Synthetic phonics has been identified as the method to be used for this case study. The purpose of this phonics learning task is to engage pairs of students in a collaborative social context on a large-scale shared digital space.
Content Analysis
1. Analyse the learning task (Does the task lend itself to individual/group learning)
Provide three letter words with corresponding images, break down words into individual sounds and letters shapes, sound-to-symbol, and learn to associate letter sounds to letter shapes, sound out letters and blending letters to form words.
2. Analyse the content Structure
Synthetic phonics – blend graphemes and phonemes to make words. e.g. /c/a/t/ The players will learn two basic components: Phonemic awareness – the individual letter sound structure within the spoken word Phonics – the relationship between phonemes, the sounds of spoken language, and graphemes, the letters in the written language. Approx. 100 3 letter words have been identified.
3. Establish the Goal (Objective)
The phonics learning task will provide students with the ability to identify and blend letter shapes, graphemes, and letter sounds, phonemes, to make words. Through activity, dividing the roles, distributing the tasks and setting goals and discussion learners will develop and strengthen their understanding of how they can improve their reading skills.

4. Identify the Goals
Two players will obtain basic literacy skills to assist in remedial literacy. The players will learn two basic components: Phonemic awareness – the individual letter sound structure within the spoken word Phonics – the relationship between phonemes, the sounds of spoken language, and graphemes, the letters in the written language.
5. Identify Goals into sub-groups
The goals are broken into sub groups. On completion the roles will reverse. 
6. Identify and sequence the prerequisites
This phonics game is in two player mode. The numbered items and solid arrows indicate the game flow. The divided arrows represent the players thought process. To begin the phonics game: Player One selects a picture-word image (1) from a list of five random words, listens to the word sound (2) and requests the missing text letter, articulating the letter sound, from Player 2 (3). Player 2 taps any letter, listening for the missing letter sound, selects the best matching letter (4) and with their finger/s, directly manoeuvres the object by flicking it across to Player 1. The final step in the process requires Player 1, also using their finger/s, manoeuvres the letter tile into the missing placeholder (5) and the appropriate feedback is given (6).



The players roles are then reversed, and the process begins again

Collaborative Task Analysis
Knowledge Creation Process

1. Collaborative Theories

Theory of Sociocultural learning - Lev Vygotsky

Vygotsky saw social interaction as being an important part in the development of cognition, known as the sociocultural principle, which begins long before formal school education. The sociocultural principle puts forward the approach that development relating to how children learn is 'interpersonal': beginning on a social level by sharing information through discussion with their peers, externally, and then 'intrapersonal': moving to an individual level, internally.

2. Discussion/Peer Interaction - How this may influence the learning activity

Assesses the knowledge creation process and looks at the historical perspective of learning, in relation to Vygotsky's sociocultural theory: that in a social context the learners acquire knowledge by sharing information, through the use of dialogue/discussion and with peer interaction.

3. Learning Environment – How this may influence the learning activity

Large-scaled shared digital spaces that have opened doors to new research areas, particularly in the area of education by providing new interactive learning environments. Typically, these devices feature touch sensitive displays of over 50 inches (diagonal) in size, with a resolution high enough to allow up to eight learners to work synchronously and face-to-face. The unique feature of this new technology is that it allows multiple simultaneous user inputs by touching the surface of the display rather than by using a mouse. Therefore, multiple learners can be active at the same time


ant.jpg ape.jpg arm.jpg axe.jpg bat.jpg bed.jpg bee.jpg bow.jpg box.jpg boy.jpg bug.jpg bun.jpg bus.jpg
can.jpg cap.jpg cat.jpg cow.jpg cry.jpg cup.jpg dad.jpg dam.jpg dog.jpg ear.jpg eat.jpg eel.jpg egg.jpg
fan.jpg fly.jpg fox.jpg gap.jpg gum.jpg gym.jpg ham.jpg hat.jpg hen.jpg hut.jpg ice.jpg ill.jpg ink.jpg
ivy.jpg jam.jpg jog.jpg jug.jpg keg.jpg kid.jpg leg.jpg log.jpg man.jpg map.jpg mat.jpg mop.jpg mud.jpg
mug.jpg mum.jpg net.jpg nit.jpg nut.jpg oar.jpg oil.jpg old.jpg one.jpg owl.jpg pan.jpg pea.jpg peg.jpg
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sun.jpg tag.jpg tap.jpg ten.jpg toe.jpg top.jpg tub.jpg two.jpg urn.jpg ute.jpg van.jpg vet.jpg wag.jpg
wet.jpg wig.jpg wok.jpg won.jpg yak.jpg yam.jpg yes.jpg you.jpg yum.jpg zap.jpg zip.jpg zoo.jpg

Appendix M: Collaborative Instructional Strategies – Specification Document

Collaborative Instructional Strategies Form		
Subject:		
Collaborative Learning Strategies	**Collaborative Interaction Strategies**	**Collaborative Assessment Strategies**
Learning Objectives	Activity Structure	Measuring Skills
Objectives: • for metacognitive and enabling skills development in the collaborative domain	Activity: • Identify the activity structure and tasks • Formal versus Informal • Structured versus Unstructured • Interdependent roles working towards common objectives	Measuring: • Metacognitive and enabling skills in the collaborative domain. • Intellectual skills that enable collaboration
Describe Learning Objectives	**Describe Activity Structure**	**Describe Skills to Measure**
Skills Identification	**Cognitive Tasks**	**Assessment Metrics**
☐ Metacognitive Skills	☐ Planning, Decision making, design	☐ Group Practices
☐ Coordination Skills	☐ Assessing situations and problem solving	☐ Coordination Skills
☐ Establishing Roles	☐ Coordination	☐ Clarifying Skills
☐ Establishing Responsibilities	☐ Communication	☐ Communication Skills
☐ Problem Solving Skills		☐ Output/Solution
		☐ Mapping Information Flow
Notes:		

TAXONOMIES					
METHODS		**PRACTICES**		**INDICATORS**	
Coordination Skills		**Roles/Task Division**		**Coordination Behaviours**	
☐	Directions – Give/take	☐	Planning, Decision making, design	☐	Effectively coordinated group interactions – work flow
☐	Coordinate/Organisation			☐	Interdependency
☐	Recording/Summarising			☐	Discussion
☐	Peer Support			☐	Peer Assessment
☐	Praising/Complementing/ Complement	**Production Line**			
☐	Networking	☐	A process where each user completes a specific task and then passes it onto the next		
				Clarifying Behaviours	
Clarifying Skills				☐	Clear/Comprehensible
☐	Debate/Negotiate/ Compromise			☐	Explicable (capable of being understood)
☐	Critiquing	**Proposer Critique**		☐	Critical review/Evaluation
☐	Advocate/Challenge	☐	Where one user works on a task and the other is critiquing	☐	Advocate
☐	Perspectives/Empathies			☐	Moving onto next task
☐	Shared Understanding			☐	Completion of task
		Ownership		☐	Quality of completed task
		☐	A user is assigned a specific icon which can be dragged onto an object thus claiming ownership		
Exchange Information Skills				**Exchange Information Behaviours**	
☐	Dialogue			☐	Communication
☐	Supply/Request Information			☐	Directive Skills
☐	Listening			☐	Reciprocity – mutual exchange
☐	Explaining	**Workspace Division**		☐	Relay – the frequency, the relevance, the coordination of spoken communication
☐	Commenting	☐	Dividing the workspace into distinct and specific individual work areas.	☐	Gestures
☐	Pointing/Directing				
Cooperative Learning Skills				**Cooperative Learning Behaviours**	
☐	Assigned duty (task)	**Unstructured**		☐	Independent/Autonomous
☐	Planning	☐	That is unrestricted access where everyone may take part (Free for all and no tracking occurs)	☐	Not Controlled
☐	Scheduling			☐	Case-by-case

Collaborative Instructional Strategies Form		
Subject: The Phonics Application		
Collaborative Learning Strategies	**Collaborative Interaction Strategies**	**Collaborative Assessment Strategies**
Learning Objectives	Activity Structure	Measuring Skills
Objectives: • for metacognitive and enabling skills development in the collaborative domain	Activity: • Identify the activity structure and tasks • Formal versus Informal • Structured versus Unstructured • Interdependent roles working towards common objectives	Measuring: • Metacognitive and enabling skills in the collaborative domain. • Intellectual skills that enable collaboration
Describe Learning Objectives	**Describe Activity Structure**	**Describe Skills to Measure**
Synthetic phonics **2 player phonics game** **Phonemic Awareness – individual sound structure within the spoken word.** **Phonics** • **Phonemes – letter sounds** • **Graphemes – letter shapes** **Players' tasks have been divided.**	**5 pictures loads on one side of the screen/an array of letter tiles appears on the other side of the screen. P1 has to touch a picture tile; the game loads the picture and the letter tiles. P1 listens to the word, identifies the missing letter sounds and requests P2 for the missing letter tile, by sound. P2 identifies and selects appropriate letter tile and passes it to P1. P1 places the letter tile into the empty slot/s to complete the word. It the word is correct, the next picture word tile loads. When 5 picture words are complete. The player's roles swap and the process begins again.**	**How does the group work as a team?** **Do they communicate?** **Do they self-correct or does one player correct the other player?**

Skills Identification		**Cognitive Tasks**		**Assessment Metrics**	
☑	Metacognitive Skills	☑	Planning, Decision making, design	☑	Group Practices
☑	Coordination Skills	☑	Assessing situations and problem solving	☑	Coordination Skills
☑	Establishing Roles	☑	Coordination	☑	Clarifying Skills
☑	Establishing Responsibilities	☑	Communication	☑	Communication Skills
☑	Problem Solving Skills			☑	Output/Solution
				☑	Mapping Information Flow

Notes:					
TAXONOMIES					
METHODS		**PRACTICES**		**INDICATORS**	
Coordination Skills		**Roles/Task Division**		**Coordination Behaviours**	
☑	Directions – Give/take	☑	Planning, Decision making, design	☑	Effectively coordinated group interactions – work flow
☑	Coordinate/Organisation			☑	Interdependency
☑	Recording/Summarising			☑	Discussion
☑	Peer Support			☑	Peer Assessment
☑	Praising/Complementing/ Complement	**Production Line**			
☑	Networking	☑	A process where each user completes a specific task and then passes it onto the next		
				Clarifying Behaviours	
Clarifying Skills				☑	Clear/Comprehensible
☑	Debate/Negotiate/ Compromise			☑	Explicable (capable of being understood)
☑	Critiquing	**Proposer Critique**		☑	Critical review/Evaluation
☑	Advocate/Challenge	☑	Where one user works on a task and the other is critiquing	☑	Advocate
☑	Perspectives/Empathies			☑	Moving onto next task
☑	Shared Understanding			☑	Completion of task
		Ownership		☑	Quality of completed task
		☐	A user is assigned a specific icon which can be dragged onto an object thus claiming ownership		
Exchange Information Skills				**Exchange Information Behaviours**	
☑	Dialogue			☑	Communication
☑	Supply/Request Information			☑	Directive Skills
☑	Listening			☑	Reciprocity – mutual exchange
☑	Explaining	**Workspace Division**		☑	Relay – the frequency, the relevance, the coordination of spoken communication
☑	Commenting	☑	Dividing the workspace into distinct and specific individual work areas.	☑	Gestures
☑	Pointing/Directing				
Cooperative Learning Skills				**Cooperative Learning Behaviours**	
☑	Assigned duty (task)	**Unstructured**		☑	Independent/Autonomous
☐	Planning	☐	That is unrestricted access where everyone may take part (Free for all and no tracking occurs)	☑	Not Controlled
☐	Scheduling			☑	Case-by-case

Appendix N: Design Phase – Design Document

MONASH University

Daniela McGivern <daniela.mcgivern@monash.edu>

Phonic Tile placement - as a guide
1 message

Daniela McGivern <daniela.mcgivern@monash.edu> 8 December 2014 at 12:33
To: William Lay <william.lay@monash.edu>

Level 1 with the first letter missing eg. _nt

Level 2 with the last letter missing, eg. an_

Level 3 with the middle letter missing, a_t

Level 4 with the first and second letter missing, eg. _ _ t

Level 5 with the second and last letter missing and finally, eg. a_ _

Level 6 is the first and last letter missing, eg. _ n _

Level 7 where all letters missing, eg. _ _ _

Daniela McGivern

PhD Student, Teaching Associate,
Faculty of Information Technology
Monash University, Caulfield Campus
[redacted]

Design Phase.

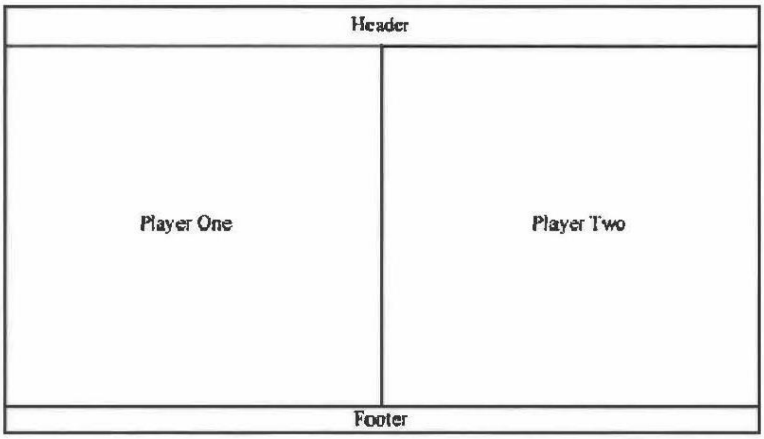


Figure 1: Phonics Application Basic Design

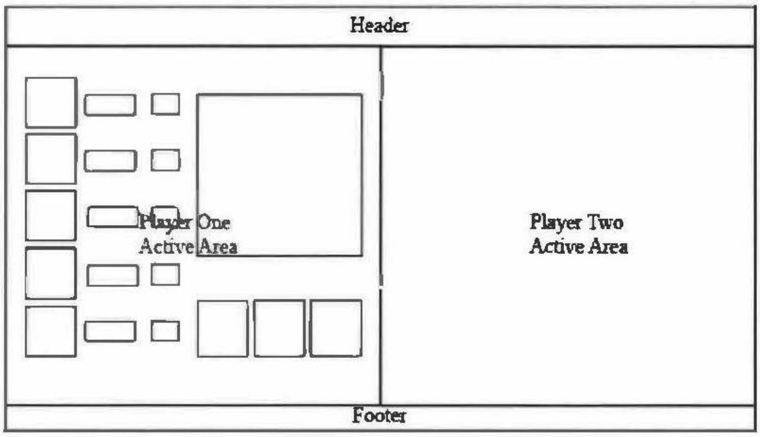
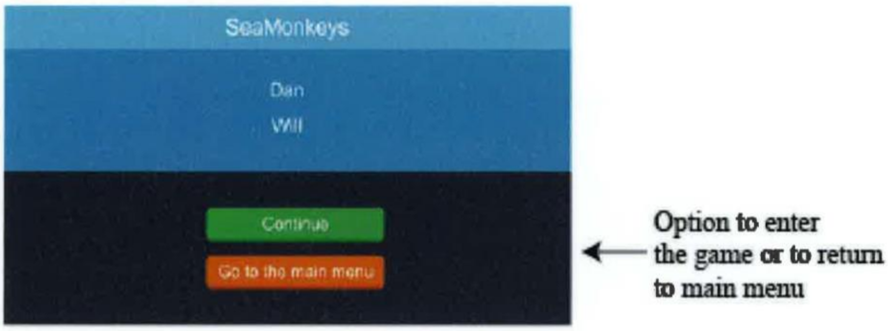


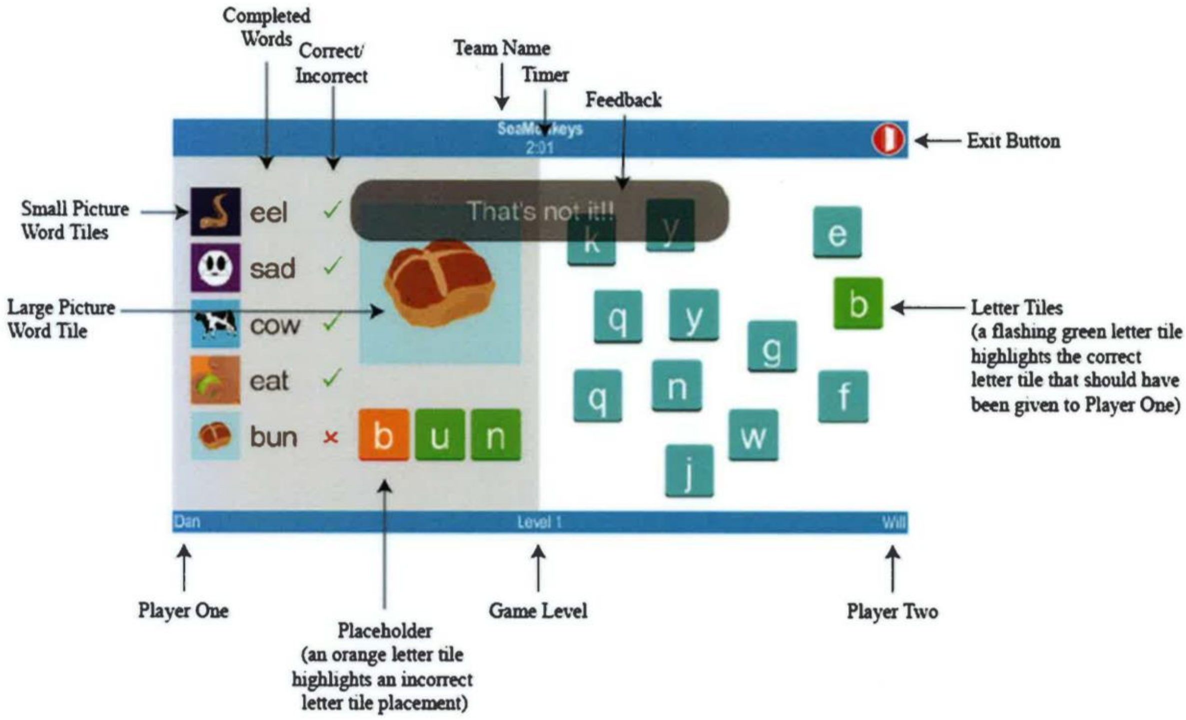
Figure 2: Phonics Application Active Play Areas

Log in screen

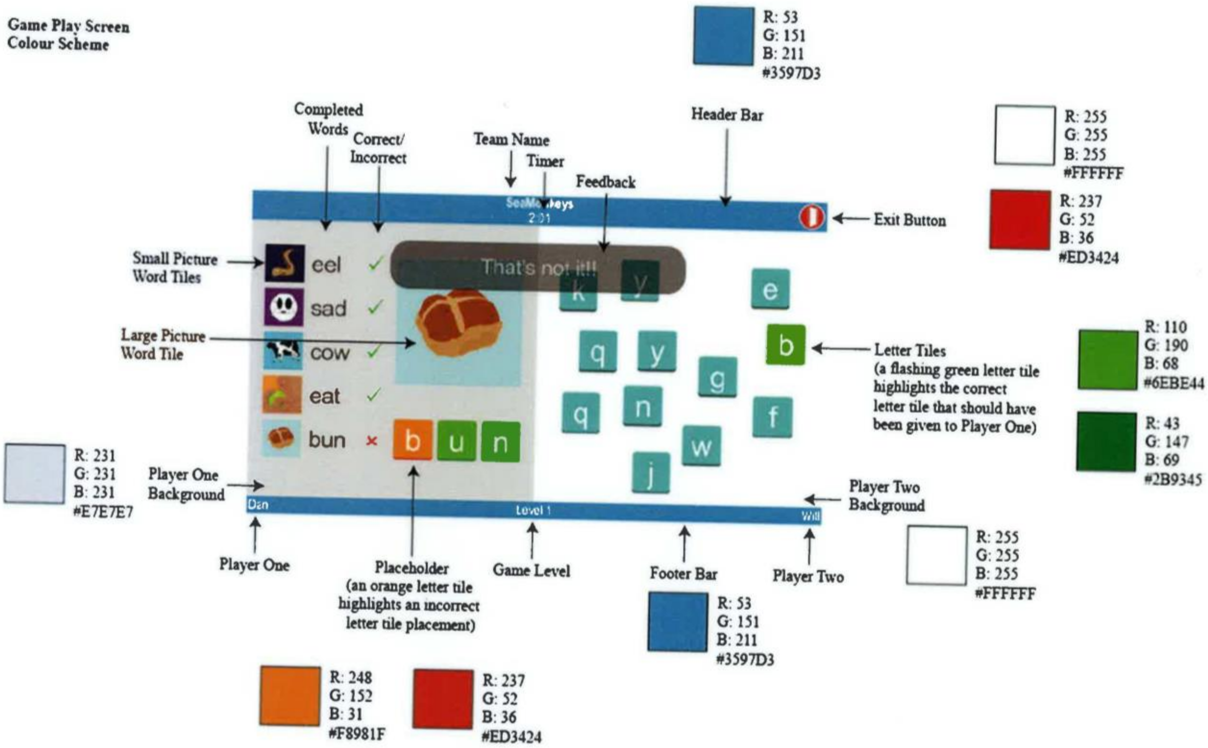
Enter/Exit game screen



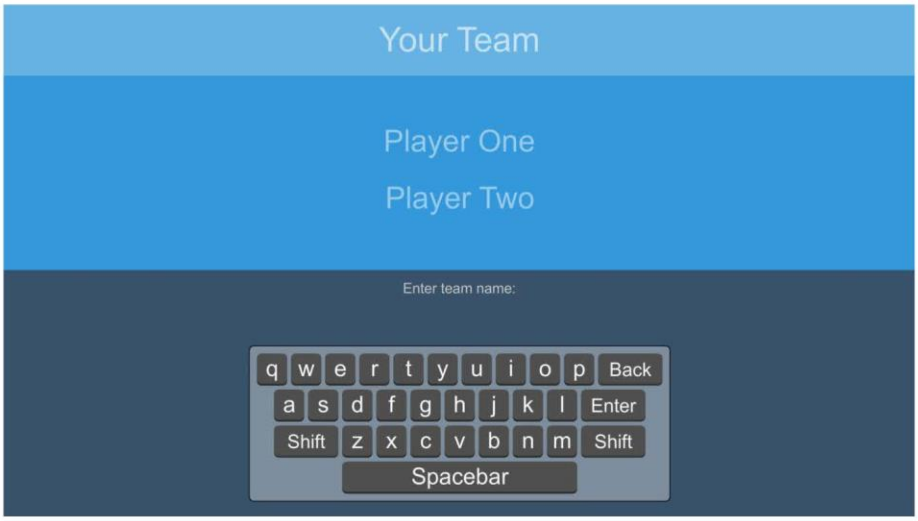
Game Play Screen



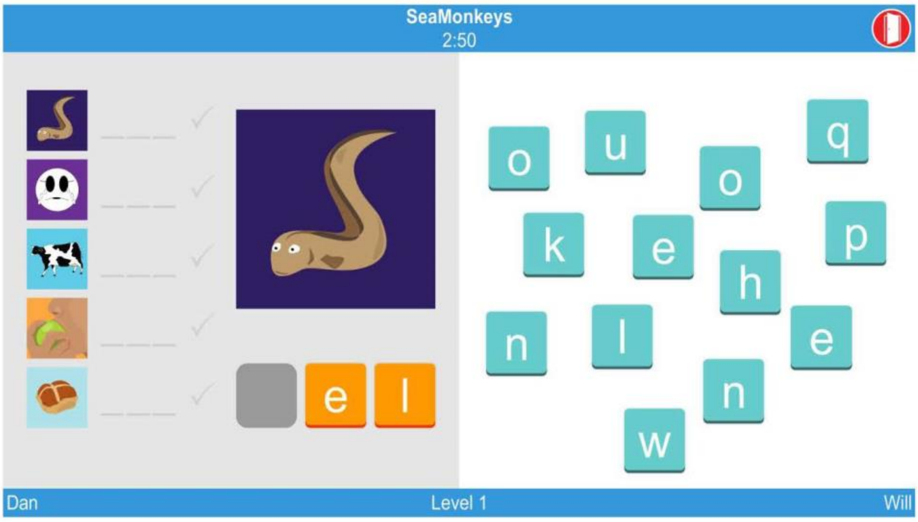
Game Play Screen Colour Scheme



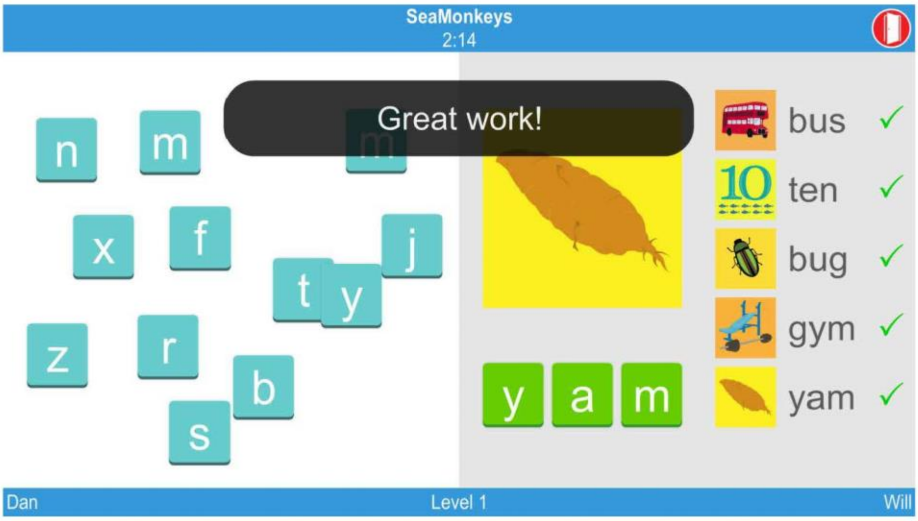
Log In Screen



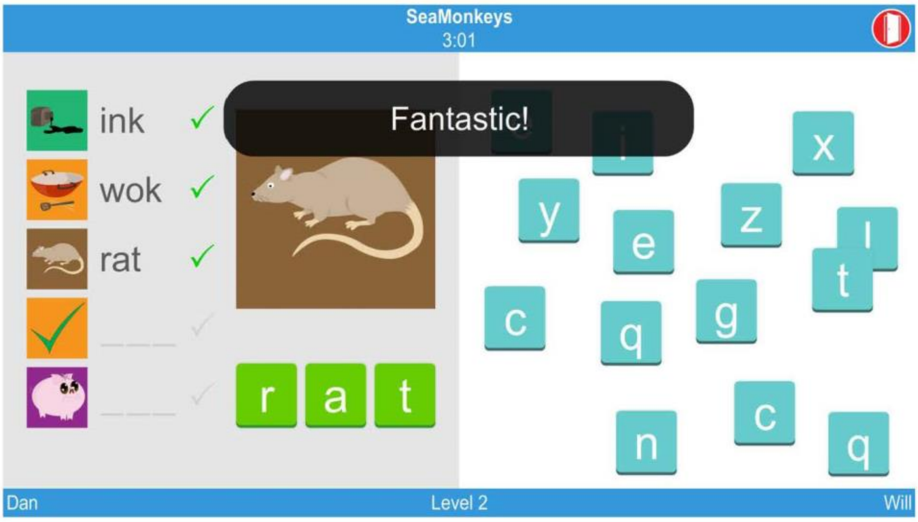
Level 1



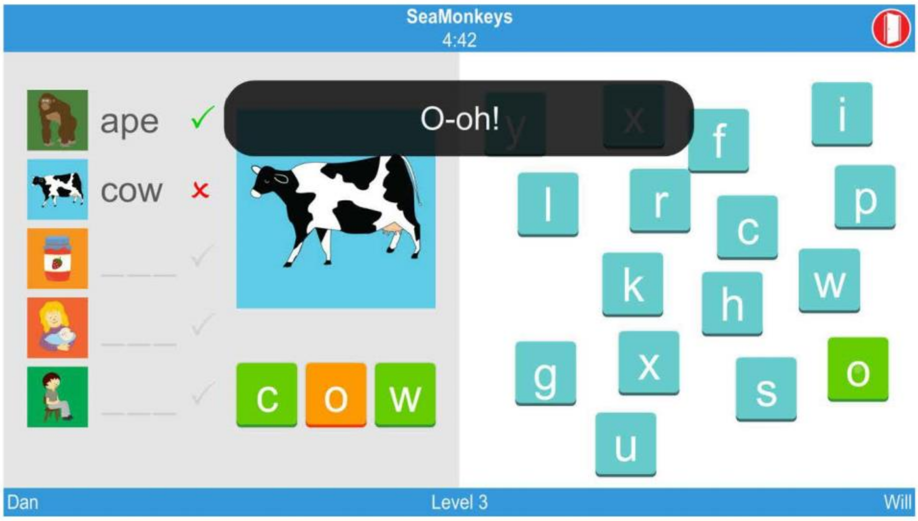
Level 1 Players Swap Roles



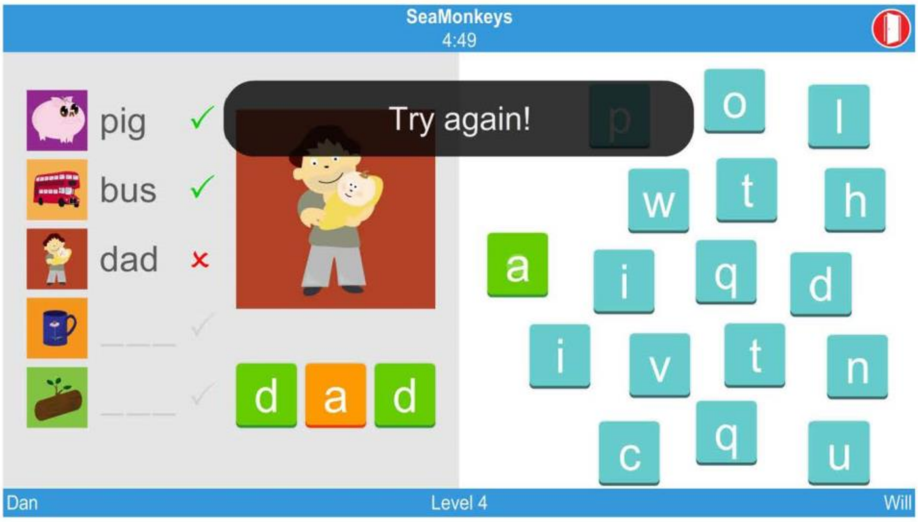
Level 2



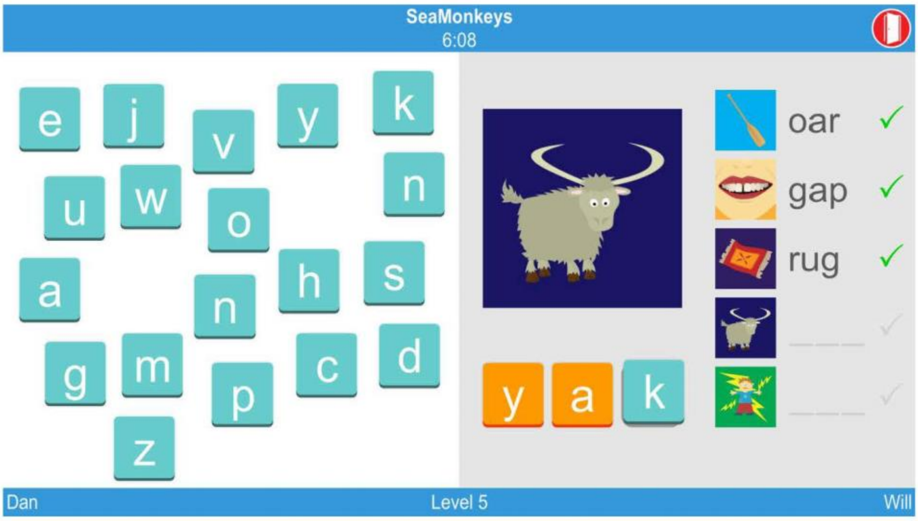
Level 3 with Feedback Screenshot



Level 4

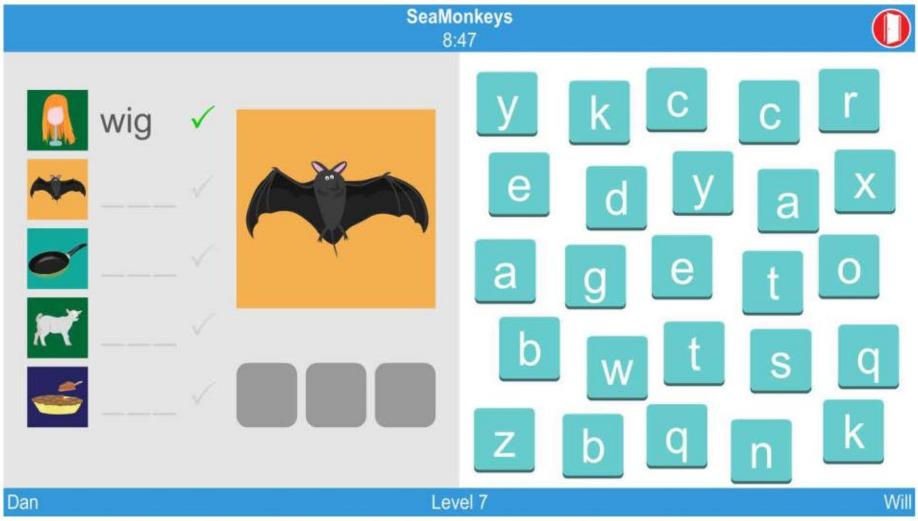


Level 5

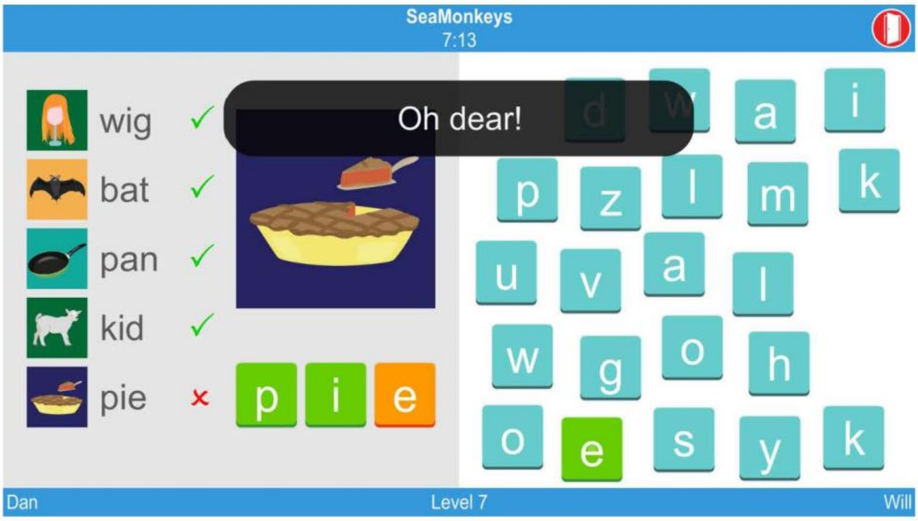


Level 6

Level 7

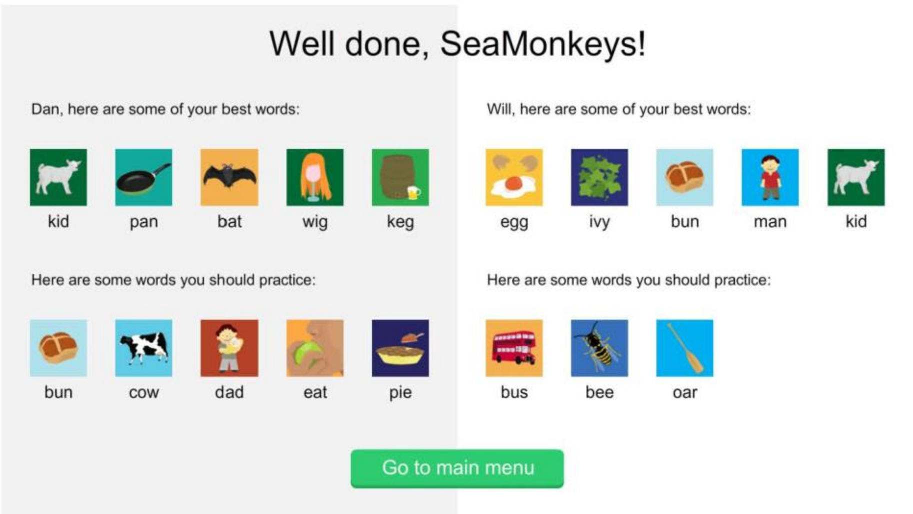


Level 7 Feedback



Level 7

Feedback Screen



Appendix O: Phonics Game – Student Log – A Complete Example

```
PHONICS GAME - STUDENT LOG
New game started: Tuesday 17 February 2015 at 11:31AM

Students have not watched the tutorial.

Team name: SeaMonkeys
Player 1: Dan
Player 2: Will

LEVEL 1 START (3:00 limit, missing _XX)
Word controller: Dan
Letter controller: Will
Available Words: eel, sad, cow, eat, bun

Time: 3:00 - Current word changed to: eel
Time: 2:43 - Will touched tile "E" (long sound)
Time: 2:42 - Will touched tile "e" (short sound)
Time: 2:41 - Will touched tile "E" (long sound)
Time: 2:38 - Will passed tile "E" (long sound) to Dan
Time: 2:38 - Dan touched tile "E" (long sound)
Time: 2:38 - Dan moved tile "E" (long sound) to position 1 (correct)
Time: 2:35 - Current word changed to: sad
Time: 2:33 - Will touched tile "S" (long sound)
Time: 2:31 - Will touched tile "s" (short sound)
Time: 2:30 - Will touched tile "s" (short sound)
Time: 2:29 - Will passed tile "s" (short sound) to Dan
Time: 2:29 - Dan touched tile "s" (short sound)
Time: 2:29 - Dan moved tile "s" (short sound) to position 1 (correct)
Time: 2:26 - Current word changed to: cow
Time: 2:24 - Will touched tile "c" (short sound)
Time: 2:24 - Will touched tile "C" (long sound)
Time: 2:23 - Will touched tile "c" (short sound)
Time: 2:22 - Will passed tile "c" (short sound) to Dan
Time: 2:22 - Dan touched tile "c" (short sound)
Time: 2:22 - Dan moved tile "c" (short sound) to position 1 (correct)
Time: 2:19 - Current word changed to: eat
Time: 2:17 - Will touched tile "E" (long sound)
Time: 2:16 - Will touched tile "e" (short sound)
Time: 2:15 - Will touched tile "E" (long sound)
Time: 2:14 - Will touched tile "E" (long sound)
Time: 2:13 - Will passed tile "E" (long sound) to Dan
Time: 2:13 - Dan touched tile "E" (long sound)
Time: 2:13 - Dan moved tile "E" (long sound) to position 1 (correct)
Time: 2:10 - Current word changed to: bun
Time: 2:08 - Will touched tile "B" (long sound)
Time: 2:07 - Will touched tile "b" (short sound)
Time: 2:06 - Will touched tile "B" (long sound)
Time: 2:04 - Will passed tile "B" (long sound) to Dan
Time: 2:03 - Dan touched tile "B" (long sound)
Time: 2:03 - Dan moved tile "B" (long sound) to position 1
(incorrect)
Time: 1:49 - Will touched tile "b" (short sound)

PLAYERS SWAP ROLES
Word controller: Will
Letter controller: Dan
```

Available Words: bus, ten, bug, gym, yam

```
Time: 3:00 - Current word changed to: bus
Time: 2:50 - Dan touched tile "b" (short sound)
Time: 2:50 - Dan touched tile "b" (short sound)
Time: 2:48 - Will touched tile "b" (short sound)
Time: 2:48 - Will moved tile "b" (short sound) to position 1
(correct)
Time: 2:45 - Current word changed to: ten
Time: 2:43 - Dan touched tile "T" (long sound)
Time: 2:42 - Dan touched tile "t" (short sound)
Time: 2:42 - Dan touched tile "t" (short sound)
Time: 2:41 - Dan passed tile "t" (short sound) to Will
Time: 2:41 - Will touched tile "t" (short sound)
Time: 2:41 - Will moved tile "t" (short sound) to position 1
(correct)
Time: 2:38 - Current word changed to: bug
Time: 2:36 - Dan touched tile "b" (short sound)
Time: 2:35 - Dan touched tile "B" (long sound)
Time: 2:34 - Dan touched tile "b" (short sound)
Time: 2:32 - Dan passed tile "b" (short sound) to Will
Time: 2:31 - Will touched tile "b" (short sound)
Time: 2:31 - Will moved tile "b" (short sound) to position 1
(correct)
Time: 2:28 - Current word changed to: gym
Time: 2:27 - Dan touched tile "G" (sound: j)
Time: 2:26 - Dan touched tile "g" (short sound)
Time: 2:25 - Dan touched tile "G" (sound: j)
Time: 2:24 - Dan passed tile "G" (sound: j) to Will
Time: 2:23 - Will touched tile "G" (sound: j)
Time: 2:23 - Will moved tile "G" (sound: j) to position 1 (correct)
Time: 2:20 - Current word changed to: yam
Time: 2:18 - Dan touched tile "Y" (long sound)
Time: 2:17 - Dan touched tile "y" (short sound)
Time: 2:16 - Dan touched tile "y" (short sound)
Time: 2:15 - Dan passed tile "y" (short sound) to Will
Time: 2:14 - Will touched tile "y" (short sound)
Time: 2:14 - Will moved tile "y" (short sound) to position 1
(correct)
```

LEVEL 2 START (4:00 limit, missing XX_)
Word controller: Dan
Letter controller: Will
Available Words: ink, wok, rat, yes, pig

```
Time: 4:00 - Current word changed to: ink
Time: 3:54 - Will touched tile "i" (short sound)
Time: 3:43 - Will touched tile "K" (long sound)
Time: 3:31 - Will touched tile "K" (long sound)
Time: 3:29 - Will touched tile "k" (short sound)
Time: 3:29 - Will touched tile "k" (short sound)
Time: 3:28 - Will passed tile "k" (short sound) to Dan
Time: 3:28 - Dan touched tile "k" (short sound)
Time: 3:28 - Dan moved tile "k" (short sound) to position 3 (correct)
Time: 3:25 - Current word changed to: wok
Time: 3:23 - Will touched tile "W" (long sound)
```

Time: 3:19 - Will touched tile "k" (short sound)
Time: 3:16 - Will touched tile "k" (short sound)
Time: 3:15 - Will touched tile "K" (long sound)
Time: 3:13 - Will touched tile "k" (short sound)
Time: 3:13 - Will touched tile "k" (short sound)
Time: 3:12 - Will passed tile "k" (short sound) to Dan
Time: 3:12 - Dan touched tile "k" (short sound)
Time: 3:12 - Dan moved tile "k" (short sound) to position 3 (correct)
Time: 3:09 - Current word changed to: rat
Time: 3:05 - Will touched tile "T" (long sound)
Time: 3:04 - Will touched tile "t" (short sound)
Time: 3:03 - Will passed tile "t" (short sound) to Dan
Time: 3:03 - Dan touched tile "t" (short sound)
Time: 3:03 - Dan moved tile "t" (short sound) to position 3 (correct)
Time: 3:00 - Current word changed to: yes
Time: 2:52 - Will touched tile "s" (short sound)
Time: 2:51 - Will touched tile "S" (long sound)
Time: 2:50 - Will touched tile "s" (short sound)
Time: 2:49 - Will passed tile "s" (short sound) to Dan
Time: 2:49 - Dan touched tile "s" (short sound)
Time: 2:49 - Dan moved tile "s" (short sound) to position 3 (correct)
Time: 2:46 - Current word changed to: pig
Time: 2:06 - Will touched tile "G" (long sound)
Time: 2:06 - Will touched tile "g" (short sound)
Time: 2:05 - Will touched tile "g" (short sound)
Time: 2:05 - Dan touched tile "g" (short sound)
Time: 2:05 - Dan moved tile "g" (short sound) to position 3 (correct)

PLAYERS SWAP ROLES
Word controller: Will
Letter controller: Dan
Available Words: jug, cry, nit, sat, bus

Time: 4:00 - Current word changed to: jug
Time: 3:56 - Dan touched tile "G" (long sound)
Time: 3:55 - Dan touched tile "g" (short sound)
Time: 3:54 - Will touched tile "g" (short sound)
Time: 3:54 - Will moved tile "g" (short sound) to position 3 (correct)
Time: 3:51 - Current word changed to: cry
Time: 3:49 - Dan touched tile "y" (short sound)
Time: 3:47 - Dan touched tile "Y" (sound: I)
Time: 3:47 - Dan touched tile "Y" (sound: I)
Time: 3:46 - Will touched tile "Y" (sound: I)
Time: 3:46 - Will moved tile "Y" (sound: I) to position 3 (correct)
Time: 3:43 - Current word changed to: nit
Time: 3:19 - Dan touched tile "t" (short sound)
Time: 3:18 - Dan touched tile "t" (short sound)
Time: 3:17 - Dan passed tile "t" (short sound) to Will
Time: 3:17 - Will touched tile "t" (short sound)
Time: 3:16 - Will moved tile "t" (short sound) to position 3 (correct)
Time: 3:13 - Current word changed to: sat
Time: 3:08 - Dan touched tile "T" (long sound)
Time: 3:08 - Dan touched tile "T" (long sound)
Time: 3:07 - Dan touched tile "t" (short sound)

Time: 3:06 - Dan touched tile "t" (short sound)
Time: 3:05 - Dan passed tile "t" (short sound) to Will
Time: 3:05 - Will touched tile "t" (short sound)
Time: 3:05 - Will moved tile "t" (short sound) to position 3 (correct)
Time: 3:02 - Current word changed to: bus
Time: 3:00 - Dan touched tile "S" (long sound)
Time: 2:59 - Dan passed tile "S" (long sound) to Will
Time: 2:59 - Will touched tile "S" (long sound)
Time: 2:59 - Will moved tile "S" (long sound) to position 3 (incorrect)
Time: 2:55 - Dan touched tile "s" (short sound)

LEVEL 3 START (5:00 limit, missing X_X)
Word controller: Dan
Letter controller: Will
Available Words: ape, cow, jam, mum, sat

Time: 5:00 - Current word changed to: ape
Time: 5:00 - Will touched tile "T" (long sound)
Time: 4:55 - Will touched tile "p" (short sound)
Time: 4:54 - Will passed tile "p" (short sound) to Dan
Time: 4:54 - Dan touched tile "p" (short sound)
Time: 4:54 - Dan moved tile "p" (short sound) to position 2 (correct)
Time: 4:50 - Current word changed to: cow
Time: 4:47 - Will touched tile "O" (long sound)
Time: 4:46 - Will touched tile "o" (short sound)
Time: 4:45 - Will touched tile "O" (long sound)
Time: 4:44 - Dan touched tile "O" (long sound)
Time: 4:44 - Dan moved tile "O" (long sound) to position 2 (incorrect)
Time: 4:36 - Will touched tile "o" (short sound)
Time: 4:32 - Current word changed to: jam
Time: 4:20 - Will touched tile "A" (long sound)
Time: 4:18 - Will touched tile "a" (short sound)
Time: 4:16 - Will passed tile "a" (short sound) to Dan
Time: 4:16 - Dan touched tile "a" (short sound)
Time: 4:16 - Dan moved tile "a" (short sound) to position 2 (correct)
Time: 4:13 - Current word changed to: mum
Time: 4:11 - Will touched tile "u" (short sound)
Time: 4:11 - Will passed tile "u" (short sound) to Dan
Time: 4:10 - Dan touched tile "u" (short sound)
Time: 4:10 - Dan moved tile "u" (short sound) to position 2 (correct)
Time: 4:07 - Current word changed to: sat
Time: 4:05 - Will touched tile "a" (short sound)
Time: 4:04 - Will touched tile "a" (short sound)
Time: 4:03 - Will passed tile "a" (short sound) to Dan
Time: 4:03 - Dan touched tile "a" (short sound)
Time: 4:03 - Dan moved tile "a" (short sound) to position 2 (correct)

PLAYERS SWAP ROLES
Word controller: Will
Letter controller: Dan
Available Words: gum, jog, dam, rug, keg

Time: 5:00 - Current word changed to: gum

Time: 4:58 - Dan touched tile "U" (long sound)
Time: 4:57 - Dan touched tile "u" (short sound)
Time: 4:56 - Dan touched tile "u" (short sound)
Time: 4:54 - Dan passed tile "u" (short sound) to Will
Time: 4:54 - Will touched tile "u" (short sound)
Time: 4:53 - Will moved tile "u" (short sound) to position 2 (correct)
Time: 4:50 - Current word changed to: jog
Time: 4:49 - Dan touched tile "O" (long sound)
Time: 4:47 - Dan touched tile "o" (short sound)
Time: 4:47 - Dan passed tile "o" (short sound) to Will
Time: 4:46 - Will touched tile "o" (short sound)
Time: 4:46 - Will moved tile "o" (short sound) to position 2 (correct)
Time: 4:43 - Current word changed to: dam
Time: 4:21 - Dan touched tile "A" (long sound)
Time: 4:19 - Dan touched tile "a" (short sound)
Time: 4:18 - Dan touched tile "a" (short sound)
Time: 4:17 - Dan passed tile "a" (short sound) to Will
Time: 4:17 - Will touched tile "a" (short sound)
Time: 4:17 - Will moved tile "a" (short sound) to position 2 (correct)
Time: 4:14 - Current word changed to: rug
Time: 4:06 - Dan touched tile "u" (short sound)
Time: 4:06 - Dan touched tile "u" (short sound)
Time: 4:05 - Dan passed tile "u" (short sound) to Will
Time: 4:05 - Will touched tile "u" (short sound)
Time: 4:05 - Will moved tile "u" (short sound) to position 2 (correct)
Time: 4:02 - Current word changed to: keg
Time: 4:00 - Dan touched tile "e" (short sound)
Time: 3:59 - Dan touched tile "E" (long sound)
Time: 3:59 - Dan touched tile "e" (short sound)
Time: 3:58 - Dan passed tile "e" (short sound) to Will
Time: 3:57 - Will touched tile "e" (short sound)
Time: 3:57 - Will moved tile "e" (short sound) to position 2 (correct)

LEVEL 4 START (6:00 limit, missing __X)
Word controller: Dan
Letter controller: Will
Available Words: pig, bus, dad, mug, log

Time: 6:00 - Current word changed to: pig
Time: 5:39 - Will touched tile "P" (long sound)
Time: 5:38 - Will touched tile "I" (long sound)
Time: 5:37 - Will touched tile "G" (long sound)
Time: 5:36 - Will touched tile "P" (long sound)
Time: 5:36 - Will touched tile "p" (short sound)
Time: 5:35 - Will touched tile "p" (short sound)
Time: 5:34 - Dan touched tile "p" (short sound)
Time: 5:34 - Dan moved tile "p" (short sound) to position 1 (correct)
Time: 5:34 - Will touched tile "i" (short sound)
Time: 5:33 - Will touched tile "i" (short sound)
Time: 5:33 - Will passed tile "i" (short sound) to Dan
Time: 5:33 - Dan touched tile "i" (short sound)

Time: 5:33 - Dan moved tile "i" (short sound) to position 2 (correct)
Time: 5:30 - Current word changed to: bus
Time: 5:28 - Will touched tile "b" (short sound)
Time: 5:27 - Will touched tile "b" (short sound)
Time: 5:27 - Will passed tile "b" (short sound) to Dan
Time: 5:26 - Dan touched tile "b" (short sound)
Time: 5:26 - Dan moved tile "b" (short sound) to position 1 (correct)
Time: 5:22 - Will touched tile "U" (long sound)
Time: 5:21 - Will touched tile "u" (short sound)
Time: 5:21 - Will touched tile "u" (short sound)
Time: 5:20 - Will passed tile "u" (short sound) to Dan
Time: 5:20 - Dan touched tile "u" (short sound)
Time: 5:20 - Dan moved tile "u" (short sound) to position 2 (correct)
Time: 5:17 - Current word changed to: dad
Time: 5:14 - Will touched tile "d" (short sound)
Time: 5:13 - Will touched tile "d" (short sound)
Time: 5:12 - Will passed tile "d" (short sound) to Dan
Time: 5:11 - Dan touched tile "d" (short sound)
Time: 5:11 - Dan moved tile "d" (short sound) to position 1 (correct)
Time: 5:09 - Will touched tile "a" (short sound)
Time: 5:09 - Will touched tile "A" (long sound)
Time: 5:08 - Will touched tile "a" (short sound)
Time: 5:06 - Will touched tile "A" (long sound)
Time: 5:05 - Will passed tile "A" (long sound) to Dan
Time: 4:52 - Dan touched tile "A" (long sound)
Time: 4:51 - Dan touched tile "A" (long sound)
Time: 4:50 - Dan moved tile "A" (long sound) to position 2 (incorrect)
Time: 4:43 - Will touched tile "a" (short sound)
Time: 4:39 - Current word changed to: mug
Time: 4:32 - Will touched tile "u" (short sound)
Time: 4:31 - Will passed tile "u" (short sound) to Dan
Time: 4:31 - Dan touched tile "u" (short sound)
Time: 4:31 - Dan moved tile "u" (short sound) to position 2 (correct)
Time: 4:31 - Will touched tile "M" (long sound)
Time: 4:28 - Will touched tile "m" (short sound)
Time: 4:28 - Will touched tile "m" (short sound)
Time: 4:27 - Will passed tile "m" (short sound) to Dan
Time: 4:27 - Dan touched tile "m" (short sound)
Time: 4:27 - Dan moved tile "m" (short sound) to position 1 (correct)
Time: 4:24 - Current word changed to: log
Time: 4:22 - Will touched tile "l" (short sound)
Time: 4:21 - Will touched tile "l" (short sound)
Time: 4:20 - Will passed tile "l" (short sound) to Dan
Time: 4:20 - Dan touched tile "l" (short sound)
Time: 4:20 - Dan moved tile "l" (short sound) to position 1 (correct)
Time: 4:19 - Will touched tile "o" (short sound)
Time: 4:19 - Will passed tile "o" (short sound) to Dan
Time: 4:18 - Dan touched tile "o" (short sound)
Time: 4:18 - Dan moved tile "o" (short sound) to position 2 (correct)

PLAYERS SWAP ROLES
Word controller: Will
Letter controller: Dan
Available Words: bee, mop, leg, rat, nut

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Time: 6:00 - Current word changed to: bee
Time: 5:58 - Dan touched tile "b" (short sound)
Time: 5:57 - Will touched tile "b" (short sound)
Time: 5:57 - Will moved tile "b" (short sound) to position 1
(correct)
Time: 5:56 - Dan touched tile "B" (long sound)
Time: 5:54 - Dan touched tile "e" (short sound)
Time: 5:53 - Dan passed tile "e" (short sound) to Will
Time: 5:53 - Will touched tile "e" (short sound)
Time: 5:53 - Will moved tile "e" (short sound) to position 2
(incorrect)
Time: 5:39 - Dan touched tile "B" (long sound)
Time: 5:31 - Dan touched tile "E" (long sound)
Time: 5:27 - Current word changed to: mop
Time: 5:16 - Dan touched tile "M" (long sound)
Time: 5:15 - Dan touched tile "m" (short sound)
Time: 5:14 - Dan passed tile "m" (short sound) to Will
Time: 5:14 - Will touched tile "m" (short sound)
Time: 5:14 - Will moved tile "m" (short sound) to position 1
(correct)
Time: 5:12 - Dan touched tile "O" (long sound)
Time: 5:12 - Dan touched tile "o" (short sound)
Time: 5:11 - Dan passed tile "o" (short sound) to Will
Time: 5:11 - Will touched tile "o" (short sound)
Time: 5:10 - Will moved tile "o" (short sound) to position 2
(correct)
Time: 5:07 - Current word changed to: leg
Time: 5:06 - Dan touched tile "L" (long sound)
Time: 5:05 - Dan touched tile "L" (long sound)
Time: 5:04 - Dan touched tile "l" (short sound)
Time: 5:03 - Will touched tile "l" (short sound)
Time: 5:03 - Will moved tile "l" (short sound) to position 1
(correct)
Time: 5:01 - Dan touched tile "e" (short sound)
Time: 5:00 - Will touched tile "e" (short sound)
Time: 5:00 - Will moved tile "e" (short sound) to position 2
(correct)
Time: 4:57 - Current word changed to: rat
Time: 4:54 - Dan touched tile "r" (short sound)
Time: 4:53 - Dan touched tile "r" (short sound)
Time: 4:52 - Dan passed tile "r" (short sound) to Will
Time: 4:52 - Will touched tile "r" (short sound)
Time: 4:52 - Will moved tile "r" (short sound) to position 1
(correct)
Time: 4:49 - Dan touched tile "A" (long sound)
Time: 4:47 - Dan touched tile "a" (short sound)
Time: 4:47 - Dan touched tile "a" (short sound)
Time: 4:46 - Will touched tile "a" (short sound)
Time: 4:46 - Will moved tile "a" (short sound) to position 2
(correct)
Time: 4:43 - Current word changed to: nut
Time: 4:41 - Dan touched tile "n" (short sound)
Time: 4:41 - Dan touched tile "n" (short sound)
Time: 4:40 - Dan passed tile "n" (short sound) to Will
Time: 4:40 - Will touched tile "n" (short sound)
Time: 4:39 - Will touched tile "n" (short sound)
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Time: 4:38 - Will moved tile "n" (short sound) to position 1 (correct)
Time: 4:37 - Dan touched tile "u" (short sound)
Time: 4:36 - Dan passed tile "u" (short sound) to Will
Time: 4:36 - Will touched tile "u" (short sound)
Time: 4:36 - Will moved tile "u" (short sound) to position 2 (correct)

LEVEL 5 START (7:00 limit, missing X__)
Word controller: Dan
Letter controller: Will
Available Words: eat, ivy, pup, zip, mum

Time: 7:00 - Current word changed to: eat
Time: 6:53 - Will touched tile "A" (long sound)
Time: 6:52 - Will passed tile "A" (long sound) to Dan
Time: 6:52 - Dan touched tile "A" (long sound)
Time: 6:52 - Dan moved tile "A" (long sound) to position 2 (incorrect)
Time: 6:51 - Will touched tile "T" (long sound)
Time: 6:49 - Will passed tile "T" (long sound) to Dan
Time: 6:49 - Dan touched tile "T" (long sound)
Time: 6:48 - Dan moved tile "T" (long sound) to position 3 (incorrect)
Time: 6:42 - Will touched tile "a" (short sound)
Time: 6:42 - Will touched tile "t" (short sound)
Time: 6:38 - Current word changed to: ivy
Time: 6:34 - Will touched tile "v" (short sound)
Time: 6:31 - Will touched tile "v" (short sound)
Time: 6:30 - Will passed tile "v" (short sound) to Dan
Time: 6:30 - Dan touched tile "v" (short sound)
Time: 6:30 - Dan moved tile "v" (short sound) to position 2 (correct)
Time: 6:29 - Will touched tile "Y" (long sound)
Time: 6:29 - Will touched tile "y" (sound: E)
Time: 6:28 - Will touched tile "y" (sound: E)
Time: 6:27 - Dan touched tile "y" (sound: E)
Time: 6:27 - Dan moved tile "y" (sound: E) to position 3 (correct)
Time: 6:24 - Current word changed to: pup
Time: 6:21 - Will touched tile "i" (short sound)
Time: 6:10 - Will touched tile "p" (short sound)
Time: 6:09 - Will passed tile "p" (short sound) to Dan
Time: 6:09 - Dan touched tile "p" (short sound)
Time: 6:09 - Dan moved tile "p" (short sound) to position 3 (correct)
Time: 6:08 - Will touched tile "U" (long sound)
Time: 6:07 - Will touched tile "u" (short sound)
Time: 6:06 - Will passed tile "u" (short sound) to Dan
Time: 6:06 - Dan touched tile "u" (short sound)
Time: 6:06 - Dan moved tile "u" (short sound) to position 2 (correct)
Time: 6:03 - Current word changed to: zip
Time: 5:59 - Will touched tile "I" (long sound)
Time: 5:58 - Will touched tile "i" (short sound)
Time: 5:57 - Will passed tile "i" (short sound) to Dan
Time: 5:57 - Dan touched tile "i" (short sound)
Time: 5:57 - Dan moved tile "i" (short sound) to position 2 (correct)
Time: 5:56 - Will touched tile "p" (short sound)
Time: 5:56 - Will touched tile "p" (short sound)

Time: 5:55 - Dan touched tile "p" (short sound)
Time: 5:54 - Dan touched tile "p" (short sound)
Time: 5:53 - Dan moved tile "p" (short sound) to position 3 (correct)
Time: 5:50 - Current word changed to: mum
Time: 5:48 - Will touched tile "u" (short sound)
Time: 5:47 - Will touched tile "u" (short sound)
Time: 5:46 - Dan touched tile "u" (short sound)
Time: 5:46 - Dan moved tile "u" (short sound) to position 2 (correct)
Time: 5:45 - Will touched tile "M" (long sound)
Time: 5:43 - Will touched tile "m" (short sound)
Time: 5:42 - Will touched tile "m" (short sound)
Time: 5:41 - Dan touched tile "m" (short sound)
Time: 5:41 - Dan moved tile "m" (short sound) to position 3 (correct)

PLAYERS SWAP ROLES
Word controller: Will
Letter controller: Dan
Available Words: oar, gap, rug, yak, zap

Time: 7:00 - Current word changed to: oar
Time: 6:52 - Dan touched tile "a" (short sound)
Time: 6:51 - Dan passed tile "a" (short sound) to Will
Time: 6:51 - Will touched tile "a" (short sound)
Time: 6:51 - Will moved tile "a" (short sound) to position 2
(correct)
Time: 6:50 - Dan touched tile "A" (long sound)
Time: 6:48 - Dan touched tile "R" (long sound)
Time: 6:47 - Dan passed tile "R" (long sound) to Will
Time: 6:46 - Will touched tile "R" (long sound)
Time: 6:46 - Will moved tile "R" (long sound) to position 3
(incorrect)
Time: 6:44 - Dan touched tile "r" (short sound)
Time: 6:40 - Current word changed to: gap
Time: 6:36 - Dan touched tile "a" (short sound)
Time: 6:34 - Dan touched tile "a" (short sound)
Time: 6:33 - Will touched tile "a" (short sound)
Time: 6:33 - Will moved tile "a" (short sound) to position 2
(correct)
Time: 6:33 - Dan touched tile "p" (short sound)
Time: 6:32 - Dan touched tile "p" (short sound)
Time: 6:31 - Will touched tile "p" (short sound)
Time: 6:31 - Will moved tile "p" (short sound) to position 3
(correct)
Time: 6:28 - Current word changed to: rug
Time: 6:26 - Dan touched tile "u" (short sound)
Time: 6:26 - Dan touched tile "u" (short sound)
Time: 6:25 - Dan passed tile "u" (short sound) to Will
Time: 6:25 - Will touched tile "u" (short sound)
Time: 6:25 - Will moved tile "u" (short sound) to position 2
(correct)
Time: 6:23 - Dan touched tile "G" (long sound)
Time: 6:23 - Dan touched tile "g" (short sound)
Time: 6:22 - Dan touched tile "g" (short sound)
Time: 6:21 - Dan passed tile "g" (short sound) to Will
Time: 6:20 - Will touched tile "g" (short sound)

Time: 6:20 - Will moved tile "g" (short sound) to position 3 (correct)
Time: 6:17 - Current word changed to: yak
Time: 6:15 - Dan touched tile "a" (short sound)
Time: 6:14 - Dan touched tile "a" (short sound)
Time: 6:13 - Will touched tile "a" (short sound)
Time: 6:13 - Will moved tile "a" (short sound) to position 2 (correct)
Time: 6:13 - Dan touched tile "k" (short sound)
Time: 6:12 - Dan touched tile "k" (short sound)
Time: 6:10 - Dan passed tile "k" (short sound) to Will
Time: 6:03 - Will touched tile "k" (short sound)
Time: 6:02 - Will touched tile "k" (short sound)
Time: 6:02 - Will moved tile "k" (short sound) to position 3 (correct)
Time: 5:59 - Current word changed to: zap
Time: 5:52 - Dan touched tile "A" (long sound)
Time: 5:50 - Dan touched tile "a" (short sound)
Time: 5:49 - Dan touched tile "a" (short sound)
Time: 5:48 - Dan passed tile "a" (short sound) to Will
Time: 5:48 - Will touched tile "a" (short sound)
Time: 5:48 - Will moved tile "a" (short sound) to position 2 (correct)
Time: 5:47 - Dan touched tile "P" (long sound)
Time: 5:45 - Dan touched tile "p" (short sound)
Time: 5:44 - Dan passed tile "p" (short sound) to Will
Time: 5:43 - Will touched tile "p" (short sound)
Time: 5:43 - Will moved tile "p" (short sound) to position 3 (correct)

LEVEL 6 START (8:00 limit, missing _X_)
Word controller: Dan
Letter controller: Will
Available Words: bug, bun, vet, one, keg

Time: 8:00 - Current word changed to: bug
Time: 7:57 - Will touched tile "B" (long sound)
Time: 7:56 - Will touched tile "B" (long sound)
Time: 7:43 - Will touched tile "b" (short sound)
Time: 7:42 - Will touched tile "b" (short sound)
Time: 7:41 - Will passed tile "b" (short sound) to Dan
Time: 7:41 - Dan touched tile "b" (short sound)
Time: 7:41 - Dan moved tile "b" (short sound) to position 1 (correct)
Time: 7:38 - Will touched tile "g" (short sound)
Time: 7:38 - Will touched tile "g" (short sound)
Time: 7:38 - Will touched tile "g" (short sound)
Time: 7:38 - Will touched tile "g" (short sound)
Time: 7:38 - Will touched tile "g" (short sound)
Time: 7:37 - Will touched tile "g" (short sound)
Time: 7:36 - Will touched tile "g" (short sound)
Time: 7:35 - Will touched tile "g" (short sound)
Time: 7:35 - Will touched tile "g" (short sound)
Time: 7:35 - Will touched tile "g" (short sound)
Time: 7:33 - Will passed tile "g" (short sound) to Dan
Time: 7:33 - Dan touched tile "g" (short sound)
Time: 7:32 - Dan moved tile "g" (short sound) to position 3 (correct)

Time: 7:29 - Current word changed to: bun
Time: 7:27 - Will touched tile "b" (short sound)
Time: 7:26 - Will touched tile "b" (short sound)
Time: 7:25 - Will passed tile "b" (short sound) to Dan
Time: 7:25 - Dan touched tile "b" (short sound)
Time: 7:25 - Dan moved tile "b" (short sound) to position 1 (correct)
Time: 7:24 - Will touched tile "N" (long sound)
Time: 7:24 - Dan touched tile "N" (long sound)
Time: 7:24 - Dan moved tile "N" (long sound) to position 3 (incorrect)
Time: 7:19 - Will touched tile "n" (short sound)
Time: 7:15 - Current word changed to: vet
Time: 7:13 - Will touched tile "v" (short sound)
Time: 7:12 - Will touched tile "v" (short sound)
Time: 7:11 - Will passed tile "v" (short sound) to Dan
Time: 7:11 - Dan touched tile "v" (short sound)
Time: 7:11 - Dan moved tile "v" (short sound) to position 1 (correct)
Time: 7:09 - Will touched tile "T" (long sound)
Time: 7:08 - Will touched tile "t" (short sound)
Time: 7:07 - Will touched tile "t" (short sound)
Time: 7:06 - Will passed tile "t" (short sound) to Dan
Time: 7:06 - Dan touched tile "t" (short sound)
Time: 7:06 - Dan moved tile "t" (short sound) to position 3 (correct)
Time: 7:03 - Current word changed to: one
Time: 6:55 - Will touched tile "O" (sound: Wha)
Time: 6:53 - Will touched tile "O" (sound: Wha)
Time: 6:47 - Will touched tile "O" (sound: Wha)
Time: 6:46 - Will passed tile "O" (sound: Wha) to Dan
Time: 6:46 - Dan touched tile "O" (sound: Wha)
Time: 6:46 - Dan moved tile "O" (sound: Wha) to position 1 (correct)
Time: 6:44 - Will touched tile "e" (short sound)
Time: 6:43 - Will touched tile "e" (short sound)
Time: 6:42 - Will passed tile "e" (short sound) to Dan
Time: 6:42 - Dan touched tile "e" (short sound)
Time: 6:42 - Dan moved tile "e" (short sound) to position 3 (correct)
Time: 6:39 - Current word changed to: keg
Time: 6:31 - Will touched tile "K" (long sound)
Time: 6:31 - Will touched tile "K" (long sound)
Time: 6:28 - Will touched tile "k" (short sound)
Time: 6:27 - Will passed tile "k" (short sound) to Dan
Time: 6:27 - Dan touched tile "k" (short sound)
Time: 6:27 - Dan moved tile "k" (short sound) to position 1 (correct)
Time: 6:25 - Will touched tile "g" (short sound)
Time: 6:24 - Will passed tile "g" (short sound) to Dan
Time: 6:23 - Dan touched tile "g" (short sound)
Time: 6:23 - Dan moved tile "g" (short sound) to position 3 (correct)

PLAYERS SWAP ROLES
Word controller: Will
Letter controller: Dan
Available Words: ham, fly, nut, one, kid

Time: 8:00 - Current word changed to: ham
Time: 7:53 - Dan touched tile "H" (long sound)
Time: 7:51 - Dan touched tile "h" (short sound)
Time: 7:50 - Dan passed tile "h" (short sound) to Will

Time: 7:50 - Will touched tile "h" (short sound)
Time: 7:50 - Will moved tile "h" (short sound) to position 1 (correct)
Time: 7:48 - Dan touched tile "m" (short sound)
Time: 7:47 - Dan touched tile "m" (short sound)
Time: 7:45 - Dan passed tile "m" (short sound) to Will
Time: 7:45 - Will touched tile "m" (short sound)
Time: 7:45 - Will moved tile "m" (short sound) to position 3 (correct)
Time: 7:42 - Current word changed to: fly
Time: 7:40 - Dan touched tile "F" (long sound)
Time: 7:39 - Dan touched tile "f" (short sound)
Time: 7:38 - Dan passed tile "f" (short sound) to Will
Time: 7:37 - Will touched tile "f" (short sound)
Time: 7:37 - Will moved tile "f" (short sound) to position 1 (correct)
Time: 7:37 - Dan touched tile "l" (short sound)
Time: 7:35 - Dan touched tile "L" (long sound)
Time: 7:31 - Dan touched tile "Y" (long sound)
Time: 7:30 - Dan touched tile "y" (sound: I)
Time: 7:30 - Dan touched tile "y" (sound: I)
Time: 7:28 - Dan passed tile "y" (sound: I) to Will
Time: 7:27 - Will touched tile "y" (sound: I)
Time: 7:27 - Will moved tile "y" (sound: I) to position 3 (correct)
Time: 7:24 - Current word changed to: nut
Time: 7:14 - Dan touched tile "n" (short sound)
Time: 7:13 - Dan touched tile "n" (short sound)
Time: 7:12 - Dan passed tile "n" (short sound) to Will
Time: 7:12 - Will touched tile "n" (short sound)
Time: 7:12 - Will moved tile "n" (short sound) to position 1 (correct)
Time: 7:09 - Dan touched tile "T" (long sound)
Time: 7:03 - Dan touched tile "t" (short sound)
Time: 7:02 - Dan passed tile "t" (short sound) to Will
Time: 7:02 - Will touched tile "t" (short sound)
Time: 7:02 - Will moved tile "t" (short sound) to position 3 (correct)
Time: 6:59 - Current word changed to: one
Time: 6:57 - Dan touched tile "O" (sound: Wha)
Time: 6:54 - Dan touched tile "O" (sound: Wha)
Time: 6:53 - Dan passed tile "O" (sound: Wha) to Will
Time: 6:53 - Will touched tile "O" (sound: Wha)
Time: 6:53 - Will moved tile "O" (sound: Wha) to position 1 (correct)
Time: 6:47 - Dan touched tile "e" (short sound)
Time: 6:47 - Dan passed tile "e" (short sound) to Will
Time: 6:47 - Will touched tile "e" (short sound)
Time: 6:46 - Will moved tile "e" (short sound) to position 3 (correct)
Time: 6:43 - Current word changed to: kid
Time: 6:39 - Dan touched tile "K" (long sound)
Time: 6:39 - Dan touched tile "K" (long sound)
Time: 6:38 - Dan touched tile "k" (short sound)
Time: 6:37 - Dan passed tile "k" (short sound) to Will
Time: 6:36 - Will touched tile "k" (short sound)
Time: 6:36 - Will moved tile "k" (short sound) to position 1 (correct)

Time: 6:35 - Dan touched tile "d" (short sound)
Time: 6:34 - Will touched tile "d" (short sound)
Time: 6:34 - Will moved tile "d" (short sound) to position 3
(correct)

LEVEL 7 START (9:00 limit, missing ___)
Word controller: Dan
Letter controller: Will
Available Words: wig, bat, pan, kid, pie

Time: 9:00 - Current word changed to: wig
Time: 8:58 - Will touched tile "w" (short sound)
Time: 8:57 - Will passed tile "w" (short sound) to Dan
Time: 8:57 - Dan touched tile "w" (short sound)
Time: 8:57 - Dan moved tile "w" (short sound) to position 1 (correct)
Time: 8:56 - Will touched tile "i" (short sound)
Time: 8:55 - Will passed tile "i" (short sound) to Dan
Time: 8:55 - Dan touched tile "i" (short sound)
Time: 8:55 - Dan moved tile "i" (short sound) to position 2 (correct)
Time: 8:53 - Will touched tile "G" (long sound)
Time: 8:52 - Will touched tile "g" (short sound)
Time: 8:51 - Will passed tile "g" (short sound) to Dan
Time: 8:50 - Dan touched tile "g" (short sound)
Time: 8:50 - Dan moved tile "g" (short sound) to position 3 (correct)
Time: 8:47 - Current word changed to: bat
Time: 8:34 - Will touched tile "b" (short sound)
Time: 8:33 - Will touched tile "b" (short sound)
Time: 8:33 - Will passed tile "b" (short sound) to Dan
Time: 8:32 - Dan touched tile "b" (short sound)
Time: 8:31 - Dan moved tile "b" (short sound) to position 1 (correct)
Time: 8:30 - Will touched tile "a" (short sound)
Time: 8:29 - Will touched tile "a" (short sound)
Time: 8:27 - Will passed tile "a" (short sound) to Dan
Time: 8:26 - Will touched tile "T" (long sound)
Time: 8:25 - Will touched tile "t" (short sound)
Time: 8:25 - Will touched tile "t" (short sound)
Time: 8:23 - Will passed tile "t" (short sound) to Dan
Time: 8:23 - Dan touched tile "t" (short sound)
Time: 8:15 - Dan touched tile "a" (short sound)
Time: 8:14 - Dan moved tile "a" (short sound) to position 2 (correct)
Time: 8:14 - Dan touched tile "t" (short sound)
Time: 8:14 - Dan moved tile "t" (short sound) to position 3 (correct)
Time: 8:11 - Current word changed to: pan
Time: 8:05 - Will touched tile "p" (short sound)
Time: 8:04 - Will passed tile "p" (short sound) to Dan
Time: 8:04 - Dan touched tile "p" (short sound)
Time: 8:04 - Dan moved tile "p" (short sound) to position 1 (correct)
Time: 8:03 - Will touched tile "a" (short sound)
Time: 8:02 - Will passed tile "a" (short sound) to Dan
Time: 8:01 - Dan touched tile "a" (short sound)
Time: 8:01 - Dan moved tile "a" (short sound) to position 2 (correct)
Time: 8:00 - Will touched tile "n" (short sound)
Time: 7:59 - Will passed tile "n" (short sound) to Dan
Time: 7:59 - Dan touched tile "n" (short sound)
Time: 7:59 - Dan moved tile "n" (short sound) to position 3 (correct)
Time: 7:56 - Current word changed to: kid

Time: 7:52 - Will touched tile "K" (long sound)
Time: 7:49 - Will touched tile "k" (short sound)
Time: 7:48 - Will passed tile "k" (short sound) to Dan
Time: 7:47 - Will touched tile "i" (short sound)
Time: 7:46 - Will passed tile "i" (short sound) to Dan
Time: 7:45 - Will touched tile "d" (short sound)
Time: 7:44 - Will touched tile "d" (short sound)
Time: 7:43 - Will passed tile "d" (short sound) to Dan
Time: 7:43 - Dan touched tile "d" (short sound)
Time: 7:43 - Dan moved tile "d" (short sound) to position 3 (correct)
Time: 7:42 - Dan touched tile "i" (short sound)
Time: 7:42 - Dan moved tile "i" (short sound) to position 2 (correct)
Time: 7:42 - Dan touched tile "k" (short sound)
Time: 7:42 - Dan moved tile "k" (short sound) to position 1 (correct)
Time: 7:39 - Current word changed to: pie
Time: 7:37 - Will touched tile "P" (long sound)
Time: 7:36 - Will touched tile "p" (short sound)
Time: 7:35 - Will passed tile "p" (short sound) to Dan
Time: 7:35 - Dan touched tile "p" (short sound)
Time: 7:35 - Dan moved tile "p" (short sound) to position 1 (correct)
Time: 7:33 - Will touched tile "I" (long sound)
Time: 7:32 - Will touched tile "I" (long sound)
Time: 7:30 - Will passed tile "I" (long sound) to Dan
Time: 7:30 - Dan touched tile "I" (long sound)
Time: 7:30 - Dan moved tile "I" (long sound) to position 2 (correct)
Time: 7:29 - Will touched tile "E" (long sound)
Time: 7:28 - Will touched tile "e" (short sound)
Time: 7:23 - Will touched tile "E" (long sound)
Time: 7:22 - Will passed tile "E" (long sound) to Dan
Time: 7:16 - Dan touched tile "E" (long sound)
Time: 7:15 - Dan touched tile "E" (long sound)
Time: 7:14 - Dan moved tile "E" (long sound) to position 3 (incorrect)
Time: 7:06 - Will touched tile "e" (short sound)

PLAYERS SWAP ROLES
Word controller: Will
Letter controller: Dan
Available Words: man, bun, ivy, keg, egg

Time: 9:00 - Current word changed to: man
Time: 8:56 - Dan touched tile "m" (short sound)
Time: 8:55 - Dan passed tile "m" (short sound) to Will
Time: 8:53 - Dan touched tile "A" (long sound)
Time: 8:51 - Dan touched tile "a" (short sound)
Time: 8:50 - Dan passed tile "a" (short sound) to Will
Time: 8:49 - Dan touched tile "A" (long sound)
Time: 8:47 - Dan touched tile "N" (long sound)
Time: 8:44 - Dan touched tile "n" (short sound)
Time: 8:43 - Dan passed tile "n" (short sound) to Will
Time: 8:42 - Will touched tile "n" (short sound)
Time: 8:42 - Will moved tile "n" (short sound) to position 3 (correct)
Time: 8:42 - Will touched tile "a" (short sound)
Time: 8:42 - Will moved tile "a" (short sound) to position 2 (correct)

Time: 8:41 - Will touched tile "m" (short sound)
Time: 8:41 - Will moved tile "m" (short sound) to position 1 (correct)
Time: 8:38 - Current word changed to: bun
Time: 8:37 - Dan touched tile "B" (long sound)
Time: 8:33 - Dan touched tile "b" (short sound)
Time: 8:32 - Dan passed tile "b" (short sound) to Will
Time: 8:31 - Will touched tile "b" (short sound)
Time: 8:31 - Will moved tile "b" (short sound) to position 1 (correct)
Time: 8:30 - Dan touched tile "u" (short sound)
Time: 8:29 - Dan passed tile "u" (short sound) to Will
Time: 8:29 - Will touched tile "u" (short sound)
Time: 8:29 - Will moved tile "u" (short sound) to position 2 (correct)
Time: 8:28 - Dan touched tile "n" (short sound)
Time: 8:26 - Dan passed tile "n" (short sound) to Will
Time: 8:26 - Will touched tile "n" (short sound)
Time: 8:26 - Will moved tile "n" (short sound) to position 3 (correct)
Time: 8:23 - Current word changed to: ivy
Time: 8:21 - Dan touched tile "I" (long sound)
Time: 8:20 - Dan touched tile "I" (long sound)
Time: 8:19 - Dan passed tile "I" (long sound) to Will
Time: 8:18 - Will touched tile "I" (long sound)
Time: 8:17 - Dan touched tile "y" (sound: E)
Time: 8:15 - Dan touched tile "Y" (long sound)
Time: 8:10 - Dan touched tile "v" (short sound)
Time: 8:09 - Dan touched tile "v" (short sound)
Time: 8:08 - Dan passed tile "v" (short sound) to Will
Time: 8:07 - Dan touched tile "y" (sound: E)
Time: 8:05 - Dan passed tile "y" (sound: E) to Will
Time: 7:48 - Will touched tile "I" (long sound)
Time: 7:48 - Will touched tile "v" (short sound)
Time: 7:48 - Will moved tile "v" (short sound) to position 2 (correct)
Time: 7:47 - Will touched tile "I" (long sound)
Time: 7:47 - Will moved tile "I" (long sound) to position 1 (correct)
Time: 7:46 - Will touched tile "y" (sound: E)
Time: 7:46 - Will touched tile "y" (sound: E)
Time: 7:45 - Will touched tile "y" (sound: E)
Time: 7:45 - Will moved tile "y" (sound: E) to position 3 (correct)
Time: 7:42 - Current word changed to: keg
Time: 7:36 - Dan touched tile "k" (short sound)
Time: 7:35 - Dan touched tile "k" (short sound)
Time: 7:34 - Dan passed tile "k" (short sound) to Will
Time: 7:34 - Dan touched tile "E" (long sound)
Time: 7:32 - Dan touched tile "e" (short sound)
Time: 7:31 - Dan passed tile "e" (short sound) to Will
Time: 7:31 - Will touched tile "e" (short sound)
Time: 7:31 - Will moved tile "e" (short sound) to position 2 (correct)
Time: 7:30 - Will touched tile "k" (short sound)
Time: 7:30 - Will moved tile "k" (short sound) to position 1 (correct)
Time: 7:28 - Dan touched tile "G" (long sound)

Time: 7:26 - Dan touched tile "g" (short sound)
Time: 7:25 - Dan touched tile "g" (short sound)
Time: 7:24 - Dan passed tile "g" (short sound) to Will
Time: 7:24 - Will touched tile "g" (short sound)
Time: 7:24 - Will moved tile "g" (short sound) to position 3 (correct)
Time: 7:21 - Current word changed to: egg
Time: 7:19 - Dan touched tile "e" (short sound)
Time: 7:18 - Dan passed tile "e" (short sound) to Will
Time: 7:18 - Will touched tile "e" (short sound)
Time: 7:18 - Will moved tile "e" (short sound) to position 1 (correct)
Time: 7:17 - Dan touched tile "g" (short sound)
Time: 7:16 - Dan touched tile "g" (short sound)
Time: 7:15 - Will touched tile "g" (short sound)
Time: 7:15 - Will moved tile "g" (short sound) to position 2 (correct)
Time: 7:14 - Dan touched tile "G" (long sound)
Time: 7:14 - Dan touched tile "g" (short sound)
Time: 7:13 - Dan touched tile "G" (long sound)
Time: 7:12 - Dan touched tile "g" (short sound)
Time: 7:11 - Will touched tile "g" (short sound)
Time: 7:11 - Will moved tile "g" (short sound) to position 3 (correct)

Dan correct words: kid pan bat wig keg one vet bug zip pup ivy log mug bus sat mum jam ape pig yes rat wok ink eat cow sad eel

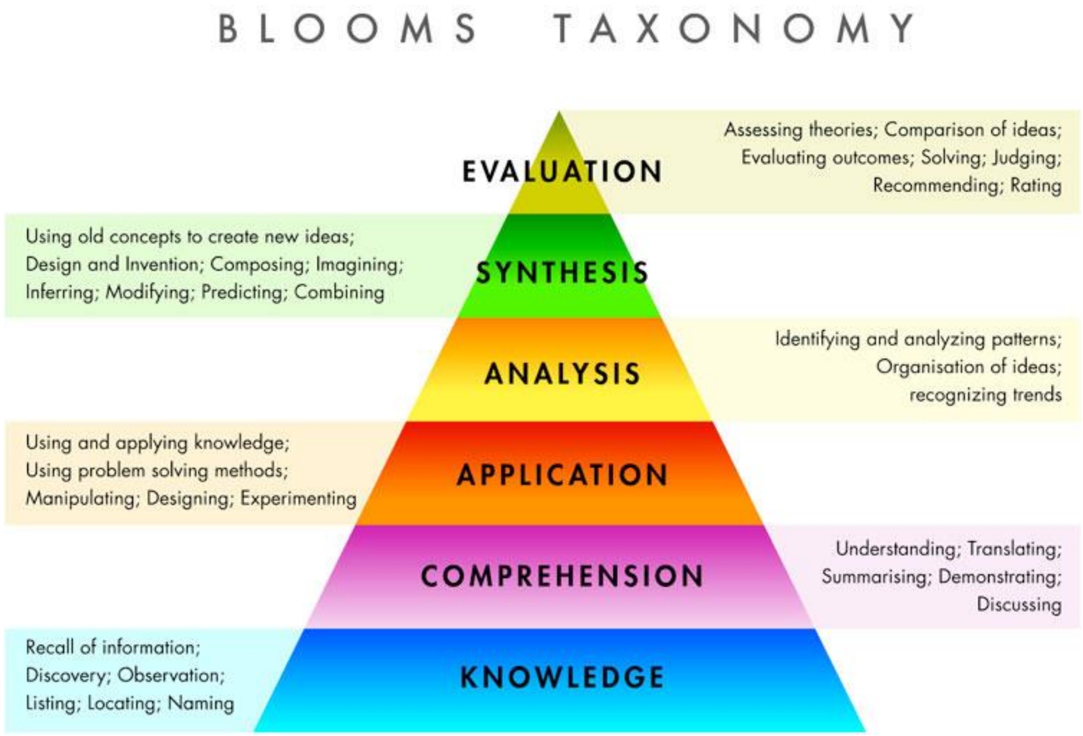
Dan incorrect words: bun cow dad eat pie

Will correct words: egg ivy bun man kid one fly ham zap yak gap nut rat leg mop keg rug dam jog gum sat nit cry jug yam gym bug ten bus

Will incorrect words: bus bee oar

LOG ENDED: 47 minutes 1 second total runtime

Appendix P: Taxonomies – Bloom's and Collaborative Instructional Strategies



Collaborative Learning Strategies

Learning Objectives
Objectives for metacognitive and enabling skills development in the collaborative domain

Skills Identification
Metacognitive Skills; Coordination Skills; Establishing Roles; Establishing Responsibilities; Problem Solving Skills

Collaborative Interaction Strategies

Activity Structure
Formal vs Informal; Structures vs Unstructures; Interdependent roles working towards common objectives

Cognitive Tasks
Plannning, decision making, designing; assessing situations and problem solving; coordination; communication

Collaborative Assessment Strategies

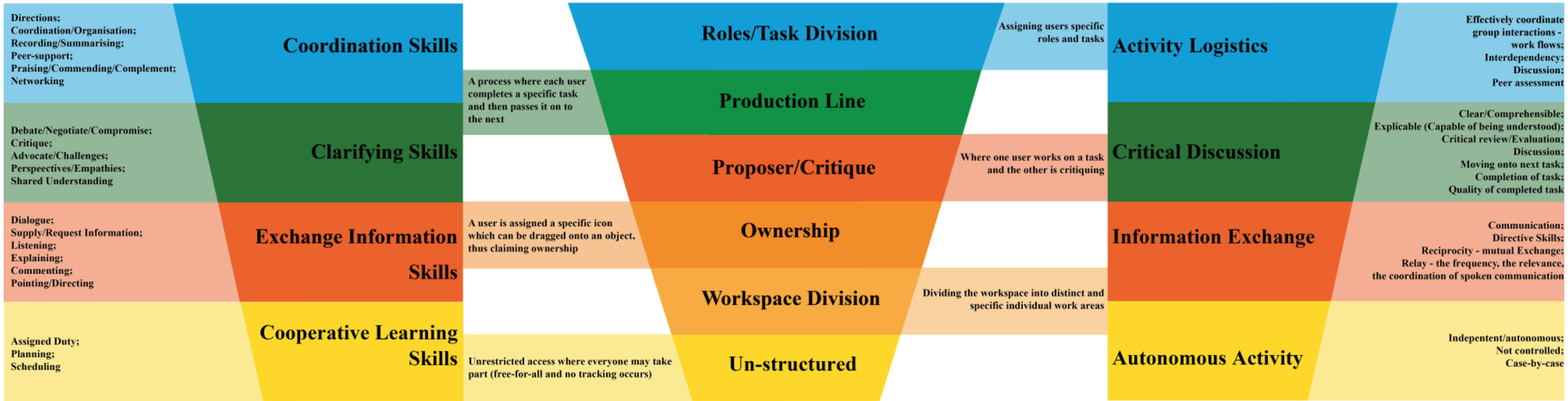
Measuring Skills
Measuring metacognitive and enabling skills in the collaborative domain

Assessment Metrics
Group Practices; Coordination Skills; Clarifying Skills; Communication Skills; Output/Solution; Mapping Information flow

Taxonomy of Collaborative Learning Strategies

Taxonomy of Collaborative Interaction Strategies

Taxonomy of Collaborative Assessment Strategies



Appendix Q: Glossary of the Three Taxonomies

Adapted from the Oxford dictionary and businessdictionary.com	
COLLABORATIVE LEARNING STRATEGIES – METHODS, TAXONOMY OF LEARNING STRATEGIES	
Coordination skills A management function where the person or persons encourages the synchronisation and integration of complex activities.	
Directions – give/take	A statement that tells the person what to do and how to do it.
Coordination/organisation	The process of organizing people or groups of people so that they work together harmoniously.
Recording/Summarising	Recording: 1. To write (something) down or make a note so that it can be used or seen again in the future, 2. To produce a record of (something). Summarising: A brief statement, done without delay or formality, quickly executed.
Peer-support	Peer support is a system of giving and receiving help.
Praising/Commending/ Complement	Praising: Express favourable judgement, to say or write good things. Commendation: The act of praising or approving. Complements: Something that adds/gives extra features/components to something else or makes it better.
Networking	The exchange of information or services among individuals, groups.
Clarifying skills A statement/skill/knowledge/activity used or implemented by the person or persons in order to make a situation clearer/comprehensible. Synchronous, and can be verbal/non-verbal.	
Debate/Negotiate/ Compromise	Debate: A discussion between people in which they express different opinions about something. Negotiate: To discuss something formally in order to make an agreement. Compromise: To reach an agreement in which each person or group gives up something that was wanted in order to end an argument or dispute.

Critiquing	A careful judgment in which you give your opinion about the good and bad parts of something.
Advocate/Challenge	Advocate: A person who works/argues for or supports a cause/policy. Challenges: To question the action or authority of someone/something.
Perspectives/Empathies	Perspective: A position from which something is considered or evaluated. Empathies: where one shares/understands another person's experiences and emotions.
Shared understanding	Where new knowledge creation is influenced by participation and collaboration and achieve by exchanging individual knowing for group knowing, thus changing from an individual perspective to a joint perspective that emerges from collective contributions.
Exchange information skills A two-way process of sharing information; a message transaction that can be verbal/non-verbal relying on the coding and decoding of information between two or more people.	
Dialogue	A conversation/Discussion between the participants.
Supply/Request Information	Supply: Contribute/provide learnt facts about something or someone. Request: Ask for details/facts or call for a detail/fact about something or someone.
Listening	To hear something with thoughtful attention (focus), give consideration.
Explaining	• Explaining is defined as making (something) clear or easy to understand, to tell, show, or be the reason for, an action, or cause of something, an event.
Commenting	A verbal or written observation/remark expressing an opinion or attitude
Pointing/Directing	Pointing: A non-verbal hand gesture, or nod. Directing: Moving an object or guiding an object from one place to another, or use a comment – For example: saying something like, “Over there”, “That one”.
Cooperative learning skills Where the person or persons are working together in small groups towards their own individual goals	

Assigned duty (task)	To give someone a particular job or duty, to require someone to do a particular task.
Planning	The act or process of making a plan to achieve or do something.
Scheduling	A plan of things that will be done and the times when they will be done.
COLLABORATIVE INTERACTION STRATEGIES – PRACTICE, TAXONOMY OF COLLABORATIVE INTERACTION STRATEGIES	
Roles/Task Division	
Assigning users specific roles and tasks. Role: a function (task) assumed or played by a person. Task: an allotted piece of work to be undertaken/completed.	
Production Line	
A process where each user completes a specific task and then passes it on to the next. For example: An assembly line where tasks are passed through a set of linear sequences.	
Proposer/Critique	
Where one user works on a task and the other is critiquing. Proposer: puts forward a suggestion/idea. Critique: one who evaluates/analysis and assesses.	
Ownership	
A user is assigned (possesses) a specific icon which can be dragged onto an object, thus claiming ownership.	
Workspace Division	
Dividing the workspace into distinct and specific individual work areas.	
Unstructured	
That is unrestricted access where everyone may take part. Free-for-all and no tracking occurs. No formal organisation or structure.	

Adapted from the Oxford Dictionary	
COLLABORATIVE ASSESSMENT STRATEGIES – INDICATORS, TAXONOMY OF COLLABORATIVE ASSESSMENT STRATEGIES	
Coordination Behaviours (Activity Logistics) A way in which the person or persons respond to a particular situation or stimulus. Coordination Behaviours relate to Activity Logistics – What/How did the people respond/manage/organise themselves or the team in order to implement/complete the activity.	
Effectively coordinated group interactions – workflow	Where the workflow (plan, venture) allowed the participants to actively work together from beginning to end.
Interdependency	Is a relationship where participants are reliant on each other, mutually dependant on one another? The word controller requestions and the letter controller passing the letter tile to the word controller is an interdependent relationship.
Discussion	Where the activity encourages the participants to verbally interact with each other.
Peer assessment	Giving and receiving feedback for learning. (Freeman & Lewis, 1998) (constructivism)
Clarifying Behaviours (Critical Discussion) What/How did the person or persons respond/react/behave when presented with a situation that was not clear or comprehensible. Synchronous, and can be verbal/non-verbal.	
Clear/comprehensible	Clarify: Make something easier to understand.
Explicable (capable of being understood)	Understandable or accounted for. Actions of being able to explain clearly and concisely their meaning.
Critical review/Evaluation	Evaluate what is happening and/or being able to express an opinion.
Advocate	Support/recommend. Argue for a position/point of view.
Moving onto next task	The group makes a conscious decision to move forward. A need to re-focus. Being aware of the next step.
Completion of task	. Where the criteria/goals/results for a task was met. The group decides that the task is finished
Quality of completed task	Being able to determine how well the task was completed. Where the group decides that the needs of the task have been met.

Exchange Information Behaviours (Information Exchange) What/How did the person or persons respond/react/behave when sharing information.	
Communication	Impart, interchange transmits thoughts and ideas.
Directive Skills	Verbalise/provide guidance.
Reciprocity – mutual exchange	Mutual exchange (swap) to make an exchange.
Relay	Being able to pass information (verbalise, communicate, talk) from one person to another. The frequency, the relevance, the coordination of spoken communication.
Gestures	The use of motions of the limbs or body as a means of expression. A form of non-verbal communication.
Cooperative learning behaviours (Autonomous Activity) What/How did learners respond/react/behave when working together in small groups towards their own individual goals	
Independent/autonomous	Not controlled by others, working on their own.
Not controlled	NOT done or organised according to certain rules, instructions, or procedures.
Case-by-case	Considering each case individually.

Appendix R: Collaborative Learning Techniques (CoLTs) -Reference Guide

Collaborative Learning Techniques (CoLTs) -Reference Guide			
	This CoLT	…is a technique in which students:	It is particularly useful for:
Discussion CoLTs			
1	Think-Pair-Share	think individually for a few minutes, and then discuss and compare their responses with a partner before sharing with the entire class.	preparing students to participate more fully and effectively in whole class discussions.
2	Round Robin	generate ideas and speak moving from one student to the next.	structuring brainstorming sessions and ensuring that all students participate.
3	Buzz Groups	discuss course-related questions informally in small groups of peers.	generating lots of ideas quickly to prepare for and improve whole-class discussion
4	Talking Chips	participate in a group discussion and surrender a token each time they speak.	ensuring equitable participation.
5	Three-Step Interview	interview each other and report what they learn to another pair.	helping students network and improve communication skills.
6	Critical Debates	assume/argue the side of an issue opposite of their personal views.	developing critical thinking and encouraging students to challenge their assumption
Reciprocal Peer Teaching CoLTs			
7	Note-Taking Pairs	pool information from their individual notes to create an improved, partner version.	helping students acquire missing information and correct inaccuracies in their notes and learn to become better note takers.
8	Learning Cell	quiz each other using questions they have developed individually about a reading assignment or other learning activity.	engaging students actively in thinking about content and encouraging them to challenge each other to pursue deeper levels of thought.
9	Fishbowl	form concentric circles with the smaller, inside group of students discussing and the larger, outside group listening and observing.	providing opportunities for students to model or observe group processes in a discussion setting.
10	Role Play	assume a different identity and act out a scenario.	engaging students in a creative activity that helps them “learn by doing.”
11	Jigsaw	develop knowledge about a given topic and then teach it to others.	motivating students to learn/process info deeply

			enough to teach it to their peers
12	Test-Taking-Teams	prepare for a test in working groups, take the test individually, and then retake the test in their groups.	helping students assess and improve their understanding of subject matter as they also teach each other test-taking strategies.
Problem-Solving CoLTs			
13	Think-Aloud Pair Problem-Solving (TAPPs)	solve problems aloud to try out their reasoning on a listening peer.	emphasizing the problem-solving process (rather than the product) and helping students identify logic or process errors.
14	Send-A-Problem	try to solve a problem as a group and then pass the problem and solution to a nearby group who does the same; the final group evaluates the solutions.	Helping students practice together the thinking skills required for effective problem-solving and for comparing and discriminating between multiple solutions.
15	Case Studies	Review a written study of a real-world scenario and develop a solution to the dilemma presented in the case.	presenting abstract principles and theories in ways that students find relevant.
16	Structured Problem Solving	follow a structured format to solve problems.	dividing problem-solving processes into manageable steps so that students don't feel overwhelmed and so that they learn to identify, analyze, and solve problems in an organized manner.
17	Analytic Teams	team members assume roles and specific tasks when critically reading an assignment, listening to a lecture, or watching a video.	helping students understand the different activities that constitute a critical analysis.
18	Group Investigation	plan, conduct, and report on in-depth research projects.	teaching students research procedures and gain in-depth knowledge.
Graphic Organizing CoLTs			
19	Affinity Grouping	generate ideas, identify common themes, and then sort and organize the ideas accordingly.	unpack a complicated topic and identify and classify its constituent parts.
20	Group Grid	are given pieces of information and asked to place them in the blank cells of a grid according to category rubrics.	clarify conceptual categories and develop sorting skills.
21	Team Matrix	discriminate between similar concepts by noticing and marking on a chart the presence or absence of important, defining features.	distinguish between closely related concepts.

22	Sequence Chains	analyze and depict graphically a series of events, actions, roles, or decisions	understand processes, cause and effect, and chronological series, and organize information in an orderly, coherent progression.
23	Word Webs	generate a list of related ideas and then organize them in a graphic, identifying relationships by drawing lines or arrows to represent the connections.	figure out and represent relationships. Like maps, they can show both the destination and the sites and sights along the way.
Writing CoLTs			
24	Dialogue Journals	record their thoughts in a journal that they exchange with peers for comments and questions	connect coursework to their personal lives and to interact with each other in content-related and thoughtful ways.
25	Round Table	take turns responding to prompt before passing the paper along to others who do the same.	practice writing informally and to create a written record of ideas.
26	Dyadic Essays	write essay questions/model answers, exchange questions, and after responding compare their answers to the model answer.	identify the most important feature of a learning activity and formulate and answer questions about that activity.
27	Peer Editing	critically review and provide editorial feedback on a peer's essay, report, argument, research paper, or other writing assignment.	develop critical editing skills and give each other constructive criticism to improve papers before they submit them for grading.
28	Collaborative Writing	write a formal paper together.	learn and perform the stages of writing more effectively.
29	Team Anthologies	compile course-related readings with student and annotations.	experience the research process without writing a formal research paper.
30	Paper Seminar	write/present an original paper, receive formal feedback from peers; engage in a general discussion of the issues with the group.	engage in deep discussion about their research and provide individual students with focused attention and feedback on individual student's work
Games CoLTs			
31	Team Scavenger Hunt	find a set of items on a list.	introducing students to key artifacts/examples associated with course content.
32	Quizo	answer questions correctly to receive a chip to place on a board as they strive to cover five sequential spaces.	introducing or reviewing factual content.
33	Team Jeopardy	choose categories and point values to receive an answer for which they	requiring students to think about content in new ways.

		supply the question.	
34	Friendly Feud	provide multiple correct answers to a prompt question.	helping students to understand that there can be multiple answers to a question and that those answers can be more or less correct.
35	Team Games Tournaments	work in heterogeneous teams to learn content and compete in homogeneous teams to earn points for the home team.	helping assess student mastery of a specific body of content.

Appendix S: Effort Needed to Implement CoLTs in Online Environments

Effort Needed to Implement CoLTs in the Four Primary Online Environments

Barkley, Elizabeth F.; Major, Claire H.; Cross, K. Patricia. Collaborative Learning Techniques: A Handbook for College Faculty (p. 136). Wiley. Kindle Edition.

	CoLT No.	CoLT Name	LMS	Web Conferencing	Virtual World	Open
Discussion CoLTs	1	Think-Pair-Share	Ease	Effort	Ease	Effort
	2	Round Robin	Enterprise	Effort	Enterprise	Enterprise
	3	Buzz Groups	Ease	Effort	Ease	Effort
	4	Talking Chips	Enterprise	Effort	Enterprise	Effort
	5	Three-Step Interview	Ease	Ease	Ease	Enterprise
	6	Critical Debates	Enterprise	Enterprise	Enterprise	Effort
Reciprocal Teaching CoLTs	7	Note-Taking Pairs	Ease	Effort	Effort	Effort
	8	Learning Cell	Ease	Ease	Ease	Enterprise
	9	Fishbowl	Enterprise	Effort	Ease	Effort
	10	Role Play	Effort	Effort	Ease	Ease
	11	Jigsaw	Ease	Effort	Enterprise	Ease
	12	Test-Taking-Teams	Ease	Effort	Effort	Effort

Problem -Solving CoLTs	13	Think-Aloud Pair Problem-Solving (TAPPs)	Effort	Ease	Enterprise	Effort
	14	Send-A-Problem	Enterprise	Effort	Enterprise	Effort
	15	Case Studies	Ease	Effort	Enterprise	Enterprise
	16	Structured Problem Solving	Ease	Enterprise	Enterprise	Enterprise
	17	Analytic Teams	Ease	Enterprise	Enterprise	Ease
	18	Group Investigation	Ease	Effort	Enterprise	Effort
	19	Affinity Grouping	Effort	Enterprise	Effort	Ease
Graphic Organizer CoLTs	20	Group Grid	Ease	Enterprise	Effort	Effort
	21	Team Matrix	Ease	Enterprise	Effort	Enterprise
	22	Sequence Chains	Enterprise	Enterprise	Effort	Ease
	23	Word Webs	Effort	Enterprise	Effort	Ease

Writing CoLTs	24	Dialogue Journals	Ease	Effort	Effort	Ease
	25	Round Table	Ease	Effort	Enterprise	Ease
	26	Dyadic Essays	Ease	Effort	Effort	Open??
	27	Peer Editing	Ease	Effort	Effort	Effort
	28	Collaborative Writing	Ease	Effort	Effort	Ease
	29	Team Anthologies	Ease	Effort	Effort	Ease
	30	Paper Seminar	Enterprise	Enterprise	Enterprise	Effort
Games CoLTs	31	Team Scavenger Hunt	Ease	Effort	Enterprise	Effort
	32	Quizo	Effort	Enterprise	Enterprise	Effort
	33	Team Jeopardy	Effort	Effort	Enterprise	Effort
	34	Friendly Feud	Effort	Enterprise	Enterprise	Effort
	35	Team Games Tournaments	Enterprise	Enterprise	Effort	Effort