DESIGNING ONLINE COURSES FOR INDIVIDUAL AND COLLABORATIVE LEARNING: A study of a virtual learning environment based in Sri Lanka

Thushani A. Weerasinghe

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Abstract

Online courses of distance learning programmes at universities are designed considering the characteristics and needs of their adult learners. Basically, there are two types of learners in an online course: individual learners and collaborative learners. Designing for learner satisfaction and learning effectiveness for both types of learners is challenging. In fact, previous research has noted that many online courses fail due to poor design. As a solution, researchers have identified instructional design principles that can guide the design of successful online courses. However, these principles lack detailed information to apply them in contexts different from where they had been identified. This consideration raises a question: how does one adapt the existing design principles to design online courses that promote both individual and collaborative learning, particularly in contexts where online courses are supposed to be conducted with minimal teacher support? In the present research, this question is addressed via two sub-research questions: (1) which course components and their design features can promote learners' satisfaction, perceived learning, and learning effectiveness, and (2) which course components and their design features can stimulate inquiry-based learning and peer-teaching? The research was carried out in the field of educational design research with sets of students and instructional designers of a virtual learning environment prepared for a university-level degree programme in Sri Lanka. Referring to the findings of this research, the thesis discusses how to design online courses that promote both individual and collaborative learning. Further, based on the findings, the thesis presents a set of design principles and guidelines to promote both individual and collaborative learning in online courses that are on information technology related subjects and prepared for distance learning programmes.

Keywords: *Design-Based Research, Design Experiments, Online Learning, Instructional Design, Design Principles, Design Guidelines, Individual Learning, Collaborative Learning, Inquiry-Based Learning, Peer-Teaching*

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Abbreviations

ADDIE	Analysis, Design, Development, Implementation, and Evaluation
BIT	Bachelor of Information Technology
CDP	Content Development Process
CoI	Community of Inquiry
EDR	Educational Design Research
ISD	Instructional System Design
LCD	Learner-Centred Design
LMS	Learning Management System
LSI	Learning Style Inventory
LSQ	Learning Style Questionnaire
MCQ	Multiple Choice Question
SME	Subject Matter Expert
UCD	User-Centred Design
UCSC	University of Colombo School of Computing
VLE	Virtual Learning Environment

Part 1

1 Introduction

Educational programmes in university departments embrace e-learning as a medium of delivering learning content, or at least as a means of a facility enabling learners to interact with each other through a network system. This is often prominent in distance learning programmes, where learners are isolated from each other and their teachers. Applications of e-learning can bring about significant benefits to teaching and learning processes in distance educational programmes (Zhang, Zhao, Zhou, and Nunamaker Jr, 2004). These benefits are associated with accessibility to updated learning materials, opportunity for students to interact with course-mates and teachers and transparency of students' learning activities, and assessment information irrespective of time, location, and pace. Nevertheless, many e-learning courses fail (Woodill, 2004). One of the most significant reasons for such failures has been associated with poor instructional design (Horton, 2011; Penna, Stara, and De Rose, 2009) — the art and science of designing e-learning material and the environment to provide persistent learning until the students achieve their learning objectives (Baran and Keles, 2011; Seimens, 2002). This implies that instructional design of an online course can influence its students' learning, and thereby the achievement of course outcomes. An online course is composed of different types of components such as interactive lessons, activities, assessments, and discussion forums. The design of course components is guided by instructional design principles. In order to promote students' learning and achieving course outcomes, educational departments interested in e-learning should consider how to design online course components using appropriate instructional design principles.

In order to understand how to design components of an online course to promote learning, researchers have studied how to design for learner satisfaction (e.g. Ecom, Wen, and Ashill, 2006; Swan, Shea, Fredericksen, Pickett, and William, 2000) and learning effectiveness (e.g. Balacheff, 2000; Swan, 2003) or students' perceived learning (e.g. Lupo and Erlich, 2001; Rovai and Barnum, 2003). Learner satisfaction with an online course is the measurement of students' positive attitudes and learning experience of studying in the online course. Learning effectiveness is the measurement of how well students of an online course can achieve their learning objectives, or in other words, how well they can score at the examinations by using only the online course and its components for their studies. Learners' perceived

learning can be defined as the extent to which the learners have achieved their learning expectations or how much they learned based on their own perception. According to the empirical findings related to at least one of the three measurements — learner satisfaction, learning effectiveness, and students' perceived learning — the success of an online course mainly depends on the extent to which that environment supports student interactions (e.g. Sims, Dobbs, and Hand, 2002; Swan, 2003).

Interactions in online courses are considered vital for deep and meaningful learning (Garrison and Anderson, 2003). There are three main types of interactions: student-content, student-student, and student-teacher. Student-content interaction can be considered as a fundamental expectation of any distance educational programme (Moore, 1989). Besides, technology can bring about potential benefits to the value and the quality of student-content interactions (Woods, Jr., and Baker, 2004). Student-content and student-teacher interactions can stimulate individual learning — the style of learning preferred by individual students who think that they can best learn when they are alone (Vaseghi, Ramezani, and Gholami, 2012). On the other hand, students who are discussion oriented and prefer collaborative learning activities, group work, and social interactions are called collaborative learners (Sadler-Smith and Riding, 1999). Their style of learning can be called collaborative learning. Collaborative learning can be mediated through asynchronous or synchronous communication platforms such as forums or chats, respectively.

Compared to synchronous communication platforms, asynchronous communication platforms are more suitable for designing learning activities with discussions for long-time durations. However, the design of each learning activity should aim at supporting students to achieve the intended learning objectives, and thereby the course outcomes. More specifically, instructional design of the course components should motivate learners to engage in individual and collaborative learning in order to help them achieve course outcomes. For this purpose, designers of online courses should be able to design course components to support both collaborative and individual learning, and they should know what course components and design features can promote collaborative and individual learning.

According to Reeves, Herrington, and Oliver (2004), there is an urgent need for educational design research (EDR) to prepare appropriate guidelines to design instructions and thereby enhance students' learning specifically in collaborative online courses. Furthermore, in order to enhance students' individual learning, existing design principles should be adapted and made more applicable to the cultural background of students (Wang and Reeves, 2007). Considering the above requirement, while finding solutions to the research questions, this thesis attempts also to formulate and improve a set of instructional design guidelines to design online courses in distance educational programmes for individual and collaborative learning. The

guidelines have been prepared based on empirical studies conducted with four online courses aimed to facilitate students following the Bachelor of Information Technology (BIT) degree programme at the University of Colombo School of Computing (UCSC), Sri Lanka.

1.1　Context

The BIT degree programme was started in 2000. From its inception, the BIT undergraduates have not been receiving any face-to-face teaching from the UCSC. The UCSC provides the syllabi, past examination papers, and the examination schedule through http://www.bit.lk. The students meet the UCSC staff only at registration with the programme, the examinations, and awarding ceremonies. As a result, there was a high dropout rate at the beginning, especially among the first-year BIT students (Wikramanayake, Hewagamage, Gamage, and Weerasinghe, 2007). In 2003, the UCSC introduced a learning management system (LMS) for the BIT students through which the students could work in groups to do their assignments, discuss with other students, and evaluate their learning achievements using quizzes. However, in an evaluation of the online learning environment, the UCSC found that the students did not work collaboratively to do their learning activities, and as a whole the students had a negative impression about the LMS. The main reason for this failure was poor learning content — PowerPoint slides of the teachers and irrelevant proprietary online learning content for learning mathematics — and poor constructive alignment of syllabi, the learning resources, and the final examinations (Wikramanayake et al., 2007). Therefore, firstly, the curriculum of the BIT programme was revised by reconsidering the assessment procedures and aligning them with the course outcomes, the learning objectives, and the content (Hewagamage, Wickramanayake, Weerasinghe, and Mozelius, 2007). Secondly, the e-Learning Centre of the UCSC introduced a virtual learning environment (VLE) with online learning environments for all the courses of the BIT degree programme in a new LMS implemented on the Moodle platform (http://moodle.org/).

1.1.1　Online courses

Online courses of the BIT degree programme were designed, developed, and delivered by a team of instructional designers and content developers at the e-Learning Centre of the UCSC. The content developers developed design components such as simulations, animations, graphics, and scripts to handle learner interactions. The instructional designers designed and developed courses with the help of the content developers. In addition, they worked as facilitators of the online courses that they developed.

Each course was coordinated by a course coordinator who was responsible for providing subject content/material for designing online learning content. A course coordinator is a subject matter expert (SME) who has a thorough knowledge and understanding of the course content. However, when a course coordinator found it difficult to provide all the content required for designing the online course, he could select one or more extra SMEs for the course. In such instances, the responsibility for providing subject material was distributed among the SMEs, including the coordinator of the course. The instructional designers worked closely with the respective SMEs during the content development process (CDP). Once a course was deployed, the SMEs of the course were considered as teachers of the course.

When starting a course, the students were welcomed to the course by a facilitator. The facilitator was not a SME but was well acquainted with the course environment and the content. The key role of the facilitator was to support students to find solutions to the course-related problems that the students might encounter during the course period. The facilitator communicated with the students mainly by using discussion forums. When there were student inquiries which could not be answered alone, the facilitator could seek help from the respective SMEs. The students were supposed to follow a set of netiquettes when communicating through the BIT VLE (http://vle.bit.lk).

An online course was composed of different types of course components. They are as follows.

Interactive learning content – presentation or guided instructional material with learner controls such as buttons and menus.

Activities – forum-based activities and animated activities with automatic feedback and hints.

Discussion forums – forums prepared for the students to interact with their peers and facilitators to solve their problems related to the courses. There was a discussion forum at the end of each course section.

Student manuals – notes prepared by the SMEs. Instructional designers used these notes to prepare interactive learning content and activities.

Student notes – mostly the text content (notes) provided by the SMEs. They were copies of respective pages of the student manuals

Quizzes – practice quizzes and assignment quizzes. Practice quizzes could be attempted any number of times, but assignment quizzes could be taken only three times. Practice quizzes did not report marks. They provided feedback and hints to find the correct answers. There was a practice quiz at the end of each section of a course. A course had only two assignments. The first assignment was given at the end of the first half of the course content and the second was given at the end of the course.

Students' learning achievements in a course were evaluated via assignment quizzes and the semester-end (course-end) examinations. They consisted of multiple choice questions (MCQs). While an assignment quiz contained 10 MCQs, the semester-end examination consisted of 40–50 MCQs (see http://vle.bit.lk/mod/page/view.php?id=1291).

1.1.2 Content development process and design principles

Content of the online courses were developed according to a CDP described in Paper I (see Part 2 of this thesis). Learning content analysis and design steps on this process describe how to define learning objectives, structure, and design the learning content according to a set of instructional design principles.

The instructional design principles were identified based on the previous experience of the UCSC in designing online courses and teaching for several years using VLEs. The principles were composed of a basic set of guides describing how to design multimedia elements and learning objects incorporating different instructional strategies. However, these principles did not include detailed information required for instructional designers to design instructional media elements, and there were no specific guidelines to design activities, in particular to design collaborative learning activities. Consequently, there was inconsistency in the design of the learning content, especially when there was more than one instructional designer responsible for designing the content of a course. In addition, student participation in forum discussions was found to be at a lower level than what the UCSC expected. Therefore, the UCSC was in need of an improved set of instructional design principles and guidelines to support its instructional designers.

1.2 Research questions

Considering the individual characteristics of adult learners (e.g. Cercone, 2008; Merriam, Caffarella, and Baumgartner, 2007) and the importance of collaborative learning (e.g. Hiltz, Coppola, Rotter, Toroff, and Benbunan-Fich, 2000; Klemm, 2005), researchers have proposed design principles that can promote learners to actively engage in individual (e.g. Gagne, Wager, Golas, and Keller, 2005; Merrill, 2002) and collaborative learning (e.g. Gunawardena, 1998; Hall, 2007; Levin-Peled, Kali, and Dori, 2007). However, the design principles are general and lack detailed information of how they can be implemented in contexts other than from where they had been identified (Zhang, 2007). Therefore, it is not clear whether prevailing design principles are sufficient or whether they can guide to promote individual and collaborative learning in online courses in the context of the

BIT degree programme, where there is minimal teacher support. This necessitates adapting the design principles to make them more suitable for designing the online courses in the BIT degree programme. Considering this necessity, a study was carried out to determine:

How do the design principles need to be adapted to design online courses for the BIT VLE to promote both individual and collaborative learning?

The BIT online courses are composed of different types of components, such as interactive lessons, student notes, activities, forums, and assessments. Effectiveness of these components for promoting learning can be evaluated with respect to parameters such as learners' satisfaction (e.g. Levy, 2007; Packham, Jones, Miller, and Thomas, 2004), perceived learning (e.g. Lupo and Elrich 2001; Swan et al., 2000), and learning effectiveness (Michele, 1997). Higher levels of learner satisfaction, perceived learning, or learning effectiveness can be achieved by designing course components with appropriate instructional design methodology (Rovai and Barnum, 2003). Therefore, in order to answer the above question, we need to know in a BIT online course environment:

1. Which course components and their design features can promote learners' satisfaction, perceived learning, and learning effectiveness?

While individual learning can take place using any course component, collaborative learning can take place using only the components such as forums and chats that can mediate and facilitate collaboration in the VLE. Among collaborative learning activities that can be practised via forum discussions, inquiry-based learning activities are considered best for enhancing learning in higher educational contexts (Duch, Groh, and Allen, 2001). In a collaborative learning environment where teacher interactions are kept at a minimum level, the student interactions can be facilitated via peers' instructions. For this purpose, online course designers for the BIT VLE should know how to design inquiry-based learning activities and obtain peer-teaching support. This consideration raises one more question:

2. Which course components and their design features can stimulate inquiry-based learning and peer-teaching?

Finding solutions to the above questions can shed light on what course components having what particular design features should be designed to support individual and collaborative learners in the BIT online courses. However, the answers do not provide adequate guidance for the instructional designers to design online courses. Therefore, this thesis further attempts to present sets of adapted instructional design guidelines based on the answers to the above two questions. It describes how to design online courses with

minimal teacher support to promote both individual and collaborative learning. The sets of instructional design guidelines will be best applicable for designing online courses in the BIT programme and can be applied for designing online courses for novice online learners following university degree-level distance learning programmes related to information technology.

1.3   Research field and approach

The research studies which are conducted with the primary objective of promoting learning by studying students' and teachers' activities in a learning environment and how they can contribute to the improvement of student learning performance fall within the research field called learning science (Sawyer, 2006, p. 10). According to Bransford et al. (2006, p.19), "designs for formal learning and beyond" is one of the main areas in learning science.

   The software design for learning is carried out to meet the learners' goals and needs. This approach to design software for the purpose of learning is called learner-centred design (LCD). It differs from user-centred design (UCD) as it considers critical issues related to the nature of learning and the characteristics of learners which go beyond software usability (Quintana, Shin, Norris, and Soloway, 2006). For example, in UCD the software designers assume that users have knowledge about the tasks that they need to perform with the software and they simply need usable software to do those tasks. Also, it expects that the users are motivated to do their activities using the software. In contrast, learners have an incomplete understanding of the learning activities which they are to complete, and they are not always motivated to learn using the learning content. Additionally, e-learning content is designed for learners to achieve certain knowledge, skills, or attitudes, and the material should be designed to make it appropriately respond to the changes in the learners' learning behaviour.

   My research work focuses on designing online course environments to promote both individual and collaborative learning, and it falls within a research field in learning science called 'educational design research' (EDR) (Van den Akker, Gravemeijer, McKenney, and Nieveen, 2006). It is also called design experiments, design-based research, development research, formative research, or simply design research (McKenney and Reeves, 2014; Reeves, McKenney, and Herrington, 2011). EDR is a 'use-inspired basic research' which is neither pure basic nor applied research but aims at solving real problems while constructing design principles which can inform future decisions (Reeves, 2000). In EDR, evaluations of new learning environments are conducted under their natural conditions in 'real-world settings' (Wang and Hannafin, 2005), and they can incorporate formative and summative

evaluations of learners' skills and knowledge demonstrated over time (Brown, 1992). Researchers involved in these studies design their learning environments using design principles which may not be detailed enough to determine every design decision (Edelson, 2002). According to Edelson (2002), this field of research is "a paradigm which treats design as a strategy for developing and refining theories" (p. 1).

By referring to Brown (1992) and Collins (1992), Reeves (2000) reports three "critical characteristics of EDR:

Addressing complex problems in real context in collaboration with practitioners,
Integrating known and hypothetical design principles with technological affordance to render plausible solutions to these complex problems and
Conducting rigorous and reflective inquiry to test and refine innovative learning environments as well as to define new design principles" (pp. 8–9).

These characteristics are listed in an order which can direct a design experiment, and the present research has followed them as an approach to conduct the study. In this regard, a complex problem in a real context was addressed. A solution for the problem needed to be found out by conducting an empirical study with a VLE. Providing a framework or a set of guidelines for instructional designers to do their work effectively and productively was the main need to be fulfilled.

1.4   Methods and techniques

The study methods include conducting surveys, interviews, examinations, and analyses of students' discussions in online courses. Surveys and interviews were conducted mainly to gather data related to student learning needs, experiences, styles, preferences, and attitudes towards the online course environments. Interviews were conducted in focus groups and debriefings using techniques such as brainstorming and learning activity co-design. Survey data were gathered using questionnaires. Students' learning styles were identified using the learning style questionnaire (LSQ) of Honey and Mumford (Honey, 2007). The rest of the questionnaires were appropriately prepared for the purpose of the data collections and considering the cultural settings of the students. Examination questions were prepared according to the same quality standard of the semester-end examination questions.

In order to analyse online discussions, a suitable analytical model had to be selected. Researchers use different models to analyse online discussions to understand students learning processes (e.g. Fahy, Crawford, Ally,

Cookson, Keller, and Prosser, 2000; Garrison, Anderson, and Archer 2000; Henri, 1992). Among these analytical models, the Community of Inquiry (CoI) model is known to be widely used and continuously improved (Buraphadeja and Dawson, 2008). Therefore, CoI model was selected to use in the present study. Further the model was adapted to make it more suitable to analyse discussions in the online courses of the BIT programme. The adapted model was evaluated to determine its reliability to analyse online discussions in the BIT courses.

The discussion content in the four online courses prepared for the first semester of the BIT programme was analysed using the adapted CoI model (see Papers V and VI for more information). The results were further analysed, and based on the findings, the thesis discusses how components of an online course can be designed to promote individual and collaborative learning. Sets of design guidelines were also prepared based on existing instructional design principles and with the implications of the findings of the study.

1.5   Delimitations

The present research is based on the area of EDR and deals only with issues related to instructional design. Therefore, the research did not consider issues related to LMS enhancements, which could be handled specifically by software engineers or system developers.

The data gatherings related to online discussions were carried out considering only forum-based discussions, assuming that the students had not used the private messaging facility in the VLE, which was found to be blocked for the students for some time. Also, the study research did not examine the students' learning processes outside the VLE.

The study was conducted with groups of students following the BIT degree programme at the UCSC, Sri Lanka. The online courses for this degree programme were designed and developed considering the requirements and learning preferences of adult students following the BIT programme in Sri Lanka. Therefore, the outcomes of this research are best applicable on future designs and developments of online courses aiming to support adult learners in Sri Lanka and possibly in other Asian contexts.

1.6   Outline of the thesis

This doctoral thesis is based on six journal papers. The first paper (Paper I) describes a CDP which can be used to develop online course content for distance learning programmes. The second, third, and the fourth papers (Papers II, III, and IV) report the findings of an empirical study conducted

with four online courses of which the course contents were developed according to the CDP described in Paper I. The remaining paper describes another empirical study and presents a set of design principles and guidelines supporting design of inquiry-based learning and peer-teaching activities.

The thesis contains two main parts: Part 1 and Part 2.

1.6.1   Part 1

Part 1 refers to the work reported in the papers attached to Part 2 and provides an introduction to the thesis, raises the research questions, presents background information and methodology, reports results, presents sets of design principles and guidelines based on the results, provides a discussion, and presents future plans. This part includes six chapters.

Chapter 1 introduces the thesis by describing the considerations associated with designing for individual and collaborative learning. The chapter presents the research problems and describes the context of the study, the research field and approach, and the outline of the thesis.

Chapter 2 presents the theoretical background of the research and information related to instructional design theories and existing design principles that inspired the research. Moreover, it provides a review of the literature on online discussion-content analysis. The purpose of this review is to establish a comprehensive understanding of online discussion-content analytical process which will support comprehension of the analytical model that was improved and used in the research presented in this thesis. The model was used to analyse discussion threads selected from four online courses. Further, information regarding these analyses is reported in Chapter 3.

Chapter 3 is the methodology chapter of the thesis. It describes the research design, methods, and procedures that were employed to conduct the research. The nature of subjects, collection of data, and analytical procedures are explained in detail.

Chapters 4–8: Chapter 4 presents the outcomes of the research. Outcomes are reported with respect to six research papers. The discussion of these outcomes by relating them to the findings of similar studies is presented in Chapter 5. Chapter 6 reports the limitations of the research, and Chapter 7 includes the conclusion of the research. Subsequently, recommendations based on the current research and plans for future research work are discussed in Chapter 8.

1.6.2   Part 2

Part 2 presents in detail the research discussed in Part 1 of this thesis. Part 2 is composed of six journal papers.

Paper I

Weerasinghe, T. A., Nishakumari, K. M. G. B., & Hewagamage, K. P. (2007). Gap between theory and practice: Human factors in designing and developing effective e-learning materials for a structured syllabus. *International Journal of the Computer and the Internet and Management (IJCIM), 15*(SP3), 19.1-6.

Paper I describes an instructional CDP which was used to develop learning content of the online courses discussed in this thesis. It provides background information on how the learning content development activities of the online courses are carried out and how the challenges during the development process are overcome.

Even though this paper does not provide a direct answer to a specific research question of this thesis, it helps to understand the context of the study.

My contribution to this paper was the review of the literature, preparing the process diagrams, and leading the writing process.

Paper II

Weerasinghe, T., Ramberg, R., & Hewagamage, K. (2008). Learners' satisfaction, learning style preferences and effective use of an OLE. *International Journal of Emerging Technologies in Learning (iJET), 3(SP3)*, 77-85.

This paper discusses the success of an online course with respect to its students' satisfaction and learning effectiveness. The course was developed according to the CDP described in Paper I. This paper is an extended version of a conference paper published and presented at an international conference, and it reports more findings related to students' learning style preferences.

The paper provides a partial answer to the first research question of this thesis by evaluating an online course module and reporting to what extent the students were satisfied and could effectively learn in an online course in the BIT VLE.

I worked as the course coordinator and the main instructional designer of the course module evaluated in this paper. In addition, I contributed to 75% of this paper in the preparation of the required data-collecting and students' learning achievement evaluation instruments (one out of the four instruments was bought), conducting research, analysing data, and leading the writing process of the paper.

Paper III

Weerasinghe, T. A., Ramberg, R., & Hewagamage, K. P. (2009). Designing online learning environments for distance learning. *International Journal of Instructional Technology and Distance Learning*, *6*(3), 21-42.

Paper III discusses the students' experiences and attitudes toward the design of an online course environment of which the evaluation results were

discussed in Paper II. Moreover, it presents sets of instructional design guidelines for the instructional designers designing online learning content for novice online learners following distance learning programmes on computer applications and information technology. The first research question of this thesis is answered referring to the findings reported in Papers II and III.

My contribution to this paper was in designing and developing online course content, reviewing related work, 75% of preparing data-collecting instruments (one out of the four instruments was bought), analysis of data, and leading the writing process.

Paper IV

Weerasinghe, T. A., Hewagamage, H., & Ramberg, R. (2012). Re-evaluation of community of inquiry model with its metacognitive presence construct. *International Journal on Advances in ICT for Emerging Regions, 5*(4), 1-13.

This paper reports about improvements done to an online discussion-content analytical model and the evaluation of the adapted model. The improved model was more suitable for identifying social, cognitive, teaching, and metacognitive presences in inquiry-based discussions in the online courses of the BIT programme. Therefore, it was used to analyse the discussion-content of the online courses discussed in Papers V and VI of this thesis, and the findings of the analysis helped to answer the second research question.

I reviewed the literature to find a suitable analytical model to analyse inquiry-based online discussions to understand students' learning processes during online discussions, conducted an evaluation with two coders, and gradually improved the model. Next, I analysed the data and led the writing process of the paper.

Paper V

Weerasinghe, T. A., Ramberg, R., & Hewagamage, K. P. (2012). Inquiry-based learning with or without facilitator interactions. *The Journal of Distance Education/Revue de l'Éducation à Distance, 26*(2) (http://www.ijede.ca/index.php/jde/article/view/779).

Paper V examines students' learning processes in a sample of online discussions selected from four online courses. The paper describes how students solve their problems related to the subject matter of the courses when they do and do not receive teacher support. The discussions were done based on the findings of the discussion-content analysis conducted using the adapted analytical model described in Paper IV. The findings of the analysis contributed to answering the second research question in this thesis.

My contribution to this paper was the review of related work, 95% of discussion-content analysis, and leading the writing process.

Paper VI

Weerasinghe, T. A., Ramberg, R., & Hewagamage, K. P. (2014). Student-led inquiry-based learning. *International Journal of Education and Information Technologies, 8*, 265-275.

This paper reports about a design workshop conducted to determine what instructional strategy would be appropriate to promote student-student interactions. Based on the findings of the workshop and the online discussion-content analysis, the paper discusses how to design a learning activity to promote peer-teaching in a distance learning course. The findings of Papers V and VI helped answer the second research question of this thesis.

The online design-workshop and 95% of the data analysis were conducted by me. Additionally, I reviewed the related work and led the writing process of the paper.

2 Background

The first online learning programmes emerged towards the end of 1960s to early 1970s, and the use of online learning for distance educational programmes became popular in 1990's (Williamson, 2009). Today, using online courses for delivering distance learning programmes has become a common practice at higher educational and vocational training institutes. An online course environment provides opportunities for the students to learn by interacting with the learning materials, peers, and teachers, and to evaluate their learning achievements.

2.1   Instructional methods and design

Since the emergence of computer-mediated communication systems, a vast amount of research has been conducted examining the learning opportunities associated with online course environments and how these environments can be designed to facilitate learning (e.g. Gilbert and Dabbagh, 2005; Sadik and Reisman, 2009). The research carried out for this purpose falls in the research area called 'Learning Science'. The literature in this research area that reports on how effective e-learning should be designed often points to three instructional methods: student-centred learning, scenario-based learning, and problem-based learning (McLaren, 2009). Each of these methods has a potential to enhance individual and collaborative learning. Learning environments or their components designed to support each of these instructional methods can be discussed with respect to 'student-centred learning design', 'scenario-based or problem-based learning designs'.

Scenario-based learning design provides tasks in scenarios and offers opportunities for learners to try out and learn with experience. These activities can be designed based on a story, a role play, or a simulation. Like scenario-based learning design, problem-based learning design often aims at providing learners with authentic problems in a structure (McLaren, 2009), and practices of both approaches usually proceed with learner interactions and facilitation. Problem-based learning is driven by students' attempts to solve problems usually provided by a teacher (Barrows and Tamblyn, 1980). Students in problem-based learning environments are supposed to find relevant information to solve the problems. This approach to learning is considered as a subset of inquiry-based learning (Spronken-Smith and

Walker, 2010), which is grounded in the educational philosophy of John Dewey (Savery, 2006). Dewey presumed that learning is collaboratively constructed and that individuals can effectively learn through inquiry processes (Duffy and Raymer, 2010). This concept has inspired the framework of the CoI that describes critical elements in an educational experience from inquiry-based learning using online communications media (Garrison, Anderson, and Archer, 2010).

Problem-based learning activities can be designed to be consistent with scenario-based learning design principles. For instance, problems can be provided in scenarios encouraging more learner engagement and reflective thinking (Brunt, 2005). Also, problem-based or scenario-based learning design can be enriched by embracing LCD principles (Vat, 2000). Therefore, even though the main instructional method of the learning environment studied in the research reported on in this thesis is LCD, problem-based and scenario-based instructional methods were also used to design learning content depending on the respective subject content and the learning objectives.

The main focus of student-centred learning design is on the needs of the learner, and it encourages active learning. There are six major principles of student-centred learning (McLean and Gibbs, 2010, referring to Brandes and Ginnes, 1986) which describe the nature of the student and the role of the teacher in a student-centred learning setting. They are "1. The learner takes full responsibility for his/her learning. 2. Involvement and participation by the student are necessary for learning. 3. The relationship between learners is more equal, promoting growth and development. 4. The teacher becomes a facilitator and resource person. 5. The learner experiences confluence in his/her education (i.e. affective and cognitive domains are integrated). 6. The learner sees himself/herself differently as a result of the learning experience (i.e. develops a higher conception of learning)" (p. 226). According to these principles, student-centred learning expects learners to be more autonomous and construct knowledge through experience under the supervision of a teacher.

Moreover, according to the principles reported by the learner-centred principles workgroup of the American Psychological Association's Board of Educational Affairs (American Psychological Association, 1997), "Learning is most effective when differential development within and across physical, intellectual, emotional, and social domains is taken into account" and "learning can be enhanced when the learner has an opportunity to interact and to collaborate with others on instructional tasks" (p. 5). These principles signify that student-centred learning environments should best be designed considering social factors, and more specifically to support students to construct knowledge collaboratively. Further, students' learning in these environments can be discussed relating to constructivist and social-constructivist learning theories (O'Neill and McMahon, 2005).

However, designing for student-centred learning is considered challenging because of the difficulties pertaining to how students should be encouraged and supported to be self-directed and responsible for their own learning (Allen, Crosky, McAlpine, Hoffman, and Munroe, 2006). Also, it is challenging to design online learning activities which satisfy the learning needs and preferences of different types of learners. As a solution, online learning courses can be designed to accommodate different learning styles (Demirbas and Demirkan, 2003; Morrison, Ross, Kemp, and Kalman, 2010), and learners should be involved in the design process of the course components to make them usable, accessible, and effective for learners' knowledge construction (Penna and Stara, 2007). Furthermore, in order to overcome failures in e-learning and to achieve expected results, learning environments should be designed to support learners to accomplish their learning objectives by engaging in learning activities (Quintana et al., 2006).

2.2   Designing for individual and collaborative online learning

Students can have different learning preferences and styles. While learning styles describe how an individual can learn most efficiently, learning preferences reveal the individual's preferred mode of learning. Some prefer to study alone in online courses, while others prefer to study in groups collaboratively with other colleagues. Findings of a study by Kirschner, Paas, Kirschner, and Janssen (2011) emphasise the importance of designing online courses for both individual and collaborative learning since each has its own benefits for the learners having different learning preferences. In other words, designing for both individual and collaborative learning will create more opportunities for learners to carry on their studies in their preferred mode of learning. Also, the environment should support learners to achieve learning objectives, and thereby course outcomes.

Designing for individual learning necessitates considering students' preferred learning styles in compliance with the idea that learners have their own styles of learning (Dede, 2005; Smith and Dalton, 2005) and that they can best learn when they study according to their styles (Palloff and Pratt, 2003). Researchers have categorised learning styles or learners by examining learning in different perspectives, and they have prepared models or tools to determine learning style preferences. For example, the Myer-Brigg's type indicator assesses psychological preferences and classifies learners into four categories: extroverts/introverts, sensors/intuitors, thinkers/feelers, and judgers/perceivers. Kolb's learning style inventory (LSI) describes learners based on their preferred approach of experiential learning. The inventory identifies four learning styles: accommodating, assimilating, converging, and

diverging. Subsequently, Peter and Mumford adapted Kolb's model and developed the learning style questionnaire (LSQ) to identify learning style preferences. The tool can categorise learners into four groups: activists, theorists, reflectors, and pragmatists. The LSQ has become very popular among its practitioners (Race, 2013), and it is more reliable than Kolb's LSI (Allinson and Hayes, 1988). This tool was decided to be used in the study reported in this thesis. How the tool was used is further elaborated in the methodology chapter.

Other than students' learning styles, characteristics and needs of adult learners should also be considered when designing online course environments for individual learning (Cercone, 2008). Thus, this thesis considers adult learners' needs and characteristics referring to the concepts of andragogy (Merriam, Caffarella, and Baumgartner, 2007), which is an important theory of adult learning. According to andragogy, an adult learner is more independent and self-directed, has previously acquired knowledge, has socially dependent learning-needs, is problem-centred and interested in practical application of knowledge, and is intrinsically motivated for learning.

There is a dramatic rate of increase in the number of adult learners selecting distance educational programmes (Gunawardena and McIssac, 2008; Levine and Sun, 2002). The main reasons for this tendency seem to be the opportunity that the learners get in distance learning programmes to find time for their other commitments during the course period (Hannay and Newvine, 2006), greater control that the students can have over their studies (Hastings, 2000), or presumably there is more opportunity to interact with the teacher (Kubo, nd). Since most distance learning programmes are delivered through online course environments and the main reason for students' selecting distance learning courses is associated with time issues, online courses tend to adapt asynchronous communication modes to facilitate students' learning (Hrastinski, 2008).

Asynchronous communication platforms allow students to continue their discussions whenever they want without being restricted to pre-scheduled online meetings. Therefore, students in asynchronous discussion environments can engage in discussions over a long period of time and use the opportunity for reflection and inferential reasoning, which inculcate cognitive and metacognitive activities (Arend, 2009; Veenman, 2012). Further, such learning environments with collaborative learning activities scheduled for a long period of time allow students to get to know each other well and can enable learners to build and nurture online learning communities (Yeh, 2010).

Additionally, a collaborative learning approach is best applicable to online courses aiming at higher order learning outcomes (Kirschner et al., 2011) that encompass knowledge and skills which are difficult to acquire by learning individually (Strijbos, Kirschner, and Martens, 2004). Learner-

learner interaction is the driving factor of collaborative learning. In collaborative learning, learners get an opportunity to present their ideas, decisively read, analyse, judge, and evaluate others' posts, and tend to write replies with comments, arguments, and appreciations. This learning process requires higher order learning and thinking skills, particularly self-directed learning and critical thinking skills (Garrison and Cleveland-Innes, 2005). These skills are considered essential for adult learners learning at a distance (Muirhead, 2005). Therefore, designers of online courses pursue methods of encouraging and sustaining learner-learner interactions for collaborative learning.

In order to support learners to achieve learning outcomes, the course design should amalgamate and enliven the instructional approach of an online course, which by nature should be constructivist and learner-centred. McLaren (2009) presumes that effective learning environments or courses can be obtained "only through the systematic blending of appropriate learning theories, instructional design theories and instructional design practices" (p. 243). Instructional design principles or guidelines are prepared based on learning theories, instructional design theories, and implications from design practices. Therefore, any contribution to the development or enhancement of guidelines or principles for designing online instructions would clearly and directly be beneficial to the design of online courses. The courses discussed in this thesis were designed following basic sets of design principles, and the sets of design principles were gradually improved and design guidelines were formulated based on the results of the evaluation studies of the online courses and their components.

2.3   Instructional design principles and guidelines

Instructional design principles are mainly derived from learning theories. Detailed information about instructional design principles, including on instructional methods and when the methods should and should not be used, are further elaborated in the respective instructional design theories. Whereas learning theories describe how learning occurs, instructional design theories, in particular the principles, provide guidance on what should be designed and why it should be designed in that way (Reigeluth, 2009). The design principles should be comprehensible and practicable for guiding instructional designers in designing online course environments that can provide multiple opportunities for students to learn collaboratively or individually and successfully engage students in learning processes (Koszalka and Ganesan, 2004). However, design principles lack information related to factors such as task, context, and technology. On the other hand, instructional design guidelines are more specific. They are context-dependent, and can be technology and task-dependent as well (Zhang, 2007).

The instructional design guidelines should be prepared based on research findings on an educational context, assuring that they can support designing instructionally sound online courses (Fabry, 2009) in that particular educational context and similar educational contexts. Accordingly, this thesis discusses improvements employed to a set of instructional design guidelines that was used by the instructional designers at the UCSC. The improvements are primarily inspired by two sets of design principles: 'Gagne's nine events of instructions' and 'Merrill's first principles of instruction'. They have been widely used and appreciated for their usefulness in designing learning environments; for instance, whereas Driscoll (2005) reports that Gagne's theory is widely used by the instructional designers in designing instructions, Cropper, Bentley, and Schroder (2009) report that award-winning courses tend to use Merrill's nine events of instructions.

2.3.1 Gagne's nine events of instruction

Gagne identified different mental processes corresponding to nine different instructional events (Kruse, 2010). The events are inspired by behavioural and cognitive theories of learning (Mergel, 1998). They are used as guides or principles leading to effective design of learning environments, and are as follows: (1) Gain attention, (2) Inform the learners of the lesson objectives, (3) Stimulate recall of prior learning (prerequisite learned capabilities), (4) Present the content (stimuli with distinctive features), (5) Provide learning guidance, (6) Elicit performance, (7) Provide feedback, (8) Assess performance, and (9) Enhance retention and transfer (Gagne et al., 2005).

The above events imply the importance of having pre-defined learning objectives, structuring learning content, constructively aligning learning content with learning objectives, providing guidance for activities and feedback, designing evaluations to measure learning achievements, and adopting strategies to enhance transfer and retention of what is learned. Even though this set of design principles is widely used and appreciated by instructional designers of different types of learning environments, according to Driscoll (2005) the guidelines may not be supportive for designing constructivist learning environments. However, Merrill's instructional design theory and the principles (Merrill, 1992) incorporate constructivist learning theories (Karagiorgi and Symeou, 2005). Therefore, Merrill's set of design principles was chosen to be used along with Gagne's design principles to overcome the deficiencies of Gagne's instructional design principles.

2.3.2 Merrill's first principles of instruction

Merrill's first principles of instruction are supported by the perspectives of the three main types of learning theories: behavioural, cognitive, and constructivist (Morrison et al., 2010). Furthermore, they are "consistent with empirical research on instruction" (Merrill, 2007, p. 14). Merrill (1992) states that "different learning outcomes require different types of mental models" — "organized and elaborated cognitive structures" (p. 100). Moreover, he presumes that instructions can be provided to facilitate construction of mental models enabling learners to engage in complex learning activities. In line with this assumption, and agreeing with various instructional design theories and models, Merrill (2002) prescribes that learning is promoted when learners (1) engage in a task-centred instructional strategy, (2) observe a demonstration, (3) apply new knowledge, (4) activate prior knowledge or experience, and (5) integrate their new knowledge into their everyday world. These five basic prescriptions to promote effective, efficient, and engaging learning are named 'first principles of instruction' (Merrill, 2009).

While the first item on the list defines a problem-centred learning context, the other items represent four phases of effective instruction — activation, demonstration, application, and integration — that are applicable in any kind of instructional setting (Merrill, 2002). Therefore, they are useful for designing instructions in any type of learning environment irrespective of the employed educational philosophy or learning theory (Cropper et al., 2009). Strengthening this opinion, Cropper et al. (2009) report that "Award-winning courses tend to use Merrill's first principles" (p. 1). However, the findings of their research indicate that there is a requirement for further improvement the design principles in order to enhance students' learning experiences, particularly to practice problem-based learning. Also, Gardner (2011) suggests that Merrill's first principles of instruction should be improved by including specific information regarding how they can be used to design real-world problems.

According to Merrill (2007), the first principles of instruction more specifically guide designing learning activities of real-world tasks. Real-world tasks can have more than one correct answer, and it is not easy to check all correct answers automatically. Therefore, in an online learning environment, the first principles may better be used for designing collaborative learning activities or activities that requires peers' feedback.

However, the first principles are not specifically aimed at supporting designing of collaborative learning activities. Therefore, two other basic principles that Kali, Levin-Peled, and Dori (2009) suggested for promoting collaborative online learning in a higher educational context were also considered. They were as follows: (a) engage learners in instruction of their peers and (b) reuse student artefacts as resources for further learning. These

principles were inspired by the perspectives of socio-constructivist learning theory, and researchers have found the principles useful for designing online courses in higher educational contexts (Levin-Peled et al., 2007).

After designing an online course or course components following appropriate design principles and guidelines, an evaluation should be conducted to determine the effectiveness of the course or its components and the design principles. Conversely, having conducted an evaluation to find what sort of course components and their design features can lead students to engage in deep and meaningful learning, the design principles and guidelines can be further improved.

3 Methodology

The research reported on in this thesis falls within EDR. EDR in learning science is a close study of learning in a learning environment. It is conducted in real environments under real settings, and the research "moves beyond descriptive accounts to offer insight" (Barab, 2006, p. 154) about the process applied and the aspects that are theoretically inspired. Accordingly, the research reported on in this thesis mainly studies students' online learning behaviours and attempts to answer questions related to design of an online course to promote students' individual and collaborative learning.

The thesis presents the design of online courses and their components that were developed basically following a CDP described in Paper I. Subsequently, it reports about findings of two data collections. While the findings of the first data collection are reported in Papers II and III, the findings of the second data collection are presented in Papers IV, V, and VI.

3.1 Author's role

The author of this thesis played multiple roles during the research (see Table 3-1). During the first data collection period, the author served as the course coordinator, team leader of the instructional design team/main instructional designer, a content developer, and the main researcher. Even though playing multiple roles created an overload of work for the author of the thesis, it helped to apply her hypothetical design principles in designing the online course environment and its content that best suits the learner requirements. In addition, it helped the author to prepare the tests to evaluate students' learning achievements with questions in the same quality (level of difficulty and format) of the semester-end examination paper.

However, playing multiple roles such as course coordinator and the main researcher might have led to the risk of becoming biased. Therefore, the author had to take several measures to reduce the risk of bias in interpreting results. For instance, the author selected students from different parts of the country, explained the reason behind the data collection to the students, and informed them that the UCSC needed their support to improve the online course environments for the benefit of future BIT students. Further, by ensuring that the students' personal data would not be disclosed to anybody

and would be kept anonymous, the author motivated the students to reveal all the issues related to learning in the online course.

Table 3-1 Author's role during the research

Period	Role	Papers
2007	The team leader of the instructional design team and the main researcher	Paper I
First data collection (2008)	A course coordinator, an instructional designer, a content developer, and the main researcher	Papers II and III
Second data collection (2010–2013)	The main researcher	Papers IV, V, and VI

During the second data collection period, the author mainly played only one role, i.e. the main researcher. During this period, being an observer rather than a facilitator in the online course environments helped the author to interact with the students in a friendlier manner. It created a stress-free atmosphere, which allowed the students to speak freely about their learning experience in the online courses. However, since the author did not have the right to create or edit course activities, she could not implement the designed peer-teaching and inquiry learning activity in the online learning environment.

3.2   Research design

The research was carried out in five major steps. A course was designed adhering to a basic set of instructional design principles practised at the UCSC and was made available to the BIT first-semester students. The first data collection from students took place in the middle of the semester (step 1 in Figure 3-1). Based on the findings of this data collection and the existing design principles discussed in section 2.3, a set of instructional design guidelines was prepared (step 2 in Figure 3-1). The instructional designers were informed of the new set of design guidelines and recommended to use the guidelines and accordingly improve the first semester courses in the BIT programme (step 3 in Figure 3-1).
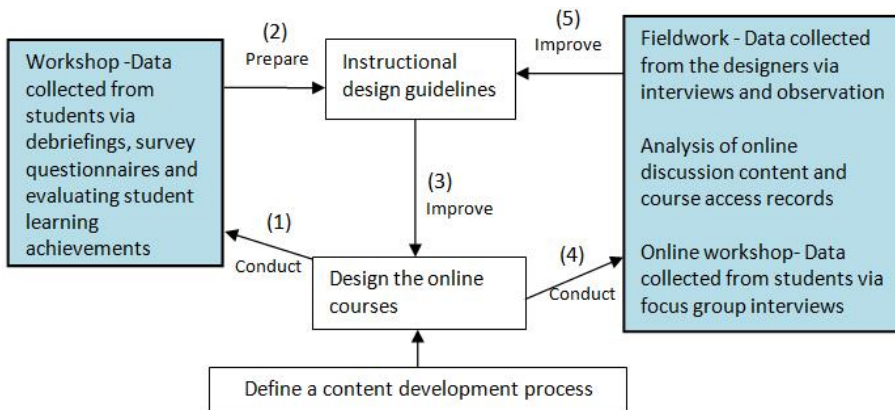
Figure 3-1 Research Design

The second data collection took place to collect data from students and instructional designers at the e-Learning Centre of the UCSC. In addition, forum discussions of the online courses were analysed to determine students' learning processes (step 4 in Figure 3-1). The gathered data were analysed and the findings were used to improve the list of instructional design guidelines (step 5 in Figure 3-1).

3.3 Methods

The question "how the existing design principles need to be adapted to design online courses for the BIT VLE to promote both individual and collaborative learning" was attempted to answer in terms of the meanings that the components of the BIT online courses had for the students and the instructional designers of the courses and by studying how the students actually used the online courses for learning.

Data for the study was collected using both quantitative and qualitative (mixed) methods. In a mixed method, researchers use combinations of strategies, approaches, and methods of both quantitative and qualitative research. This approach helps to provide a better solution to the research problem by overcoming weaknesses associated with individual methods (Johnson and Onwuegbuzie, 2004). Also, the choice of a mixed method approach enables the researcher to best understand the research question by employing strategies of inquiry to collect data either sequentially or simultaneously (Creswell, 2013). Additionally, in a mixed method, researchers can use triangulation to study the same phenomena using a combination of methodologies and yield valid results (Denzin, 2009; Jick, 1979).

In the attempt to answer the first research question of this thesis, quantitative methods were used in order to measure student satisfaction,

perceived learning, and learning effectiveness (details are given in Papers II and III). Furthermore, qualitative methods were employed to explain in detail the results found in the quantitative measures. The researchers who have applied quantitative research methods to study interactions in online courses recommend or at least suggest that future research should be carried out with qualitative research methods to understand the level of reflective thinking and collaborative learning (Balaji and Chakrabarti, 2010) and for a deep analysis of knowledge construction activities in online discussion environments (Arbaugh and Benbunan-Fich, 2007). Accordingly, an answer to the second research question was attempted by qualitatively analysing sets of discussion threads and student interview records (see Papers IV, V, and VI for detailed information). Quantitative methods were employed to present the findings of the discussion-content analyses. Data collected through multiple methods were triangulated in the analysis of data.

3.4 Data gathering techniques

The research was conducted mainly with (1) workshops to collect data from the students, (2) online discussion content and course access records analyses, and (3) a fieldwork consisting of an observation and an interview to collect data from the instructional designers (see Figure 3-1).

3.4.1 Workshops: Collect data from the students

Two workshops were conducted to collect data from the students. The first workshop was held in a physical location at the UCSC. The second workshop was conducted online. Each workshop consisted of three meetings.

During the first workshop, a survey, debriefings, and tests to assess students' learning achievements were conducted. A survey is considered a useful technique for finding information related to human factors such as attitudes, experience, and opinions (Boone, 2004). Therefore, it was selected as an appropriate technique to gather the students' learning experience and attitudes towards the online course. Further, debriefings were conducted in order to gather more details concerning the topics of the survey questionnaires.

At the second workshop, data were gathered mainly through focus group interviews. According to Denzin and Lincoln (2008), a focus group interview is more appropriate for gathering data related to an event or experience shared by interviewees. This technique can provide participants (students) more time for reflection, and thereby allow for the gathering of more data related to learning experience and attitudes. The focus groups to

conduct interviews were identified based on the students' willingness and availability to attend the workshop.

3.4.2 Content analysis: Analyse online discussions

The students in the online courses used discussion forums to discuss their problems related to the course content. A discussion forum can be considered as a "gold mine of information" concerning students' learning strategies, knowledge, and skills (Henri, 1992). Therefore, in order to understand how students actually constructed knowledge by interacting with the course components and their peers, sets of discussion threads in the courses were analysed. The discussion contents were analysed using an adapted version of the CoI model (Shea et al., 2010).

3.4.3 Fieldwork: Collect data from instructional designers

Data from the instructional designers were collected during the second data collection period when the author of this thesis played only the role of the main researcher. Data needed to be collected without disturbing the usual activities of the instructional designers at the e-learning Centre of the UCSC. Therefore, 'participant observation' was used since it is a useful technique to collect data from the participants in a context without disturbing the situation (Bogdan, 1973). All the instructional designers were observed and their inquisitive tasks related to forum participation and learning activity design were recorded.

Since an individual interview is considered more appropriate for exploring in-depth and gathering data related to personal experience and opinions on certain factors (Petty, Thomson, and Stew, 2012), sets of interviews were individually conducted in order to clarify and further describe the inquisitive tasks, which were recorded at the participant-observation. Moreover, the interview questions addressed concerns related to the design of collaborative learning activities for online learners of the BIT courses. The findings were triangulated with the findings of the online course evaluations and determined the kind of collaborative activity to be introduced to promote learner participation in online discussion forums.

3.5   Instruments

The study employed survey and interview questionnaires to gather data from the students and the instructional designers, the LSQ of Honey and Mumford to identify students learning styles, test papers to evaluate students' learning achievements, and the CoI model to analyse online discussions.

Survey and interview questionnaires were used to collect students' learning experiences and attitudes toward the online courses and its components. When preparing the questionnaires, cultural and contextual factors such as language and conventions were considered. The questionnaires were composed of open-ended questions and MCQs on Likert-scales.

3.5.1 Learning style questionnaire

There are different types of tools or instruments to identify students' learning styles. Among them, Honey and Mumford's LSQ is known to be an extensively used tool to assess learning styles (Coffield, Moseley, Hall, and Ecclestone, 2004). The LSQ is based on Kolb's learning style model, which is widely accepted and supported by empirical investigations (Koob and Funk, 2002). Results of an evaluation study conducted by Cockerton, Naz, and Sheppard (2002) imply that LSQ is not only reliable and valid but also easy to use. The tool is appreciated for its usefulness in identifying students' learning styles as learning behaviours (e.g. Chan and Mak, 2010). The UCSC also had experience in using previous versions of this tool in its training programmes, and it was known to be a reliable and interesting tool to identify students' learning styles. Therefore, the LSQ of Honey and Mumford was used in the study reported in this thesis. How the tool was used is elaborated in section 3.7.1.

3.5.2 Test papers

Two test (assessment) papers of 30 minutes duration were prepared to assess students' learning achievements from learning using the online course. Each test consisted of a set of MCQs and was based on respective modules of the online course that the students were instructed to study per week. Each test question followed the same structure and the level of difficulty of the questions in the semester-end examinations of the BIT programme. Section 3.7.1 describes how these tests were carried out.

3.5.3 Community of Inquiry model

In order to analyse online discussions, the analytical model of the CoI framework (Garrison et al., 2000) was selected. The model is one of the most widely used (Arbaugh, Bangert, and Cleveland-Innes, 2010; Swan and Ice, 2010) and continually improved analytical instruments by the subsequent research dealing with online discussion-content analysis (Buraphadeja and Dawson, 2008). The CoI model is appreciated for its usefulness in analysing online discussions and determining online learning processes (Garrison, 2007; Garrison and Cleveland-Innes, 2005).

The theoretical framework of this model is grounded in the theories of teaching and learning in higher education, particularly on studies of John Dewey pertaining to community and inquiry (Garrison et al., 2010). The CoI model is composed of three major components: cognitive, social, and teaching. The primary aim of developing this model was to understand students' inquiry-based learning processes by analysing online discussions, which is congruent with the objective in the forum content analysis. Therefore, the CoI model was chosen as the analytical model to conduct the discussion-content analyses as discussed in this thesis.

The CoI model used by Shea et al. (2010) was evaluated to determine its reliability to analyse discussions in the BIT online courses. The results from the evaluation necessitated modifying some of the indicators and category definitions and adapting the model to make it more suitable for analysing discussion content in the online courses of the BIT programme. The adapted model was re-evaluated to determine its reliability. The first evaluation was done by analysing four discussion threads, having randomly selected one discussion thread from each of the four courses in the first semester of the BIT programme. The sample of discussions for the second evaluation consisted of eight discussion threads, which included the four discussion threads selected for the first evaluation and four other randomly selected discussion threads, with one discussion thread selected from each of the four courses. Each thread had at least five messages and dealt with student inquiries. Altogether, the eight discussion threads contained 99 student messages and 11 facilitator messages. The evaluation was done by two independent coders. The coders followed the same coding process employed by Shea et al. (2010) in a study to re-evaluate the CoI model. The unit of the analysis was a chunk of a message. A chunk could be a message or a segment of a message with a cue of a presence that is described in the CoI model.

3.6   Participants

The study was conducted with sample groups of first-semester students in the BIT VLE. The majority of the students belonged to the age group of 18–25 years. Most of the students that enrolled in the first semester were fresh school leavers, having passed their secondary school-end (advanced level) examinations. They did not have experience in online learning or computer-based learning. Even though the courses of the BIT degree programme were conducted in the English language, the mother tongue of the majority of students was either Sinhala or Tamil, and they had received their entire education in their mother tongue. Therefore, we predicted that most of the students had difficulty studying in English (Wedikkarage, 2009; Weerakkody, Dwivedi, and Kurunananda, 2009). Students who did their

secondary school education from any subject stream could register for the BIT degree programme.

The majority of the students who participated in the research were employed, and some were married and had children. The students had financial difficulties, and some did not have their own computers with internet facility to access the BIT VLE from their homes. Instead, they accessed the online courses from e-cafes or from their workplaces.

The students could learn from private institutions where BIT courses were conducted. However, there were some students who did not attend any private institution to study for the BIT degree. According to a study conducted in 2006, there were more than 50% of students who used self-study — using the BIT VLE as the main learning resource and not receiving any private tuition — as the method of learning to pass the BIT degree instead of joining an institution (Attygalle, Gamage, Jayasinghe, Samaranayake, and Wimalaratne, 2006).

3.7   Data collection procedure

The study includes two data collections at steps 1 and 4 (see Figure 3-1). Data were gathered through techniques such as survey questionnaires, interviews, debriefings, fieldwork, and observation, as well as from information sources such as results sheets of assessments and LMS reports: course content access records, activity reports, and forum discussions.

3.7.1   First data collection

The findings based on the first data collection contribute to answering the first research question — "which course components and their design features can promote learners' satisfaction, perceived learning, and learning effectiveness?" Therefore, the data collection aimed mainly to gather information related to students' learning experience using an online course in the VLE and attitudes towards the online course and the VLE. In order to measure learning effectiveness, the students were asked to study some lesson sections in an online course at their usual study places and come for a test to evaluate their learning achievements at the UCSC. This could not be done at one meeting. Also, in order to see how they progressed and changed their attitudes during the study period, a workshop was planned to be held at four consecutive meetings: the first meeting to introduce the activities and to obtain students' consent, and the other three meetings to conduct tests and collect students' learning experiences and attitudes towards the online course. Detailed information related to this data collection is available in Papers II and III.

The first data collection (step 1 in Figure 3-1) took place in 2008 at four consecutive meetings. There were 2,681 students who sat for their first semester examination in March 2008. The data collection was started five weeks after making the VLE available for the BIT students. There were four courses in the first semester of the BIT programme. Among these courses, one which had been coordinated by the author of this thesis was selected for the study. During that time there were about 1,000 active students in the online course. Of these, 120 were selected by considering the course content access records of each student and their place of residence. They were invited for face-to-face meetings, and 40 students participated in the first meeting. During the meeting, the purpose of the workshop and what was expected from the participants were explained to the students. Before collecting data, the students' willingness to participate in the study by attending the future meetings was inquired.

The meetings were conducted as shown in Figure 3-2. At the first meeting, the students answered the LSQ and a questionnaire to collect students' learning experience using the online course in VLE. The second and the third meetings started with the tests. The tests were conducted to evaluate students' learning achievements from having used the online course for their studies. At each of the second and third meetings the students received a test of one hour duration. Once the test was completed and the answer sheets were collected, the results were discussed. Subsequently, the questionnaires were distributed and the debriefing sessions were conducted to discuss the problems that students faced during learning using the online course. The questions were aimed to assess learner satisfaction and perceived learning. Also, they addressed issues such as how the students preferred to have the course environment and what else students expected from the UCSC as a support to complete their degree successfully.

Twenty-seven students participated in all the meetings. There were 9 females and 18 males. The majority of the students belonged to the age group of 20–25 years.
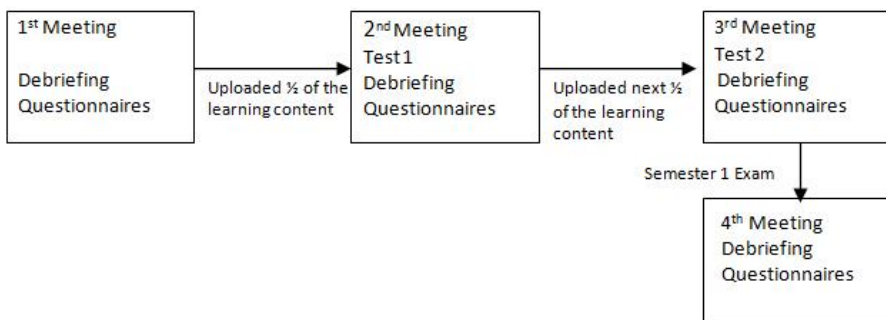
Figure 3-2 First data collection (discussed in Papers II and III)

Paper II — "Learners' satisfaction, learning style preferences and effective use of an online course" — attached to this thesis reports the results of the data gathered at the first, second, and third meetings. Paper III — "Designing online learning environments for distance learning" — reports the students' learning experiences collected at the first, third, and fourth meetings.

3.7.2 Second data collection

The second data collection (step 4 in Figure 3-1) was held during the period 2010–2013. The aim of the second data gathering was to determine the course components and design features that could stimulate inquiry-based learning and peer-teaching, and thereby attempt to answer the second research question of this thesis. For this purpose, design ideas of the instructional designers at the e-learning centre of the UCSC were inquired and prepared a peer-teaching and inquiry-based learning activity with the students in a design workshop. Moreover, in order to determine the design features of the course components that could promote inquiry learning, course access records from the VLE and student discussions in the BIT online courses were further analysed. Additionally, an online workshop with three meetings was conducted to gather data from the students. The findings of this data collection are discussed in Papers IV, V, and VI.

Data collection from instructional designers:

The data from the instructional designers at the e-Learning Centre were collected in September 2010. Data were gathered from all six instructional designers who worked at the e-Learning Centre via field notes taken at observations and interviews. The observations were made at the workplace of the instructional designers' without intervening in their usual work. Instructional design processes and activities of each designer that seemed inquisitive, such as an activity not in the CDP, were recorded. The interviews were driven with requests and questions such as "Show me a

sample of course content/learning object that you have designed and that you like most", "Explain why you like it", "How do you expect students to learn with this content?", "How can they assess their learning?", "What do you think about collaborative learning activities?", and "How can we design a collaborative activity?"

Data collection from students:

Data regarding students' learning experience were gathered in December 2011 through an online workshop. An open invitation to participate in the online workshop to discuss issues related to forum discussions was published in the BIT VLE. Twenty-one students gave their consent to participate in the workshop. These students were grouped considering the date and time that they would like to spend at the workshop, which was conducted at three consecutive meetings (see Figure 3-3). The meetings consisted of debriefings and focus group interviews. The meetings had to be repeated providing an opportunity for more students to participate in the discussions. However, only 8 students could participate in all the meetings.
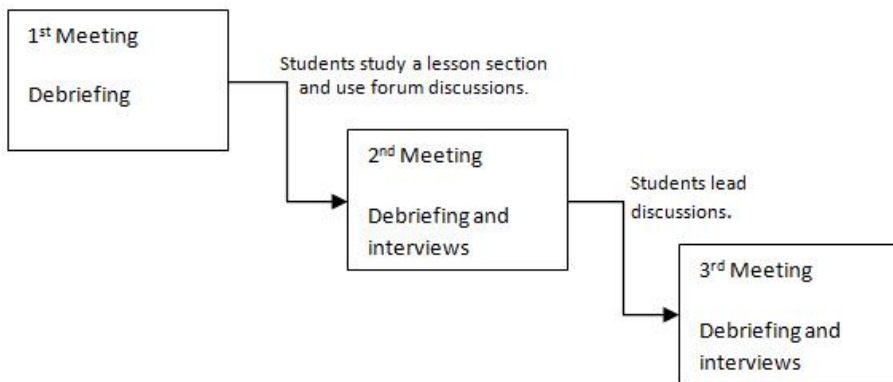
Figure 3-3 Second data collection (discussed in Paper VI)

The purpose of the workshop was explained at the first meeting, and the students were encouraged to speak about their learning experience in using forums to discuss their problems related to the subjects of the courses. During the first meeting, the students were instructed to study a lesson according to the schedules provided in the online courses and post questions and answers to peers' questions in the relevant discussion forums.

At the second meeting, in a debriefing session, the students discussed their experience in using forum discussions and shared their ideas on how to improve the discussion environments. Further information about these ideas and experience were collected at focus group interviews. A peer-teaching and inquiry learning activity was introduced to the students. The activity required the students to study a lesson section and start teaching it to others.

The students were instructed to do the activity and participate in the next meeting.

After a week, the students met to discuss their experience in doing the activity which was introduced at the second meeting. They were interviewed to collect more information about their learning experiences and to get their ideas to design the instructions of the activity for future students in the first semester.

Selecting discussions for analyses:

In this research, forum discussions were selected and analysed three times for three purposes. The first analysis was conducted to adapt the CoI model. The second analysis contributed to the understanding of whether students in the online courses could solve their problems and engage in inquiry-based learning without interacting with the facilitator. The third analysis gave insight into how to design a peer-teaching activity to promote inquiry-based learning. The discussion threads were gathered from the students who sat for their semester-end examination in March 2010.

Selection 1: A random sample of discussion threads having inquiry-based discussions was selected. The sample consisted of 99 student messages and 17 facilitator messages (see Paper IV for more information).

Selection 2: A sample of discussions consisting of 173 messages, all posted by the students, and another sample of discussions with 206 student messages and 45 facilitator messages were selected for the analysis. The results of the analysis of two samples were compared to see whether students in the BIT online courses can solve their problems without interacting with the facilitator (see Paper V for more information).

Selection 3: A sample of 80 discussion threads — with 20 discussion threads randomly selected from each course — was analysed using the CoI model. The sample was composed of 536 student messages and 77 facilitator messages (see Paper VI for more information). Discussions were further analysed to identify student-content interactions during each of the phases of the inquiry process.

Retrieving course access records:

Course access records were considered for determining the learning effectiveness of the online course. Also, based on the findings of the discussion-content analysis, course access records in the VLE were retrieved to determine student-content interactions during each of the phases of the CoI process. This helped to identify the course components that the students accessed during the inquiry process.

3.8   Ethical considerations

The workshops with the BIT students were conducted with the support of the BIT coordinators. The students were informed about the workshop, including what was expected from the participants and the reason for conducting it. The students' willingness to participate in the workshop was inquired. The students were assured that they could remain anonymous and were informed of their right to discontinue participation at any time.

The interviews with instructional designers were conducted with the permission of the coordinator of the e-Learning Centre. The instructional designers were informed of the purpose of the interviews and the observations. Data were collected with their consent for the participation in the research, and the collected data was kept anonymous.

The course access data, reports, and discussion threads in the BIT VLE were analysed with the permission of the coordinator of the e-Learning Centre and the director of the UCSC. The permission was given under the agreement that none of the personal data of the users in the VLE would be published. Therefore, for publication purpose, the required quotes were carefully extracted from the discussions and the names of students were replaced with substituted names such as S1 and S2. Evaluations of the model were conducted using discussions in papers, and once the evaluations were completed, all the papers were collected back from the coders.

4   Results and Contributions

The research was conducted following the EDR approach recommended by Reeves (2000). This approach can result in three primary outputs (see Figure 4-1): design knowledge, interventions, and professional development. Design knowledge is the primary type of knowledge sought in the field of EDR (Reeves, 2006), which can be considered as design principles, guidelines, theories, or lessons learned. The products that are designed, developed, and/or improved during the process of EDR are known as interventions. For example, student or teacher guides, learning content, process, policies, and online course environments are some of the interventions in an EDR. These are valuable for the educational department for which the product is developed and further can be reused in other similar contexts. The third type of outcome, professional development of researchers involved in the study, is a contribution of the research methodology of an EDR (Van den Akker et al., 2006). This output informs how members of the research team developed their teaching career and improve their teaching practices during the research. Other than these three major outputs, there can be other types of contributions of the EDR which may also be worth noting. In this thesis, they are categorised under the title "other contributions".
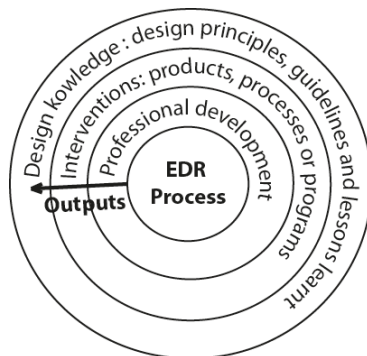
Figure 4-1 EDR Outputs (adapted from Van den Akker et al., 2006)

The findings, results, and contributions of the present research are discussed with respect to the above three types of outputs and other contributions of the research process. Having presented the findings and results, this chapter attempts to answer the two research questions: which course components

and their design features can promote learners' satisfaction, perceived learning, and learning effectiveness (Q1) and which course components and their design features can stimulate inquiry-based learning and peer-teaching (Q2).

4.1 Promoting learner satisfaction, perceived learning, and learning effectiveness (Q1)

Q1 is answered referring to the outputs/contributions reported in Papers I, II, and III. Paper I presents a CDP which supported the development of online course contents that were investigated during this research study. Therefore, it was an intervention to the online course development process and can be considered as an intervention to the EDR described in this thesis.

Following the CDP, an online course was designed and developed. Papers II and III describe the design components and features of this online course. The online course is the main intervention resulted during the research. The course environment was evaluated for its learner satisfaction, perceived learning, and learning effectiveness. The findings helped to identify design principles and guidelines which can be used by instructional designers for designing similar online learning environments.

4.1.1 Intervention: Content development process

With the introduction of the Moodle-based VLE, the UCSC wanted to develop a set of online courses which was to be delivered via the VLE. There were issues with the e-learning CDP. In order to make the online course content development work smoothly, a CDP needed to be defined. For this purpose, existing instructional system design (ISD) models such as ADDIE, Kemp, Dick, and Carey were studied. Among these ISD models, ADDIE (analysis, design, development, implementation, and evaluation) was identified as a common and widely used method of instructional system development (Peterson, 2003). According to McGriff (2001), the ADDIE model is the only ISD model which describes design and implementation of the CDP. The prevailing research also claims that application of an ADDIE process can improve the quality of instruction (Dick, Carey, and Carey, 2005). Therefore, the ADDIE model was used as the basis for preparing the CDP, and this CDP is elaborated in Paper I, which provides a starting point to the research study reported on in this thesis. The content-development and instructional development teams at the e-Learning Centre of the UCSC found this CDP very useful for developing the online courses of their BIT degree programme.

The CDP can be used by instructional designers and online course developers as a guide to carry out their instructional content development work. It can also support educational departments and institutions to develop and deliver online learning content for their distance learners. More specifically, it can guide curriculum development and e-learning course development processes by defining how the work should be systematically carried on.

4.1.2   Intervention: Online course content

A section of an online course was designed and developed according to a set of design principles that was based on two sets of design principles — Gagne's nine events of instruction and Merrill's first principles — and on the authors' experience in online course designing and teaching at the UCSC. The section dealt with subject content related to web development and was a complete module in the Personal Computer Applications course in the first semester of the BIT degree programme at the UCSC. The online learning environment (http://vle.bit.lk) of the Personal Computer Applications course was also improved and consisted of downloadable reading materials (student manuals), online forums, and interactive learning content: online lessons, activities, and quizzes. The downloadable reading materials were composed of detailed descriptions of the subject content and some learning activities. The forums were prepared to mediate collaborative learning activities and encourage inquiry-based learning. The online lessons were composed of graphics, audio, animations, interactions, and simulations. The activities and quizzes provided automatic feedback in response to student interactions.

The improved online learning environment was evaluated for learner satisfaction and learning effectiveness. The evaluation was conducted with a sample group of students following the course (see section 3.7.1). The results could be interpreted as that the students were satisfied with the online course and could learn effectively using the content. Further analysis of data revealed what design components and design features of the online course components could lead to student satisfaction and learning effectiveness (see section 4.1.3). More information about this study and the implications for course improvement are reported in Papers II and III.

The content of the online course designed and developed during this study can contribute to the field of online learning by supporting the development of online courses aimed at enhancing basic computer application skills required for web design. The e-Learning Centre of the UCSC has already reused this content for creating online courses in its Free and Open Learning Environment (http://www.e-learning.lk/vle/) and Fundamentals of Information Technology programme (http://fit.bit.lk).

4.1.3 Other contributions: Course evaluation findings

The section of the online course designed and developed was evaluated for learner satisfaction and learning effectiveness through questionnaires and conducting tests to evaluate students' learning achievements (see Paper II). Data were gathered at three in-person meetings held in three consecutive weeks (see section 3.5 for more details). Students' answers for the questions on the Likert Scale were represented with 10, 5, 0, -5, and -10 in the order of most positive to most negative attitudes or experiences. The resultant values were then averaged and are presented in percentages in Table 4-1.

Learner satisfaction with the online course

According to the results of the questionnaire, when moving from the second meeting to the third meeting, the students' attitudes towards the online course positively increased (Table 4-1). Also, the students could more easily solve their problems by interacting with the course content and their peers. The students found that the online course section was quite helpful for them to score at the test. At both meetings the students all agreed that the content in the online course was easy to understand, and their attitude regarding the usefulness of the online learning content for their studies was positive and significant (81%, see Table 4-1).

   The results implied that the students were satisfied with the online course section for its helpfulness in their studies. Further, at the debriefings the students expressed their satisfaction with the learning components and facilities like the interactive learning content, discussion environments, private messaging feature, activities, and the quizzes available in the online course.

Table 4-1 Students' satisfaction with the online course

		2nd Meeting AVG	3rd Meeting AVG
General attitudes gained by experiencing the online course section	Usefulness of e-learning material	81%	81%
	Confidence in using the online course	62%	71%
	The online course solves problems	29%	71%
	Can learn successfully only using the online course	-14%	10%
Factors affecting the score of the test result	Could easily discuss problems	12%	31%
	Helpfulness of the online course to score in the test	50%	76%
Specific attitudes regarding online learning content	Content was easy to understand	100%	100%
	Do not need someone to explain	52%	62%

Learning effectiveness of the online course and design components

The learning effectiveness of the online course section was measured with respect to two parameters: (1) students' learning achievements that were obtained from the test scores and (2) the course content (interactive learning content, activities, forums, and quizzes) access records. The results revealed that the students who had viewed the interactive learning content which included activities with automatic feedback, done forum based-activities, and attempted the quiz could score relatively high marks at the test.

The students also reported that they did not receive any formal teaching during this study period and studied the lessons only using the online course. This implied that the students of the study could learn effectively only using the online course.

The results showed that there was a relationship between the test scores and the number of LMS hits (course access records). Further, this relationship improved when moving from the second meeting to the third meeting. This indicated that once the students got familiar with the online course they could use the online course and its content more efficiently.

Relationship between learning style preferences and other variables

According to the results obtained through the LSQ of Honey and Mumford (Honey, 2007), there were 11 activists, 7 reflectors, 4 pragmatists, and 6 theorists in the sample group of students. The students' learning style preferences, tests scores, and course content access records were analysed, but there was no significant relationship among them. However, the results revealed that the students managed to score well regardless of their learning styles. Also, when moving from the second meeting to the third meeting, the students with different types of learning style preferences could improve their learning achievements (test scores) and positively improve their attitudes towards the online course and the VLE. Moreover, the results revealed that reflectors, who are characterised as quiet students in a physical classroom, interacted with the online learning content and participated in forum discussions as activists or at least as pragmatists (see Paper III for more information). Theorists in the sample could also efficiently learn using the online course section and showed more positive attitudes towards the online course than the others. These results implied that the online course section could support learners with different learning style preferences.

4.1.4 Design knowledge: Implications for learning design

The study aimed to determine what course components and their features could promote learner satisfaction and perceived learning (learning effectiveness of the course as perceived by the students). Additionally, it

attempted to find whether there was a relationship between students' learning styles and their learning design preferences.

Design components that led to learner satisfaction

The students learning attitudes and experiences reported on in the learning content evaluation questionnaire and debriefings were used to find the design components that led to learner satisfaction with the online course. The debriefing held at the first meeting reported that the learner satisfaction with the online course was led mainly by the downloadable student manual and the quiz. However, when moving from the first to the fourth meeting, the students appreciated the support they received from the interactive online learning content, activities, and the quiz more than the support they received from the student manual. Additionally, students' experiences and attitudes reported on in the questionnaire revealed that the students appreciated the features of the interactive learning content more than the other components in the online course, especially for their helpfulness and usefulness for learning.

Students' learning styles and learning design preferences

There was a relationship between students' learning style preferences and the students' preferences for design components or features of the online course and its content. For example, activists appreciated the online learning content with activities, which challenged them to solve problems, and reflectors appreciated the animated lessons, which helped them to remember the lessons more easily than the text-based notes.

Design features that led to the students' perceived learning

The students' learning experiences and attitudes towards the online course and its content that were reported on in the questionnaires and debriefings were used to find the design features which led to the students' perceived learning. According to the findings, students' perceived learning was led by the structure of the learning content, presentation of the online learning content, and design of the activities and quizzes.

> *Structure of the learning content* – Structured and organised learning content on the navigational system helped the students to access the learning content they required easily and quickly. The students requested to provide access to some student support facilities via the menu page of the online course.
>
> *Online learning content* – Students appreciated the multimedia elements such as text, graphics, animations, and simulations that were used to design the online learning content. However, the students reported some difficulties in downloading some graphic files, too much text on some pages, and not enough white space between the blocks of text.
>
> *Activities and quizzes* – Students found activities quite useful in their studies, and the quiz helped them to evaluate their learning achievements. However, they

reported that they needed to access the relevant forums from the interface of the interactive online learning activity or the learning content.

The students' suggestions for improving the learning content were used to enhance the sets of instructional design guidelines which were followed to design the online course and its content (see Paper III).

Instructional design principles and guidelines

Based on the implications for learning design reported in section 4.1.4, a set of design principles and guidelines was identified. The design principles and guidelines are presented here in Table 4-2, dividing them into two groups — general and specific guidelines — with respect to their applicability of designing instructions in printed and online learning materials. Therefore, specific guidelines can be considered instructional design guidelines specifically prepared for designing online learning materials for novice online learners following distance learning programmes in computer applications and information technology. The general guidelines are not only applicable in designing online instructions but also in designing paper-based learning materials, for instance.

Table 4-2 Instructional design principles and guidelines

General Guidelines	Specific Guidelines
Principle 1: Consider students' learning styles	
• Consider the learning style preferences in designing learning content – Make sure that students having strong learning style preferences can start learning with their preferred learning style.	• Organise the course components (lessons, activities, quizzes, and forums) allowing learners to start learning from whatever component that they prefer.
Principle 2: Structure the learning content	
• Display the learning outcomes of the course at the beginning of the course and display the learning objectives of each section at the beginning of its section content. • Organise the learning content according to the syllabus. • Add activities to each unit of the learning content. • Add at least one quiz to the end of each section of a course.	• Divide the learning content into small units and place them on an appropriate navigational system. • Add discussion forums and chat rooms where required. • Add student guides to use the learning environment. • Add contact information of student support services like technical guidance to the menu page which contains hyperlinks to access the relevant lesson content pages.
Principle 3: Select appropriate media	
• The selected media should support understanding of the lesson content.	In selecting media for online learning, consider whether it • can motivate the learners, • can entice the learners, • is constructively aligned with the learning objectives, • can handle or support interactivity,

	• will not exceed the weight limit that the network can have, and • simplifies the meaning.
Principle 4: Design text appropriately	
• Limit the number of text on one page – Place the most important text required to deliver the message to the learner. • Divide the text area into blocks of text as needed – Divide the text into blocks and keep enough space between blocks of text. • Use lists to present text if possible. Otherwise arrange the text in short paragraphs. • Use simple language. • Bold key words. • Keep one line of white space between blocks of text to increase readability. • If the main page has text that cannot be easily accommodated in the available space on the template, then redesign the text by placing it on two or more consecutive main pages.	• Use a tool tip (pop-up text label) to explain the technical/scientific terms used in the text area.
Principle 5: Select suitable graphics or design graphics appropriately	
• Use the example on the foreground and non-examples on the background. • Use bright colours to clearly show foreground picture while keeping the background in light colours. • Use design effects to highlight the idea you want to transfer to the audience. • Label the parts of the picture where necessary with clear text. • Do not keep illegible or unnecessary text on graphics – When reusing images having text, we need to remove the text if that text is not needed for the new learning content. • Add picture borders if a picture also contains some text or change its background colour to a different colour to increase the clarity of the text. • Keep some space between graphics and the surrounding text.	• Check the weight of the graphic before adding it to the online learning content. If it exceeds the weight limit, split it into two using graphic-editing software and add them close to one another on the online learning content.
Principle 6: Design suitable animations	
• Replace animations with images where animations are not really needed. • Keep it as simple as possible.	• Add user control buttons where necessary. • Do not make your animation play in a loop. Add a replay button to the end of the movie. • Play the text more slowly in an animation which contains text and graphics. • Design the animation with steps and add control buttons to allow learners to control the pace of it.

Principle 7: Design audio clips to get the learner's attention.	
• Link/show audio script.	• Add audio control buttons. • Add audio where necessary if it is not going to exceed the weight limit of the file. • Make sure that students without audio playing facilities can also receive the same message in text or in text and graphics.
Principle 8: Apply a suitable interactivity handling method.	
	• Check whether a simple script can handle the interactivity. • If not, add/design interactivity using Flash animations. • Check the database for available media elements before designing a new one.
Principle 9: Design appropriate learning activities.	
• Check whether the learning activity helps students to achieve their learning objectives. • Design different types of activities – Students can get bored of doing the same type of activities throughout a course. • Divide complex activities into small activities if possible – Complex learning activities can be provided using a scaffolding technique. These types of activities can be given in steps (set of small activities). • Give clear and appropriate instructions – The students should be able to clearly understand what is expected from them (what they should do as a whole and what they should send as the answer).	• If one activity leads to another activity after completing it, then place them on an internal navigational structure. • Add guided or help text where appropriate – If a learning activity is designed based on a simulation, add guided or help text to motivate the learners to complete the activity. Activities which may need further clarifications for individual students can be designed based on forums (asynchronous discussion rooms). • Add relevant feedback for the students' interactions – Students in an online course need to receive feedback to their responses. • If a lesson activity leads to a forum discussion, give the link to access it from the activity. • If there is an activity based on a lesson page or a sub-section of a lesson which leads to a forum, give the link to access that forum within the learning content itself.
Principle 10: Design evaluations (quizzes) allowing learners to self-evaluate their learning achievements	
• Use only the questions given or accepted by the SME. • Place the quiz at the end of each course section. • Check whether you have added the questions to the appropriate quiz – The questions on a quiz should be based only on the course section where it is placed.	• On failures to find the correct answer at the first attempt, provide hints to support and encourage learners to find the correct answers. • Add constructive feedback.

The above set of design principles and guidelines along with detailed descriptions of how to use the principles and guidelines are included in Paper III.

4.1.5 Professional development: Experience gained

The author of this thesis used the set of design principles and guidelines to design her online courses in a bachelor's degree programme and in a master's degree programme at the UCSC. She also used it in her teaching in the e-Learning and Instructional Design course and trained the students to design and develop e-learning content. Additionally, the set of design principles and guidelines was given to the team of instructional designers at the e-Learning Centre of the UCSC. The instructional designers, especially the newly recruited ones, found the set of design principles and guidelines very useful. Therefore, this output could contribute not only to the author's professional development but also for staff development at the e-Learning Centre.

4.2 Stimulators of inquiry-based learning and peer-teaching (Q2)

The interviews carried out with the instructional designers at the e-Learning Centre of the UCSC and the findings of the first data collection (section 3.7.1) raised the requirement for finding how to promote inquiry-based learning in the online courses. Therefore, the next half of the research reported in this thesis was directed to find how to promote inquiry-based learning in the BIT online courses.

The discussions in the online courses were to be studied to understand student learning processes during discussions and to determine whether students can engage in inquiry-based learning using online forums. In order to analyse online discussions, a discussion-content analytical model was selected and adapted (see Paper IV). This does not fall within the definitions of any type of output described by Van den Akker et al. (2006). However, this adapted analytical model can be considered another major contribution of the present research. Therefore, it is described here under the category 'other contributions'. The adapted analytical model was used to analyse discussion content in the BIT online courses. Based on the findings of this analysis, a study was conducted with a group of students and co-designed an online peer-teaching and inquiry-based learning activity, which was another intervention of this research. The findings of this study contributed to the development of a set of design principles and guidelines which could be considered as another output of type 'design knowledge'.

4.2.1 Other contributions: A discussion-content analytical model

Online discussion-content analysis can be conducted using analytical instruments which are commonly referred to as content analysis models. These instruments support the study of factors such as student participation, interactions, cognitive, metacognitive, and social cues, (Henri 1992; McDonald 1998), critical thinking (Fahy et al., 2000; Garrison et al., 2000; Newman, Webb, and Cochrane, 1995) and group development (McDonald and Gibson, 1998). Among them, the CoI model of Garrison et al. (2010) is known to be one of the most widely used and continually improved analytical instruments by the subsequent research dealing with online discussion-content analysis (Buraphadeja and Dawson, 2008). The primary aim of developing this model was to understand students' inquiry-based learning processes by analysing online discussions, which is congruent with the objective of the forum content analysis. Additionally, ever since its inception, researchers who adapted and used the CoI model have appreciated its usefulness for analysing discussion content. Therefore, considering the wide recognition of this model for analysing inquiry-based online discussions, a decision was made to use it in the research study reported on in this thesis.

CoI model

The CoI model is composed of four components: cognitive, social, teaching, and metacognitive presences. Among these components, cognitive, social, and teaching presences consisted of the most critical elements for experiencing higher education using online communication media (Garrison et al., 2010). The fourth component, the metacognitive presence, was the final component added to the model. This component represents the presence of metacognitive knowledge and skills in an online discussion. Metacognitive skills and knowledge are considered essential for distance learners, especially for students studying in online courses (Hauck, 2005). As the model evolved, one by one the components of the analytical model were introduced and evaluation studies were conducted to measure the reliability of the model components for analysing online discussion content. The evaluation results of the social, teaching, and cognitive presence components of the CoI model are reported in Rourke, Anderson, Garrison, and Archer (1999), Anderson, Rourke, Garrison, and Archer (2001), and Garrison, Anderson, and Archer (2001), respectively.

In 2010, Shea et al. introduced minor modifications and revaluated the model with its three main components: social, cognitive, and teaching presence. In the present study, this improved model was re-evaluated along with the metacognitive presence construct, which was developed based on the classifications of Akyol and Garrison (2011). The purpose of the

evaluation was to determine the reliability of the model to analyse discussions in the BIT online courses. However, the inter-rater reliability (IRR) values were not at satisfactory levels. Therefore, considering the comments of the coders and the issues reported by the contemporary researchers, an attempt was made to further improve the CoI model. Table 4-3 and Table 4-6 describe the issues associated with the model and the relevant modifications done to mitigate those issues.

Table 4-3 Cognitive presence coding scheme: Issues and modifications

Category	Indicator	Issues: previous research	Issues : present research	Modification
Exploration and integration categories	-All-	Encountered some discrepancies between the two categories (Garrison et al., 2001).	Instructions given in the coding scheme were not clear. Very difficult to distinguish the chunks to be matched with the two categories.	Modifications were done by referring to the explanations available in Garrison et al. (2000), Garrison et al. (2001), and Garrison et al. (2010).
Resolution /application	New: 'judging or evaluating and expressing satisfaction'	Many researchers have pointed out that there is a difficultly moving to the higher levels of the inquiry process (Garrison, 2007).	The coders encountered messages containing expressions of satisfaction after solving a problem which caused a 'triggering event'. These chunks could be interpreted as clues of resolutions.	Added new indicator – 'judging or evaluating and expressing satisfaction'.

Table 4-4 Metacognitive presence coding scheme: Issues and modifications

Category	Indicator	Issues : present research	Modification
Knowledge of 'cognition'		Difficult to understand the meaning of the term 'knowledge of cognition'.	A set of examples were added to the category.
	New: Knowledge about general learning strategies and tasks	There is a discrepancy between the category definitions and the theory.	Removed the terms which created confusion and added one more indicator.
Monitoring cognition & regulation of cognition'		Difficult to differentiate the meaning of the two category names.	A set of examples was added to each category.
Regulation of cognition	New: Suggesting taking an action	There were clues of regulation of cognition which could be identified as suggestions to take action.	Added a new indicator to the list of 'applying strategies'.

Table 4-5 Teaching presence coding scheme: Issues and modifications

Category	Indicator	Issues: previous research	Issues : present research	Modification
Designing and organisation	'Setting curriculum and communicating assessment methods ...', 'designing methods', and 'macro-level comments about the course'. New: 'Informing notices'.	According to Swan et al. 2008), design and organisation should be practised only by the teacher.	These indicators were found irrelevant to the context; the facilitator or the students were not supposed to do such activities. The facilitator could use the discussion forums to post relevant announcements.	Removed the indicators 'Setting curriculum and communicating assessment ...', and 'designing methods' and 'macro-level comments about the course'. Added a new indicator, 'informing notices'.
Facilitating discourse	'Encouraging, acknowledging or reinforcing student contribution' and 'drawing in participants and prompting discussions'.	The three-component framework for teaching presence may need to be revised (Shea, Li, Swan, and Pickett, 2005).	Irrelevant to the context and not easily comprehensible.	Modified the indicators to 'acknowledging or reinforcing student contribution' and 'encouraging or motivating students'.
Direct instruction	New: 'Providing specific instructions' and 'encouraging doing activities'. 'Offering useful illustrations' and 'making explicit references'. Supplying clarifying information'.	Indicators in this category do not seem reliably helpful for identifying the latent component of a teaching presence construct (Shea et al., 2005).	The students had provided task-specific instructions to peers and encouraged them to try out challenging activities. Quite similar to two other indicators. However, the definition of the indicator provided an additional explanation of 'teaching role'.	Added a new indicator, 'providing specific instructions' and 'encouraging doing activities'. Modified the indicators to 'offering useful illustrations or examples' and 'providing extra learning resources'. The existing indicator was replaced with 'providing additional explanations'.

Category	Indicator	Issues: previous research	Issues: present research	Modification
Assessment	The list of indicators in Shea et al. (2010).		Existing indicators are irrelevant to the context and cannot be matched with the clues of assessment.	Replaced the existing indicators with 'Providing constructive feedback to student posts'.

Table 4-6 Social presence coding scheme: Issues and modifications

Category	Indicator	Issues: previous research	Issues : present research	Modification
Affective expression	Expression of emotions and use of humour	Issues in investigating clues of expressions of emotions and humour (Rourke, Anderson, Garrison, and Archer, 2001)		Added more clarification and examples.
	Conventional and unconventional expressions		Difficulty in distinguishing conventional expressions from unconventional ones. There were indications of expressing emotions and tone of voice using big or capital letters and colour text.	The two indicators were combined and the definition of the combined-indicator was modified accordingly, including other signs of affective expressions.
	Expressing values	'Expressing values' is highly subjective and it caused reliability issues (Shea et al., 2010)	Difficult to determine the meaning of 'expressing values'. Clues of expressing values could also be considered as self-disclosures.	Included 'expressing values' in the 'self-disclosure' indicator and modified the definition of 'self-disclosure' to consider personal values such as beliefs, vision, and attitudes.
Affective and open communication	'Expressing emotions' in Affective category and 'expressing appreciation' in Open communication category	Inclusion of affective indicators may be more trouble than it's worth (Rourke et al. 1999).	Ambiguity of the two indicators: 'expressing emotions' in Affective category and 'expressing appreciation' in Open communication category.	Modified the indicator under open communication to 'encouraging or complementing'.

Open communication	New: 'Accepting mistakes' and expressing willingness to support'.	There was a considerable number of clues that urged to create two new indicators.	Added 'accepting mistakes' for the recognition of each other's contribution and 'expressing willingness to support'.
	Asking questions	There were messages not in the form of a question but requesting clarification.	Modified the indicator 'asking questions' to 'requesting support'.

The adapted model was evaluated to determine whether the model had been improved appropriately. The IRR values of this second evaluation were at satisfactory levels.

Evaluation results of the adapted model

A comparison of results of the first evaluation (Eval 1 – before adaptation) and the second evaluation (Eval 2 – after adaptation) can be seen in Table 4-7. While initial IRR values of Eval 2, which was conducted with a sample of discussions after modifying the model, ranged from RC=0.7391–1.0000 and K=0.5593–1.0000, the negotiated IRR values for the sample ranged from RC=0.9000–1.0000 and K=0.7820–1.0000. At Eval 2, another sample of discussions was also analysed to evaluate the model. Most of the initial IRR values found with this sample were above RC=0.8000 and K=0.5000, and the negotiated IRR values ranged from RC=0.9600–1.0000 and K=0.8818–1.0000. These high levels of IRR values could be interpreted as very good agreements between the two coders. The findings implied that the modifications could improve the coding schemes. Therefore, the adapted CoI model can be considered as a reliable analytical model that can be used in future research studies to understand students' learning behaviours during discussions in online courses on information technology and related subjects. The tool is more suitable for analysing online discussion content, particularly in Sri Lankan contexts and probably of Asian students. Furthermore, it may be simply adapted by replacing the existing examples with context-specific examples to analyse discussion content in different disciplines. However, this possibility for adaptation needs further investigation.

According to the position and the description of the metacognitive component in the CoI framework, clues of metacognitive elements should indicate some signs of teaching presence and cognitive presence (Akyol and Garrison, 2011). However, in the samples of discussions there were clues of metacognitive presence which could not be matched with the categories either in the teaching presence or in the cognitive presence coding schemes.

This implies that metacognitive construct is not properly positioned in the CoI framework. This is one of the important findings of the present research.

Coding Scheme	Course	Eval 1 - Initial IRR		Eval 1 - negotiated IRR		Eval 2 - Initial IRR		Eval 2 - negotiated IRR	
		Eval 1 Initial IRR - RC	Eval 1 Initial IRR - K	Eval 1 - negotiated IRR - RC	Eval 1 - negotiated IRR - K	Eval 2 Initial IRR - RC	Eval 2 Initial IRR - K	Eval 2 - negotiated IRR - RC	Eval 2 - negotiated IRR - K
Social presence	C1	0.7711	0.5834	0.9670	0.9145	0.9524	0.8756	1.0000	1.0000
	C2	0.5333	0.3182	0.8235	0.5714	0.9474	0.8182	1.0000	1.0000
	C3	0.8354	0.6393	0.9756	0.9231	0.8627	0.6322	1.0000	1.0000
	C4	0.6667	0.4330	0.9000	0.7250	0.8333	0.6386	1.0000	1.0000
Teaching presence	C1	0.2857	-0.1667	0.8000	0.5000	0.9167	0.8667	1.0000	1.0000
	C2	0.8000	0.5714	0.8000	0.5000	0.8333	0.6216	1.0000	1.0000
	C3	0.4286	0.2473	0.8750	0.6154	1.0000	1.0000	1.0000	1.0000
	C4	0.6667	0.5383	1.0000	1.0000	0.9333	0.8049	1.0000	1.0000
Cognitive presence	C1	0.4783	0.2200	0.7586	0.6432	0.8163	0.7222	0.9630	0.9357
	C2	0.3871	0.1359	0.7170	0.5492	0.8205	0.7113	1.0000	1.0000
	C3	0.4364	0.1575	0.7957	0.6513	0.7391	0.5593	1.0000	1.0000
	C4	0.3600	0.0636	0.6522	0.5014	0.8889	0.8014	1.0000	1.0000
Metacognitive presence	C1	0.5957	0.2000	0.7925	0.5016	0.9688	0.9068	1.0000	1.0000
	C2	0.4762	0.1250	0.7500	0.4767	0.7778	0.5714	0.9000	0.8608
	C3	0.5172	0.2027	0.7188	0.4363	0.8333	0.6340	0.9180	0.7820
	C4	0.5600	0.2694	0.7586	0.4960	0.8846	0.7494	0.9434	0.8787

Table 4-7 Comparison of IRR values of sample 1 at Eval 1 and Eval 2

4.2.2 Other contributions: Guidelines for discussion-content analysts

During the evaluations, the coders experienced difficulties pertaining to online discussion-content analysis. This resulted in preparing a set of guidelines that can support novice analysts to analyse online discussions using an analytical model and achieve valid results. The set of guidelines is as follows:

Reformulate messages where it is essential – Read and understand all the discussion threads before starting the analysis and carefully improve the clarity of the messages where it is essential.

Study the context of the discussion – Go to the online course environment where the discussion emerged and study the context of each discussion before starting the analysis.

Understand the inquiry process – If an analyst is going to use the CoI model, read and understand the articles written about the CoI framework and the inquiry process.

Comprehend the coding schemes – Grasp the instructions and information provided in the coding schemes before starting an analysis.

Consider only one coding scheme at a time and double check the work – Use only one coding scheme at a time until all the discussions are analysed, and recheck the analysis before going to work with the next coding scheme.

The set of guidelines was followed and found useful when analysing the discussion threads of the subsequent discussion content analyses reported in this thesis. Hopefully, future researchers may also find the set of guidelines useful in their discussion-content analyses. Therefore, this can also be considered another important contribution of this research.

4.2.3 Other contributions: Discussion-content analysis findings

In the present research, the next discussion content analysis was conducted to determine whether students can solve their problems collaboratively, without any teacher (facilitator) interaction, and to understand how students support each other in solving problems. In order to determine whether students can solve their problems collaboratively, without any teacher (facilitator) interaction, a purposively selected sample of 40 discussion threads was analysed using the adapted version of the CoI model. These 40 threads consisted of 20 threads (S_A) where the facilitator had not contributed to the discussion and 20 threads (S_P) where each thread had at least one message in the first half of the thread posted by the facilitator. Each discussion thread in the samples was composed of at least five messages.

Problem-solving capability

According to the results, the sum of the percentages of students' teaching presence and facilitator's teaching presence in S_P was closely equivalent to the percentage of students' teaching presence in S_A. The percentages of cognitive presence and metacognitive presence in S_A were higher than those in S_P. Further, the comparison of the analysis results of the two samples using a cognitive presence coding scheme showed that the students could find solutions to their problems, irrespective of the facilitator's presence or absence in the discussions.

Subsequently, correlations were calculated to determine whether there was a relationship between facilitators' or students' teaching presence and the other presences. Even though there was no significant correlation between the facilitators' teaching presence and the other presences, there was a significant correlation between students' teaching presence and the cognitive presence (CP). Also, students' teaching presence had a positive impact on both metacognitive presence (MP) and social presence (SP). The correlation statistics of both samples were quite similar (see Table 4-8). The results indicated that students in the courses could engage more in the inquiry processes when they received more teaching support from their peers.

Additionally, correlation statistics showed that students' metacognitive and social presence had a positive impact on students' cognitive presence, which could be interpreted as students' social relationships, motivation, and regulatory skills had been supportive for students' learning. Further analysis of social presence elements in the two samples revealed that students had a similar pattern of interaction in building their social presence in both sample groups of discussions. However, the distributions of metacognitive presence elements of the two samples among their categories were slightly different. For instance, S_A had 42% while S_P had only 33% of monitoring of cognition. This could be interpreted as when the facilitator was not participating in the discussions the students took more responsibility for monitoring their learning (cognition).

	SP						SA		
Course	F'-TP & S'-SP	F'-TP & CP	F'-TP & MP	S'-TP & CP	S'-TP & S'-SP	S'-TP & MP	S'-TP & CP	S'-TP & SP	S'-TP & MP
C-1	0.3872	0.5822	-0.0165	0.7467	0.8939*	0.8107	0.6585	0.9546*	0.9262*
C-2	0.0702	-0.5190	-0.3418	0.9795**	0.7450	0.9511*	0.9798**	0.9544*	0.9576*
C-3	0.5166	0.5577	0.1420	0.8043	0.9486*	0.5742	0.8447	0.9258*	0.8983*
C-4	0.4209	0.8539	-0.0831	0.7887	0.5796	0.7361*	0.7350	0.6736	0.5979
All	0.3423	0.4245	0.1277	0.8386**	0.8441**	0.6744**	0.7539**	0.9059**	0.8853**

N=20

Notes: * p-value <.05; **p-value <.01

Table 4-8 Correlations in SA and SP

Peer support

In order to understand how students support each other, the 'presences' of the two samples were further examined with respect to their category indicators. The findings signified that the students performed the role of teaching more when the facilitator was not participating in the discussions. They also revealed that the students engaged more in facilitating discourse and assessing peer contributions when the facilitator was not participating in the discussions.

S_A had 6% of clues matched with the indicator 'utilising medium effectively' in the category 'design and organisation'. Five of these clues were in the discussions initiated with examination questions. The initiator of the discussion had also participated in the discussion by exploring, integrating and applying, or testing the solutions. The sixth clue matched with the indicator 'utilising medium effectively' seemingly had been used for the purpose of using the medium to discuss some issues relevant to the students' studies.

Most of the teaching presence elements in both samples were categorised with the direct instruction category. The students had engaged more in providing specific instruction or advice, offering useful examples or illustrations, providing additional explanations, and making references or providing extra learning resources than the other activities in the list of indicators in the teaching presence coding scheme.

There were signs —students expecting their peers to comment or give feedback on their replies — and indications — students motivating others to reply to unsolved problems — which could be matched with the facilitating discourse category. The students' ability to assess or judge was identified with respect to three indicators: 'assessing other's ability/skill or knowledge', 'assessing message content', and 'assessing work/task'. There were more signs of assessing message content and assessing work/task rather than assessing other's ability/skill or knowledge.

The findings related to students' problems solving ability and tendency to support each other would be useful when enhancing online courses in the future. Collaborative learning activities such as inquiry-based learning activities can be designed especially by taking advantage of students' capabilities and natural tendencies during discussions.

4.2.4 Other contributions: Findings related to inquiry learning design

During inquiry-based learning, the students can access different types of course components. Therefore, appropriately designed course components may stimulate inquiry-based learning. This consideration raises a question: what course components and their design features can stimulate inquiry

learning? An answer to this question is attempted by referring to the findings of the second data collection (see section 3.7.2 and Paper VI for more information).

The data was gathered through an interview with instructional designers and analysed together with a sample of online discussion content and course content access records in the VLE in order to identify instructional requirements to design a peer-teaching and inquiry learning activity. Furthermore, an online workshop was conducted to design, implement, and evaluate the learning activity. The analysis of online discussion content was conducted employing the adapted CoI model. The unit of analysis was a chunk that could be a complete message or a meaningful segment of a message, with a cue of a presence that is described in the CoI model. The analysis was conducted using the same coding procedure followed by Shea et al. (2010) and the set of guidelines for analysts (in Paper IV).

The analysis of data collected from the instructional designers necessitated preparing a set of design guidelines to design collaborative inquiry-based learning activities. The findings of the analysis of online discussions and online course access records showed indications of student accesses to content outside the VLE, especially during the exploration integration phases of the inquiry process. The findings suggested that in order to motivate inquiry learning, the online courses should provide a list of links to external resources and related downloadable reference materials, including the useful discussion and reference materials of students in previous batches. The course components that students accessed during the triggering event and while finding a solution to the triggering event (exploration, integration, and resolution) were graphed (Figure 4-2 and Figure 4-3) to determine what components can stimulate inquiries (triggering events) and what can support solving problems.

According to the graphs in Figure 4-2 and Figure 4-3, student manuals, practice quizzes, and interactive lessons had been stimulating or supporting for causing triggering events and solving problems. The results of the workshop re-affirm this finding. Additionally, the workshop participants suggested that improving the interactive lessons with more interactive animations, audio, videos, and some challenging activities leading to forum discussions would enhance inquiry-based learning processes in the online courses. The findings of the workshop also suggested the following new additions or improvements to the online courses: adding welcome videos; improving the course components such as quizzes, student manuals, and interactive lessons that can promote inquiry learning; adding a common room for students to discuss all common issues related to the four courses in the semester; and creating forums for sharing information and inquiries.
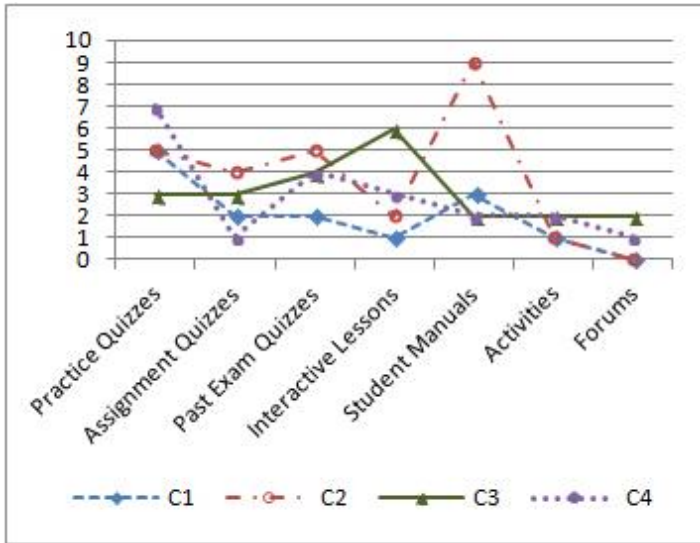
Figure 4-2 Course components causing triggering event
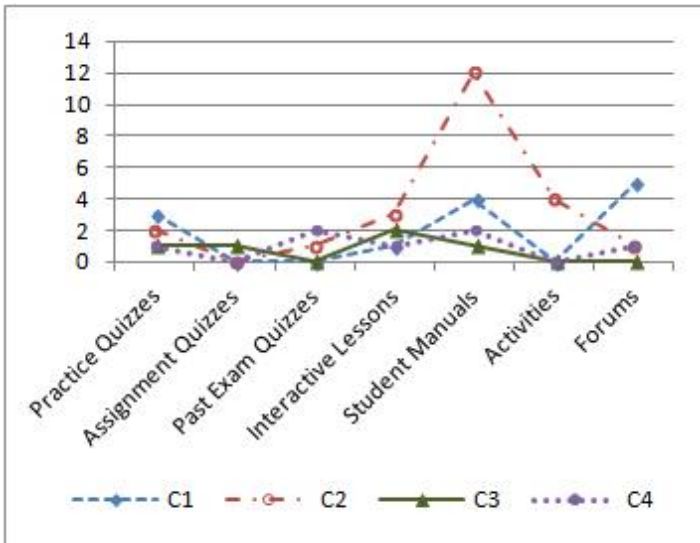
Figure 4-3 Course components supporting problem solving

4.2.5 Intervention: Instructions for a peer-teaching and inquiry learning activity

In order to initiate peer -eaching and inquiry learning activity, a set of instructions were provided to the students referring to the adapted CoI model in Paper IV. This was done in a debriefing held at the second meeting of the online workshop. The instructions were as follows:

1. Select a section among the lesson sections that should be covered according to the schedules uploaded in the online courses.
2. Start a discussion thread with a meaningful subject title and an interesting question. Provide the background information of your question.
3. Adhere to the netiquettes.
4. Encourage peers to explore information related to your question.
5. Acknowledge the input of others.
6. Integrate information and encourage peers to integrate information provided by you and the others.
7. Motivate peers to judge and evaluate peers' responses.
8. Support your peers to resolve the problem.
9. Bring in examples and experiences of practical applications.
10. Try to achieve learning objectives.

At the third meeting of the workshop the students' learning experiences and attitudes were gathered to measure students' perceived learning and satisfaction with the activity, and thus the effectiveness of the learning activity and the set of instructions were evaluated. According to the findings, the students were satisfied with the online learning activity and reported that they had a higher level of perceived learning. The results implied that the activity had been appropriately designed during the workshop. Therefore, the set of instructions can also be considered as an important intervention of the present research.

This is a basic set of instructions that can be used to implement any inquiry-based learning activity which requires peer-teaching/support. Therefore, designers of online learning environments may find this set of instructions useful.

4.2.6 Design knowledge: Design principles and guidelines to promote inquiry learning

Based on the results of the study and relevant and contemporary research, a set of design guidelines was formulated for the easy applicability of the design principles that were used to design the peer-teaching and inquiry learning activity. This can be considered another major output of type 'design knowledge' of this research. There are six design principles. The first two principles were proposed by Kali et al. (2009) for promoting collaborative learning in a higher-educational context, and the rest were formulated based on a set of issues that instructional designers had to handle when practising inquiry-based learning (Lim, 2004).

Table 4-9 Design principles and guidelines

Guideline	Implications: Paper VI	Implications: Other
Principle 1: Engage learners in instruction of their peers		
Make students aware of the inquiry process, netiquette, and the discussion schedule.	This information was found to be essential for students to initiate and participate in the activity.	It is important to disseminate supportive information as a prerequisite to a learning activity (Gagne et al., 2005).
Implement a strategy to select student leaders.	Some of the students were not willing to become student leaders.	Voluntary leaders tend more to support peers than randomly selected leaders (Centorrino and Concina, 2013).
Provide appropriate instructions to the student leaders	The students wanted to know what they could do and what they should not do to facilitate peers.	Students prefer more control over instructional options (Clark and Mayer, 2011).
Principle 2: Reuse student artefacts as resources for further learning		
Select exemplary discussions of previous batches and make them accessible to students in the present batch. Select useful resources (may be on links) referred by the students in previous batches, obtain permission from right parties to make them accessible via the course environments, or provide the list of references.	The students wanted to read useful discussions and reference materials of the students of their previous batches.	According to Levin-Peled, Kali, and Dori (2007), students' artefacts disseminated in a collaborative learning environment become parts of that environment, and new students should have the opportunity to build on and further advance knowledge in the artefacts.
Principle 3: Represent the inquiry process visually		
Illustrate the inquiry process.	The students who participated in the workshop preferred to know about the inquiry process in an interactive short video or an animation.	In order to engage learners in a learning activity, we have to find a better way of presenting, representing, and visualising the information that we need to communicate (Shedroff, 2009).
Make sure it provides a clear and concise description of the inquiry process.	Too much information presently linked to the help icon on the messaging interface seemed to have created a tendency to ignore the message help.	Text and graphics can be designed adhering to the recommendations provided in Clark and Mayer (2011).
Principle 4: Provide appropriate instructions to students in order to motivate their peers with the right questions		
Review the inquiry process through questions and answers.	The students wanted to remember the inquiry process.	Lim (2004) claimed that students should be motivated with right questions.
Add social networking facilities.	The students suggested that social networking facilities	Social presence is one of three essential elements of a

	in the VLE should be improved.	CoI (Garrison, 2007).
Enhance both asynchronous and synchronous communication facilities provided via online course environments.	The students appreciated online workshops to discuss issues and matters related to their studies.	Asynchronous and synchronous communication each has its own particular advantage for learning in online learning environments (Hrastinski, 2008).

A detailed description of the set of design principles and guidelines in Table 4-9 are presented in Paper VI. It provides information on how the design guidelines and principles can be applied. Hopefully, the set of design principles and guidelines will serve as an important contribution to the discipline of instructional design, particularly to the field of online collaborative learning.

Together with this, the set of design principles and guidelines presented in Table 4-2 can be used to design online learning environments aiming to promote both individual and collaborative learning. The design principles and guidelines describe how student-content interactions should be designed for learner satisfaction and learning effectiveness (as perceived by students) and how peer-teaching activities can be designed to promote inquiry-based learning. There are guidelines for structuring learning content, presenting learning content with media, and designing learning activities and quizzes. The guidelines are provided with detailed information, making them easily comprehensible by less experienced instructional designers (see Papers III and VI for more information). The guidelines can be best applied to designing online courses that are on subjects related to information technology and aimed to support individual and collaborative learners at a distance.

4.2.7 Professional development: Understanding online students' learning processes

In order to study students' learning processes during online discussions, more than 80 discussion threads with about 800 messages were analysed. Each thread was analysed according to the set of guidelines for content analysts (see section 4.2.2.). The analyses helped the authors of this thesis to broaden their own understanding of the students' learning processes during forum-based discussions. This understanding will indeed help not only to improve the online courses of the BIT programme but also to design better online learning environments for other courses for Sri Lankan students.

5 Discussion

The research aimed at answering two questions: which course components and their design features can promote learners' satisfaction, perceived learning, and learning effectiveness, and which course components and their design features can stimulate inquiry-based learning and peer-teaching?

5.1 Design for students' satisfaction, learning effectiveness, and perceived learning

The results of the evaluation of an online course could be interpreted as that the online course was successful in achieving learner satisfaction (see Paper II). Further analysis of data revealed that the learner satisfaction with the online course was led by the interactive learning content, learning activities, and practice quizzes (see Paper III). Student-content interactions were a major and a common factor in all these components. Therefore, the findings can be interpreted as that student-content interactions led to the student' satisfaction with the online course. This implies that in order to achieve learner satisfaction with an online course, its learning contents need to be designed to promote learner-content interactions. This complies with the results of Alderman (2005), who evaluated an online course with interactive learning activities and reported that student-content interaction was an essential contributor to learner satisfaction. Further, the design guidelines that were formulated based on the findings of the study and presented in this thesis describe how student-content interactions should be designed for learner satisfaction.

The analysis of data related to learning effectiveness revealed that the students could score high marks at examinations if they had interacted with the instructional (interactive learning) content, completed activities — including forum-based online activities — and attempted the quiz in the online course (see Paper II). Moreover, analysis of data pertaining to students' perceived learning implied that the perceived learning was led by the structure of the learning content, presentations of learning content, and the design of the activities and quizzes. These two findings can be interpreted as that the students' perceived learning and the learning effectiveness of the online course were led by the design of the learning

content, the activities, and the quiz. Student-content interactions were a common design feature of the activities and the quiz. Since forum-based online activities necessitate student-student interactions, we can suppose that student-student interactions had also been supportive for student learning. Therefore, the findings can be interpreted as that the design of the learning content (interfaces) and student-content interaction as well as the student-student interaction contributed to learning effectiveness and perceived learning. This finding is supported by many other researchers (e.g. Jaggars and Xu, 2013; Sher, 2009; Sigala, 2002), who noted that student-student interaction is a key factor determining the higher level of learning effectiveness, and the reasoning of Swan (2003), who stated that interactions with well-designed interfaces can enhance learning. Student-student and student-content interactions can be designed as described in this thesis, which might help keep learners actively engaged throughout the entire learning process and motivate them to complete the course successfully.

According to Yoon (2003 – referring to Moore, 1989), there are three types of interactions — student-student, student-content, and student-teacher — that are essential to make distance learning effective and satisfactory. However, even though the student-teacher interactions in a BIT online course were kept at a minimum level, the course evaluation results revealed that they were successful in achieving learner satisfaction, learning effectiveness, and perceived learning (see Paper II for more information). This implies that student-teacher interaction is not necessarily a key factor determining the successfulness of online distance learning. This implication contradicts Steensma, Howard, Lyles, and Dhanaraj (2012) and Ali, Ramay, and Shahzad (2011). The plausible interpretation of the finding of the present research study is that well-designed student-student and student-content interactions in an online learning environment can diminish or substitute the requirement of student-teacher interactions. This interpretation is supported by Lee and Rha (2009), who noted that issues due to poor or no teacher interactions in distance courses can be overcome by proper design of learning materials. This finding also strengthens the online learning theory of Anderson (2003).

5.2 Design to stimulate inquiry-based learning and peer-teaching

As Anderson (2003) theorised, deep and meaningful learning can take place in an online learning environment as long as at least one of the three forms of interactions — student-student, student-teacher and student-content — is kept at a high level while the other two forms of interactions are left at low levels or even eliminated without degrading the educational experience.

According to the findings of the discussion-content analysis reported in this thesis, the students in the BIT online courses can engage in deep and meaningful learning even when there is no facilitator interaction, and peer support is a key factor determining students' inquiry-based learning (in Paper V). Therefore, the findings may be interpreted as students in collaborative learning environments of higher educational programmes like BIT can engage in deep and meaningful learning during inquiry-based learning if they receive peer support.

Further, the findings of the present research informed that inquiry-based learning processes can be promoted via well-designed quizzes, student manuals, and interactive lessons. Based on the findings, the thesis described how to design online course components to stimulate inquiry-based learning and peer-teaching (see Paper VI for details) by presenting a set of design principles and guidelines. These principles and guidelines can be used to design peer-teaching and inquiry-based learning activities in similar learning contexts.

5.3   Design for individual and collaborative learning

Based on the findings of the present research and some existing instructional design guidelines, two sets of design principles and guidelines were prepared. These sets of design principles and guidelines can help the instructional designers to design online courses even if the courses are to be conducted with lack of teacher support.

The design of such courses will support students to be more co-directed and co-regulated in their learning. Thereby, the probable issue of loneliness in online course environments (Kobayashi, 2012) will be mitigated. The research reported in this thesis can therefore be considered as an attempt to meet the requirement stated by Reeves et al. (2004) for EDR to prepare design guidelines to enhance collaborative learning in online courses.

The design principles and guidelines presented in this thesis are supportive for designing both collaborative and individual learning. Online course environments that are designed following these principles and guidelines intend to give their students an opportunity to direct learning according to their learning preferences and styles. As a result, the students in the online courses may tend to be more responsible for their own learning. Accordingly, the design principles and guidelines can contribute to the designing of learner-centred learning environments.

The findings indicated that both individual and collaborative learning activities in the online courses could help to keep students actively engaged in the learning. This signified the importance of designing components of an online course to fulfil both individual and collaborative learning requirements of its students. More specifically, some of the students at the

online workshop were reluctant to become student leaders in the discussions. However, all of the students enjoyed participating in the collaborative learning activity. This finding implied that online learners prefer collaborative learning. This implication is strengthened by the observation of Ke and Carr-Chellman (2006), who noted that even individual learners prefer collaborative learning methods such as online discussions due to the opportunities that these methods can provide for greater reflection.

In a study conducted at some schools and a university in Helsinki, Lakkala (2010) found that most students do not spontaneously tend to support other students and help them to achieve their learning goals. However, according to the findings reported in this thesis (see Paper V for more details), the students in the BIT online courses were willing to support each other even by teaching small sections of lessons that seemed difficult for other students to understand.

Collaborative learners expect to share their learning experience with others by working together for common goals and objectives. However, unless the activities are compulsory, the level of collaboration is left up to the individual learner, and student-student interactions cannot take place if students are not willing to collaborate with each other. The results of the present study suggested that the distance online learners do not want any of the collaborative activities to be compulsory. Making collaborative learning activities compulsory can dissatisfy distance learners because they appreciate the nature of flexibility to manage their learning independently, whereas compulsory collaborative learning activities expect positive interdependence between peers (Dewiyanti, Brand-Gruwel, Jochems, and Broers, 2007).Therefore, while designers of online learning environments satisfy the learning requirements of individual as well as collaborative learners, they should not make any of the collaborative learning activities compulsory.

The students should be given an opportunity to select and continue their studies in their preferred mode of learning. Even though collaborative learning activities are supportive for developing higher order learning skills, online course designers and coordinators should not expect all students to participate in online discussions. Nevertheless, if collaborative learning activities are properly designed as discussed in this thesis, more and more students may tend to participate in online discussions, which could create an online learning community. More the students will play teaching role, the more the facilitators can spend time for observing and judging students' activities.

6 Limitations

Data for the study were collected by conducting workshops, interviews, and debriefings, and via data sources such as course access records and students' activity reports retrieved from the LMS records and online discussion forums. Some limitations were encountered during the data collection and analysis.

6.1 Data collection

The students in the BIT programme are distance learners. They are from different parts of the country. Usually they do not come to the UCSC for their studies. Also, many of them did their studies part-time while working jobs. Therefore, it was difficult to motivate students to participate in the workshops. In the sample of students who participated in the workshop (described in Papers II and III) conducted at the UCSC, there were students who had to spend more than four hours to reach the UCSC. Due to this issue, the number of students who participated in the workshop was found to be low. However, a large number of students (about 10%) were invited to the workshop held at the UCSC (described in Papers II and III), and an open invitation was published to welcome students for the online workshop (described in Paper VI). All the students who participated in the workshops were willing to spend time and gave their consent to participate in the research activities.

6.2 Discussion-content analysis

A sample of discussion threads were analysed in order to understand students' learning processes during online discussions. However, the students had the opportunity to discuss with other students via the private messaging service available through the VLE, over the telephone, or even face to face if they accessed the course pages simultaneously at the same place. At the workshop, the students revealed that they experienced difficulty in contacting students via the private messaging service in the VLE. However, specific and detailed information about these facts were not considered in the present study since the main focus was on the

understanding of students' learning processes during online discussions by analysing discussion content on forums.

7 Concluding Remarks

The research reported in this thesis fell within the field of EDR, which address complex problems in educational practices by designing developing and evaluating educational interventions while contributing to the advancement of design knowledge. The research was guided by the research question of how existing design principles could be adapted to design online courses of the BIT degree programme at the UCSC, Sri Lanka, to promote both individual and collaborative learning. This question was addressed by examining the online course components and their design features that can promote learners' satisfaction, perceived learning, and learning effectiveness, and by examining online course components and their design features that can stimulate inquiry-based learning.

The research was carried out with a group of students in the VLE of the BIT degree programme and with the team of instructional designers at the e-Learning Centre of the UCSC. The findings implied that in order to support individual learning, online course environments should be well organised and designed with interactive learning content, activities, and quizzes incorporating student-content interactions. Moreover, findings of the discussion-content analysis revealed that inquiry-based learning can be promoted by improving interactive learning content, student manuals, quizzes, and activities with challenging questions. Student-content interaction seemed to be the common design feature of all these components. Therefore, as the online learning theory of Anderson presumes, further improving and attempting to maximise student-content interactions would probably enhance deep and meaningful learning in the online courses.

The research resulted in interventions, design knowledge, and professional development of the participants in this research. The online course CDP, the online courses for the BIT VLE, and the activity to promote inquiry-based learning and peer-teaching were the main interventions. The research participants, the researchers of the present research, had been inventing learning tools which can be included in the BIT VLE and seeking design knowledge grounded by evidence and supported by theories of instructional design. These activities aided the researchers enhancing their skills and knowledge related to online course design. Also, they could broaden their understanding pertaining to online learners' learning behaviours, which indeed will help them to design better online learning environments for distance online learners in the future.

The design knowledge was in the form of a set of instructional design guidelines and principles. This set of instructional design guidelines was initially prepared based on the existing instructional design principles: Gagne's nine events of instruction, Merrill's first principles of instruction, and Levin-Pelled et al.'s basic principles of promoting collaborative online learning in higher educational contexts. The design principles were adapted, and a set of design guidelines was identified based on the evidence from the present research. This set of principles and guidelines would be best applicable in designing online courses environments prepared for university-level distance learning programmes on information technology related subjects in Sri Lanka, and possibly in other Asian contexts.

8 Future Research

The findings and contributions such as the adapted CoI model and the sets of design guidelines of this research can be used to carry out studies in different contexts. This would help to further improve the analytical model and the set of design guidelines (Reeves, 2000), and also to determine the applicability of the adapted analytical model and the design guidelines in different contexts.

8.1 Recommendations

The findings and contributions of the research suggest the following recommendations. They are discussed with respect to the main contributions of the research reported in this thesis.

8.1.1 Design principles and guidelines

Online courses of the BIT programme should be improved following the set of design principles and guidelines presented in this thesis. The design principles and guidelines can be used to design effective online courses for distance learning programmes on information technology related subjects. Further, in order to promote deep and meaningful learning using an inquiry-based learning approach, interactive lessons of the online courses should be improved with audio, video, and animations. Also, manuals (downloadable notes), activities, and quizzes should consist of more challenging activities and questions. Furthermore, peer-teaching activities should be introduced to online learners of distance learning programmes. Peer-teaching activities can be designed as described in this thesis.

8.1.2 Online course content

Evaluation results of the BIT online courses implied that the courses are appropriately designed for learner satisfaction and learning effectiveness. Therefore, the thesis recommends that online course content of the BIT programme can be reused to design new courses. For instance, the course content can be provided with some more basic content and design basic-level courses. Advance courses can be prepared by adding some advance content

to and re-organising the content in the BIT courses in a new course environment.

8.1.3 Community of Inquiry model

The findings suggested that the adapted CoI model can be used more reliably to analyse discussion content in the BIT VLE. Therefore, the thesis recommends using the adapted CoI model to analyse discussion content in the BIT online courses and other online distance learning courses, particularly in Sri Lanka, to understand students' online learning processes. Online students of the BIT online learning environment tended to support each other and solve problems collaboratively. This implied that students of the BIT online learning environment could be self-directed and self-regulated. Therefore, online courses designed for higher educational context should be more student-centric, allowing learners to play the role of teacher while teachers play the role of observer and evaluator.

8.2 Adaptability and expandability

The BIT online courses and their components should be improved as recommended by the enhanced set of design principles and guidelines. The improved courses should be evaluated again to make sure there is an improvement in learner satisfaction, perceived learning, and learning effectiveness. That may give implications of the applicability of the sets of guidelines to design successful online courses supporting both individual and collaborative learning and which deliver courses in other subject areas. Moreover, the sets of design guidelines can be given to the instructional designers designing online courses for distance learning programmes in disciplines other than information technology and check whether they can apply the design guidelines easily and productively.

Findings of the re-evaluation of the CoI model implied that the metacognitive presence component was not properly positioned within the CoI framework. In order to assure this and make necessary adjustments to improve the CoI framework, a large sample of discussion threads needs to be analysed. For this purpose, threads can be selected from different contexts. The findings of this analysis can also be used to further improve the CoI model and adapt the CoI model to analyse discussion content in the online courses related to information technology and other disciplines in Sri Lanka and other countries where English is a second language. Moreover, the improved CoI model can be used to evaluate students' learning achievements during participation in online discussions.

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