



Designing for eAssessment of Higher Order Thinking

An Undergraduate IT Online Distance Education Course in Sri Lanka

Hakim Usoof



Department of Applied Educational Science
Umeå University 2012

Designing for eAssessment of Higher Order Thinking

An Undergraduate IT Online Distance
Education Course in Sri Lanka

Hakim Usoof



Department of Applied Educational Science
Umeå, 2012

Copyright © Hakim Usoof
ISBN: 978-91-7459-455-3
ISSN: 1650-8858
Cover Design: Hans Karlsson
Electronic version available at <http://umu.diva-portal.org/>
Printed by: Print & Media
Umeå, Sweden, 2012

Dedicated to my parents who dedicated their lives for us.

Acknowledgements

Thank you God almighty for giving me the wisdom to take this journey in the path of knowledge.

Firstly, thank you to all my informants for your time and patients and your most valuable insights. Without you this thesis would not be a reality.

My heartfelt gratitude goes to my supervisor, Brian Hudson, for your insight, critical views, patience and guiding supervision. My gratitude also goes to Eva Lindgren, also my supervisor for your encouragement, loud thoughts, challenging questions, guidance and support and probing supervision. My sincere gratitude also goes to Priyantha Hewagamage, my Sri Lankan supervisor, for your advice, guidance, encouragement, critical reviews, administrative support and intriguing discussions. My gratitude also goes to Gihan Wikramanayake, also my Sri Lankan supervisor for your advice, guidance, critical reviews, administrative support and valuable discussions. My deepest gratitude also goes to Isa Janke, the reader at my final seminar. Your valuable constructive critique made a big difference for me to reach greater heights.

The Swedish Program for ICT in Developing Regions (SPIDER) and the National eLearning Centre Project (NeLC) have funded my doctoral studies, thank you to SPIDER and NeLC, and your staff for all the support given. There are two people if not for whom I would not be at Umeå University and at the Department of Interactive Media and Learning. Lars Glimbert and Fredrik Paulsson through their contacts made it possible for my studies at Umeå University, thank you to the both of you. My gratitude also goes to Ruvan Weerasinghe, former director of the UCSC for his support and guidance paving the way for me to embark on this journey. My gratitude also goes out to the Salika Ariyaratne the coordinator of the BIT office and her staff for providing me with all the data I needed for this thesis, thank you all.

Many students say that a doctoral degree is a very lonely journey, but mine has not been so. I have been flanked by friendly, jovial, supportive and sometimes critical and very interesting group of doktorands. Thank you Carina Granberg, Peter Bergström, Eva Mårell-Olsson, Danyun Key and Henning Eriksson.

My stay in freezing Umeå was made warm not only by the bitter coffee, but all those who shared it with me during fika. Thank you to all my colleagues at the Department of Interactive Media and Learning and the Department of

Applied Educational Sciences. Thank you for your support, encouragement, intriguing conversations, skiing and fishing trips, Easter and midsummer fests and most importantly your friendship. My gratitude also goes to Bengt-Johansson the former head of IML, Dag Österlund Assistant Head of TUV and Gunnar Schedin, Head of TUV for all the support and encouragement you have given me.

My loving gratitude also goes out to my family for the encouragement and support. You were there for me as always.

Last but not least my deepest gratitude goes to Tarangi Wijesuriya, my loving wife, for the encouragement to join the UCSC and the support, encouragement and advice for me to keep on this journey. Thank you for tolerating my shadowy presence for the last five years, my mood swings and wild ideas. You were my pillar of strength throughout this long journey.

Hakim Usoof
Umeå, August 2012

Table of Contents

Acknowledgements	i
Table of Contents	iii
Abstract	v
Abbreviations	vi
List of Papers	vii
Introduction	1
The domain of technology aided distance education	2
Aim and research questions	3
Structure of the Thesis	4
Context of the study	5
Sri Lankan context	5
BIT context	6
<i>Learning and Teaching</i>	6
<i>Assessment</i>	7
The research field	8
ICT in Education	8
Enhancing learning	9
<i>Higher order thinking</i>	9
<i>Collaborative learning</i>	11
Assessment	12
<i>Students' perspective</i>	12
<i>Student centred assessment</i>	13
<i>Summative and Formative assessment</i>	13
<i>e-Assessment</i>	15
Theoretical point of departure	16
Vygotsky's socio-cultural theory	17
Zone of proximal development	17
Methodology	18
Design-based research	19
<i>Design-based research in the domain of technology and education</i>	20
<i>Criticism of design-based research</i>	20
Design of this study	21
<i>Part A: Addressing plagiarism</i>	21
<i>Paper I</i>	21
<i>Paper II</i>	22
<i>Part B: Design of an Assessment model</i>	22
<i>Identification of design requirements</i>	22
<i>Evaluation of the design and assessment criteria of the FADE model</i>	22
<i>Paper III</i>	23
<i>Paper IV</i>	23

Validity and Reliability	23
Summary of results	26
<i>Results Paper I</i>	26
<i>Results Paper II</i>	27
Ethical considerations	29
Discussion	30
Assessment Practices	30
<i>The students' perspective</i>	30
<i>Text-based versus multimedia content</i>	31
<i>Factual knowledge and higher order thinking</i>	32
<i>Collaborative learning</i>	33
<i>Technology use</i>	33
Plagiarism: detection and prevention	34
Evaluation of design	35
<i>Learning</i>	36
<i>Students competencies</i>	37
<i>Attitudes</i>	37
Key considerations in designing assessment	39
Contributions	39
Implications for the BIT degree programme	40
Future research	40
Reference	42

Abstract

Distance education has seen rapid growth over the recent decades. The rapid development of Information Communication Technology [ICT] has been one of the main drivers of this growth in distance education. However, distance education and ICT themselves posts challenges to both students and educators alike. This thesis finds its basis in the problem of high failure rates and quality assurance issues in the Bachelor of Information Technology [BIT] distance degree programme conducted by the University of Colombo School of Computing in Sri Lanka. A Formative Assessment for Distance Education [FADE] model that promotes the development of and assesses higher-order skills in a collaborative online distance-learning environment was designed based on a methodological approach involving design-based research. The main study was focussed on two main problems, plagiarism in distance education [part A] and the use of technology to address the issues of learning and assessment [part B]. Research questions arising from different aspects of the design required the use of multiple methodologies. Issues of plagiarism in technology aided assessment in distance education put forward questions that required the use of a quasi-experiment and a literature survey. The empirical material of this phase of the study comprised of keystroke logs and questionnaire data. The design and evaluation of the FADE model employed a mixed method two-phase sequential explanatory strategy. The empirical material of this phase of the study comprised of questionnaires, observations coding, interviews and examination and registry data. The quasi-experimental data was analysed using a fuzzy logic engine. The questionnaire, observation coding and examination and registry data were statistically analysed and interviews were used to interpret and explain finding. The results of the part A of the study indicate that there are keystroke patterns for individuals that are stable within and across different tasks. However, the results of the literature review on plagiarism suggested the use of both technological and pedagogical approaches to plagiarism. Part B of the study, showed relationships between higher order thinking demonstrated by students and their course results and attitudes. Collaborative learning skills demonstrated by students showed relationships to the students' purpose of use of the FADE forum and their experience on the social web. This study finds that both technological tools and pedagogical practices have to be used in conjunction to limit the possibility of plagiarism. With reference to assessment with a focus on the development of higher order thinking, the study indicates that assessment should be based on the student's perspective, the purpose and aim of the assessment and the assessment environment. Furthermore, the study finds that in distance education collaboration seems particularly important.

Abbreviations

BIT	Bachelor of Information Technology Degree programme
FADE	A model for Formative Assessment for Distance Education
ICT	Information and Communication Technology
IT	Information Technology
LMS	Learning Management System
MCQ	Multiple Choice Question
UCSC	University of Colombo School of Computing
VLE	Virtual Learning Environment

List of Papers

This thesis is based on the following articles, which will be referred to in the text by Roman numericals.

- I. Usoof, H., Lindgren, E. (2008). Who is who and doing what in distance education? Authentication and keystroke dynamics. *Journal of Research in Teacher Education*, nr 3-4. p173-187.
- II. Usoof, H., Hudson, B. & Lindgren, E. (in press). Plagiarism: Catalysts and Not so Simple Solutions. In K. Sullivan, P. Czigler & J. Sullivan Hellgren (Eds.), *Summary of Cases on Professional Distance Education Degree Programs and Practices: Successes, Challenges and Issues*. Hershey PA, USA: IGI Global.
- III. Usoof, H., Hudson, B. & Wickramanayake, G. (in press). Technology enhanced assessment for learning in a distance education IT degree programme in Sri Lanka. *Accepted by The International Journal on Advances in ICT for Emerging Regions*.
- IV. Usoof, H. (Under review). Assessment for Learning: Designing Online Assessment to Promote Higher-order Thinking using Collaborative Learning in Distance Education. *Submitted to International Review of Research in Open and Distance Learning*.

Introduction

This thesis finds its roots in the problem of high failure and dropout rates in the Bachelor of Information Technology (BIT) degree programme conducted by the University of Colombo School of Computing (UCSC). The BIT degree programme commenced in the year 2000 and has experienced high failure and dropout rates and graduation rates as low as 1.5 per cent during 2003 and 2004 (Hewagamage, 2005; Usoof & Wickramanayake, 2009). The lack of learner support and the assessment practices of the BIT degree programme have been identified as the main causes of these problems. In order to address these issues, the UCSC introduced online support via a Learning Management System (LMS) for the BIT degree programme in the 2003/04 academic year and a Virtual Learning Environment (VLE) in the eBIT degree programme in the 2006/07 academic year. In addition, modifications to the assessment criteria were carried out during these phases in an attempt to improve completion rates (Usoof, Hudson & Wickramanayake, submitted). The graduation rate had increased to 22 per cent by 2007 (Gamage, 2007 cited in Andersson 2008), but this was still considered to be poor.

Similar high dropout and failure rates have been faced in other distance education programmes (Simpson, 2004). The root causes identified by other researchers highlight the need for students to be intrinsically motivated, self-regulatory, self-directed, responsible for their time management, self-aware of their competencies, and the ability to be independent thinkers (Home, 1998; Parker, 2003; Liu, Lavelle & Andris, 2002). The lack of contact with other students and instructors and a lack of feedback on an ongoing basis have also been identified as contributing factors to high dropout rates in distance education (Galusha, 1997; Doherty, 2006; Mazza, 2004). This study has focused on issues related to the lack of contact with other students and the lack of feedback in relation to the BIT degree programme.

The UCSC has considered using assessment as a tool to address these issues. The UCSC uses a database of Multiple-choice questions on the BIT VLE in an attempt to provide some form of formative assessment that is aimed at students' learning. A Multiple-choice question, or MCQ, is a form question which consists of a stem and options. The stem is the introductory question or incomplete statement. The options are a set of possible answers, where one or more may be the correct option(s) and the rest are distracters or incorrect answers (Kehoe, 1995). This formative assessment system in the BIT VLE only informs of right and wrong answers and does not provide any tangible feedback that the students can use to further their knowledge. If the students require further clarifications they have to post their problem on the BIT online forum and depend on a peer or facilitator response. A further

concern is the development of higher order thinking skills by students that are considered as a quality assurance requirement of a degree programme (Coates, 2005; Bath et al, 2007). This form of formative assessment or an end semester MCQ summative assessment does not provide opportunities for students to foster higher order thinking skills (Scouller 1994 1998; Gipps, 1994; Paxton, 2000). Moreover, these formative assessment activities are optional and have no implication on the final grades of the students. The main reason for this is that there is no method of authenticating the student taking the assessment and there is no barrier against cheating and plagiarism. Melissa (2002) and Rowe (2004) also identify the issue of plagiarism as a problem in relation to online assessment in distance education. They also argue that insufficient attention has been focused on this issue. A further concern is that when concerned with high-stake assessments, students are more likely to plagiarise than when the assessment has no impact on the grades (McDowell & Brown, 2001).

For these reasons the study focused on two main problems. These two problems are referred to as part 'A' and part 'B' in this thesis. Part A of the study concerns the problem of plagiarism in online assessments in distance education pertaining to the authentication of an online examinee or authentication of an assessment artefact developed at a distance and measures that can be taken to minimize the opportunity for plagiarism. The aim of this section of the study is to identify approaches to address the issue of plagiarism in online assessment and incorporate these approaches when designing the assessment model. Part B of the study concerns the online aspect of distance education and the use of technology to address the issues of learner support and assessment using the concept of assessment 'for' learning. The concept of assessment 'for' learning is based on the notion that assessment practices have to be developmental rather than solely judgemental (Brown, 2004). Assessment for learning relies on the sequential activities of assessment followed by feedback aimed at helping students know where they stand and where they need to be, and finally what they need to do to get there (Sadler, 1989).

The domain of technology aided distance education

Figure 1 illustrates the domain of technology aided distance education as conceptualised in this thesis. The technological component is the medium of interaction between the learner, content and the educator, whilst the pedagogical dimension encompasses the educational strategies for the entire learning process. Stahl et al (2006) quotes LeBaron's (2002) commentary title "Technology does not exist independent of its use" and further adds, "Substitute, 'activities, artefacts and environments' for 'technology' and the

message remains the same” (p. 10). Therefore, this study considers the technological component and the pedagogical component as complementary to each other in the learning and assessment process. Consequently, assessment practices have been designed by taking into consideration the available technologies and their affordances whilst incorporating them using pedagogical approaches in order to create an assessment model with the aim of achieving authentic assessment of student learning and supporting the process of assessment ‘for’ learning. Furthermore, technological and pedagogical approaches for addressing the issue of plagiarism need to complement each other. The issue of plagiarism is only considered in the case of high-stakes assessment or assessment that contribute to the final grade.

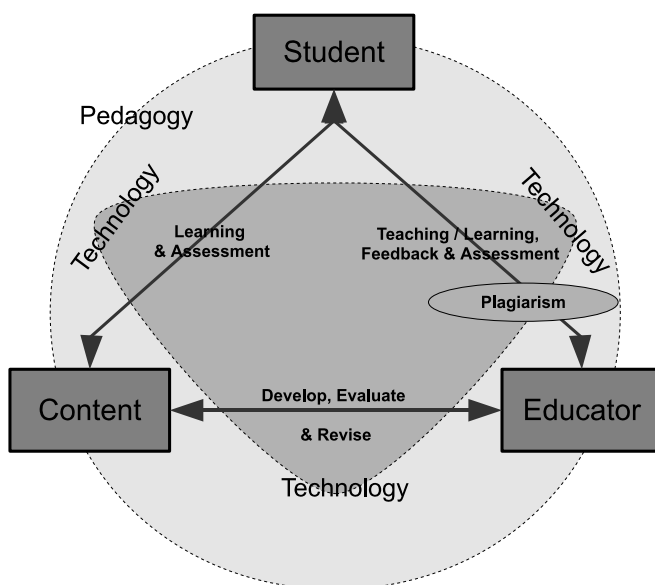


Figure 1. Relationships in Technology aided Distance Education

Aim and research questions

The aim of this study is to contribute to a better understanding of the effective pedagogical use of technology for the purpose of the enhancement of students’ learning through assessment. This aim includes two main dimensions that run in parallel, assessment practices and the identification and prevention of plagiarism. The study has involved the designing of an online formative assessment model in the distance education context (the

FADE) that aims to assess learning outcomes that may be achieved, not only in the BIT degree program but also in other educational contexts. The overall research questions are:

- What is the impact of the FADE online forum on the learning process, student learning and students' attitudes?
- What are the relationships between students' performances in the assessment criteria of the FADE model, their achievement in the end semester examination and the students' competencies and attitudes?
- How can candidates be verified online and what measures can be taken to minimize plagiarism?

Structure of the Thesis

This thesis starts by introducing the context of the study, which consists of a national and a local context. It is then followed by a review of ICT in education and research on learning and assessment. The review of the research on learning focuses on higher order thinking and collaborative learning, whilst the review of the research on assessment focuses on the students' perspective, student centred assessment, summative and formative assessment and e-assessment. The theoretical point of departure that describes the theoretical foundation of this thesis is then outlined. This is followed by an outline of the methodology used in this study focussing on design-based research, which includes the design of the study, validity and reliability issues, summary of results and ethical considerations. Finally, the discussion presents a synthesis based on insights gained through the integration of theories and methods. Firstly, the synthesis focuses on assessment practices elaborating on the student perspective, text-based versus multimedia content, factual knowledge and higher order thinking, collaborative learning and the use of technology. Secondly, it focuses on plagiarism prevention and detection. Thirdly, it focuses on the evaluation of the design elaborating on learning, competencies and attitudes. Finally, it summarises key considerations in designing assessment. The thesis concludes by stating contributions, implications for the BIT degree programme and future research.

Context of the study

The purpose of this section is to contextualise the research problem in order to create a clear understanding of the scope of the study, assumptions made and the limitations of the study.

Sri Lankan context

This thesis contributes to the furthering of knowledge with respect to online learning and assessment in distance education. It also contributes to addressing issues of plagiarism with regard to online assessment in distance education. The BIT degree programme that is the focus of this thesis is also important in a national context due to the opportunity it creates for greater access to and increased levels of participation in higher education in Sri Lanka.

The Sri Lankan university system is governed by the state and overseen by the University Grants Commission [UGC]. Sri Lanka has fifteen universities and seventeen other higher education institutions (UGC, 2011a) with a total enrolment of 73,398 undergraduate students and 4,984 academic staff (UGC, 2011b). In addition to the UGC sanctioned institutes there is one more institute that is permitted to award degrees. Sri Lanka also has private educational institutes that act as proxies to foreign universities in order to provide higher education in Sri Lanka.

The admissions to the state university system are based on the results of the G. C. E. Advanced Level [A/L] examination, which is a national examination that can have four streams of study and is conducted by the Department of Education. The streams of study determine which degree programme a student is allowed to enrol for at the University. Approximately 210,000 students sit for the A/L examination and about 130,000 qualify with the minimum grades required for the university admission. However, the state run universities have placements for about 21,000 students, which is about 16 per cent of the students who have qualified to gain admission to university. The students who gain admission are provided with education that is free and follow degree programs on campus. These programs are referred to as Internal degree programs.

As a solution to the issue of the lack of places at university, some universities conduct External degree programs where students study off campus and are also required to pay for their studies. The BIT degree programme is one such external degree programme conducted by the UCSC.

In addition to the above issue of limited access to higher education, there is a further economic issue. It is estimated that Sri Lankans spend around 700 million US dollars per year for higher education in foreign countries. In

comparison, Sri Lanka spent about 150 million US dollars on university education in 2009 (Nanayakkara, 2010). Therefore, the provision of more opportunities through increased access can help to minimise the negative impact on the Sri Lankan economy.

BIT context

The BIT degree programme is an external degree program offered by the UCSC. This is a three-year study programme that provides education for students who have an interest in the field of Information Technology [IT]. This programme is modelled so as to provide students with opportunities to exit the programme with a qualification at the end of each year if they have fulfilled the minimum criteria. At the end of the first year they have an opportunity to obtain a Diploma in IT, in the end of the second they have the opportunity to obtain a Higher Diploma in IT, and at the end of the third year they can gain their degree of Bachelor of IT.

The enrolment of the BIT study programme is over 1,500 students per year. In a study conducted by Usoof, Hudson and Wikramanayake (in press), withdrawal rates for the first year were identified as being as high as 55 per cent, and first attempt success rates (passing all courses to continue to the next stage) for the first year were as low as 11 per cent. To address the issue of the lack of learner support, the UCSC introduced the BIT website in 2003/4 which hosted learning material such as detailed syllabuses, presentations and video lectures. In 2006/7 the BIT VLE was introduced and hosted courses on the Moodle environment. The VLE consisted of a course book, interactive learning objects, video lectures, practice quizzes and online forums. The assessment criteria were also amended during this period. These measures succeeded in reducing the first year withdrawal rate to 38 per cent and in increasing the first year students' first time success rate to 41 per cent.

Learning and Teaching

BIT students have adopted varied study methods. Some attend group classes conducted by private educational institutes that focus on the BIT course syllabus, others study in groups and some employ self-study.

The UCSC does not perform any teaching activities and acts as an administrative body. Administration of students, creating courses, preparing and conducting examinations and marking are the main activities conducted by the UCSC. At the induction to the BIT degree programme the UCSC provides a detailed syllabus with learning outcomes, topics covered and specific references to aid students in learning. In addition, the UCSC conducted TV programs and provided some assignments which students

could submit online. With the introduction of the VLE funded by the Swedish International Development Cooperation Agency [SIDA], the UCSC developed student course manuals, online learning content, practice tests, online assignments, video lectures and discussion forums in order to support student learning online.

The students did not have any contact with the academic staff that led the courses, but a learning facilitator was employed to manage the online courses if students had any problems and questions. The assignments were Multiple Choice Questions [MCQs] and the students were given automated feedback.

Assessment

The assessment process in the first year of the BIT degree programme consists of a final examination that is conducted at examination centres located in the main cities around Sri Lanka. The examination consists of 40-60 MCQs and mainly focuses on factual knowledge. The final examination contributes 100 per cent of the marks in deciding the final grade. The assignments during the course are only considered as a prerequisite for obtaining the Diploma or the Higher Diploma at the end of the first year and second year of study respectively.

The research field

The aim of this section is to provide an insight into concepts that are relevant to the field of study in order to create an overall perspective of the thesis and bring into focus previous research that this thesis builds upon.

ICT in Education

The focus of this section is on the capacity of Information and Communication Technology [ICT] to both enhance education and improve accessibility to education. Furthermore, it focuses on the important factors that need to be considered for the effective application of ICT in the domain of education.

There is a rapid deployment in the field of ICT. The technology has moved on from large stationary computers to devices that fit in pockets, from fixed-point access to wireless access even in remote regions, and from a static web to a dynamic and social web. There is also a rapid growth in Internet penetration around the globe. World Internet Stats (2012) indicate that from 2000 to 2011 Internet penetration has increased by 150 per cent in North America, 800 per cent in Asia, 1200 per cent in Latin America, 2200 per cent in the Middle East and 3000 per cent in Africa. This development of information technology and the rapid growth in Internet penetration make ICT a powerful medium to deliver education to the masses. In their 1998 report the World Bank states,

[ICT] greatly facilitates the acquisition and absorption of knowledge, offering developing countries unprecedented opportunities to enhance educational systems, improve policy formation and execution, and widen the range of opportunities for business and the poor. One of the great hardships endured by the poor, and by many others who live in the poorest countries, is their sense of isolation. The new communications technologies promise to reduce that sense of isolation, and to open access to knowledge in ways unimaginable not long ago.

The World Bank report refers to the facilitation of the acquisition and absorption of knowledge offered by ICT. There have been many attempts, not only in the developing world but also in the developed world, to apply ICT in education, but many have failed to achieve their goals (Kirkup, 2005; Collins, 2001; Watson, 2006). On this question, Underwood (2004) argues that one reason is that there has been ‘failure of the ICT educational community to make contact with the central body of educational research’ (Underwood, 2004). This highlights the need for the consideration of pedagogical aspects when integrating technology in educational settings in order to make them more effective. This is echoed in the work of Hudson (2011), who puts forward an Integrative Didactical Framework for ICT and

Learning which addresses the ‘what, why and how of ICT use in relation to content, design and interaction/ICT use’. In considering the central question of why use ICT at all, the overall purpose of this study is embedded within that of the BIT degree programme as a whole, which is one of enhancing equity in education by widening access to higher education in Sri Lanka on a major scale.

Enhancing learning

Whilst the main use of ICT in the BIT degree programme has been as a mode to improve access to education, this is only one aim of the use of technology. The other aim is to enhance education, which leads to the question of ‘what is implied by enhancing education?’. This involves improving access to information and the quality of communication and interaction between all involved in the process of education. It also relates to improving quality in terms of what is expected from a graduate in higher education. Some of the identified values and attributes in recent research studies on this aspect highlight the importance of critical thinking, problem solving, interpersonal understanding, communication skills, creativity, intellectual curiosity and imagination (Coates, 2005; Bath 2007). This thesis does not address all the above values and attributes but instead focuses on higher-order skills and collaboration which are seen as key competencies required for the ICT industry (Bently, Lowry & Sandy, 1999; Neo, 2003; Wickramasinge & Perera, 2010; Macan Makar, Madurapperuma & Maroulis, 2006), and which are reflected in the main aims of the BIT degree programme.

Higher order thinking

The development of higher order thinking skills on the part of students has been identified as an important quality assurance factor for an undergraduate degree programme. In their attempt to derive a definition for higher order thinking, Lewis and Smith (1993) determine that philosophers and psychologists have different interests in higher order thinking. They identify that philosophers are primarily concerned with the “use of logical reasoning and perfections of thinking to decide what to believe and do” (p 132), and that in contrast psychologists are mainly concerned with the “thinking process and how this process can help people make sense of their experience by constructing meaning and imposing structure” (p 132). Through this it is determined that whilst philosophers emphasise reflective thinking and logic, psychologists emphasise problem solving in defining higher order thinking.

A further perspective is brought forward by Lewis and Smith (1993) to determine if there is such a thing as higher order thinking as opposed to lower order thinking. Newman (1993) differentiates higher order thinking, which is signified by challenge and which expands the use of the mind, whereas lower order thinking is signified by routine, mechanistic application and constraints on the mind. Newman (1993) goes on to elaborate that the challenge and expanded use of the mind occurs when an individual must “interpret, analyse, or manipulate information because a question to be answered or a problem to be solved cannot be resolved through the routine application of previously learned knowledge” (p 2). However, Newman forwards the notion that the requirement for an individual to engage in higher order thinking or lower order thinking in answering a question or solving a problem is relative to that individual’s intellectual capacity.

A further definition is offered by Hopson (2002), who defines higher order thinking as cognitive skills that function at the analysis, synthesis and evaluation levels of Bloom’s taxonomy. McLoughlin & Mynard (2009) add comprehension to Hopson’s definition whilst Miri, David & Uri (2007) define higher order skills as a combination of critical thinking, decision-making and problem solving. It is also important to note that some writers use the term critical thinking as an alternative to higher order thinking (Halpern, 1998).

Having defined higher order thinking as a combination of critical thinking, decision-making and problem solving which involves cognitive function at the analysis, synthesis and evaluation levels of Bloom’s taxonomy, the focus shifts to the question of ‘what measures can be taken to develop higher order thinking on the part of learners?’. Assessment can drive learning according to Boud (2000). As a result, it is identified that assessment can be a key tool to promote the development of higher order thinking in learners. In the context of this study, assessment is currently in the form of MCQ tests. These tests are inclined towards testing factual knowledge rather than higher order skills and so can encourage rote learning on the part of students. The work of Scouller (1994 1998), Gipps (1994) and Paxton (2000) all support this view. Another common problem is the guessing factor when dealing with MCQs. Innovative MCQ development such as “confidence measurement” (Farrell & Leung 2004, Davis 2002) and “computer adaptive testing” (Conole & Warburton 2005) may still be used to solve this issue, but it still does not fully eliminate the guessing factor since MCQs feed the answer rather than encouraging the student to construct an answer.

Buchanan (1998 as cited in Kendle & Northcote, 2000) recognises that higher order thinking skills are difficult to develop or to assess through MCQ tests. Therefore it is important that learning and assessment activities should be included which encourage the development of higher order skills.

In addition to the impact on assessment in developing higher order thinking, Garrison & Vaughan (2008, p 29) identify that “for there to be a higher cognitive presence, both reflection and collaboration must be there”. Gokhale (1995) and Garrison et al (2000) also identify that one of the means of nurturing higher order skills is through collaborative learning. Garrison et al (2000, p 103) concluded in their study that “computer conferencing appears to have considerable potential for creating an educational community of inquiry and mediating critical reflection and discourse (i.e., critical inquiry)”.

Collaborative learning

In addition to nurturing higher order thinking, collaborative learning also promotes the nurturing of communication skills and interpersonal understanding and collaboration that are identified as skills that are expected from a graduate in higher education. Dewey (1959 cited in Garrison et al 2000) highlights that the educational process has both a psychological and a sociological side. He argues further that neither is subordinated to the other, and nor can one be neglected without consequences. Therefore, as important as it is to promote knowledge and critical thinking, it is also just as important to promote collaboration and social interaction.

Collaborative learning can be defined as ‘what takes place when a small group of workers or students engage together in cognitive activities like problem solving or knowledge building’ (Stahl, 2006). However, even though this definition could also include co-operative learning, it is important to note that collaborative learning and co-operative learning are distinct from each other. On the one hand, Roschelle and Teasley (1996) identify co-operative learning as being based on the division of labour, where each participant is responsible for a portion of the problem. On the other hand, they identify collaborative learning as being based on a mutual engagement of participants in a coordinated effort to solve the problem.

This particular cognitive activity perspective of the construction of knowledge in a social context can be associated with the socio-cultural theory of Vygotsky (1978). Employing collaborative learning as a means of enhancing learning can also be seen as supporting learning within the ‘Zone of Proximal Development’ (Vygotsky, 1978), and is also related to the concept of ‘scaffolding’ (Bruner, 1978) the learning process. From this perspective, it is important that there exists an environment that students can work in collaboration with a teacher/tutor and/or with peers. A study by Andersson (2008) showed that students in the BIT degree programme identify the value of peer-collaboration and its importance to improving learning. A further study by Usoof and Wickramanayake (2009) confirmed Andersson’s conclusions.

With the development of technology, learning communities are no longer restricted to the traditional classroom or to particular moments in time or particular places in a physical space. Computer supported collaborative learning [CSCL] has made it possible for time- and space-wise separated individuals to collaborate in the same learning community (Strijbos et. al, 2007; Rovai, 2000; Brown, 2001; Jin 2002). In the BIT context, the student is separate from his educators [i.e. Teacher or Learning Facilitator] and his or her peers in both time and space, and therefore CSCL has been seen to offer the potential of acting as an effective tool for the BIT study programme.

Assessment

Assessment is defined by Reeves (2000, p 102) as the “activity of measuring student learning and other human characteristics such as aptitude and motivation”. As mentioned earlier, although assessment drives learning, it may also drive ‘out’ deep learning (Boud, 2000). Therefore it is important to understand which assessment method drives learning and which drives it ‘out’. The students’ approach to learning in terms of assessment is a function of three factors (Boud, 1995). The first factor is the intrinsic qualities of the assessment being used. The second factor is the way in which the assessor transforms the material requiring assessment into the given format and the way the appropriate assessment task is selected in relation to the subject and the specific learning goals, and the third factor is how the student interprets the assessment task and the context of the assessment. From this we can develop a set of prerequisite conditions for developing assessment.

Students’ perspective

From the three factors that were mentioned above which determine the students’ approach to learning in terms of assessment, how the student interprets the assessment task and the context of the assessment are two of the most important factors. Boud (1995, p 37) states that “[Interpretations and] perceptions cannot be assumed: they are only available from the students themselves”. Another important consideration is that students are brought in as partners into the assessment process in order that students build a sense of having a partnership and being in charge rather than being victims of the assessment. Furthermore, it will help them build self-confidence (Stiggins, 1999). As the student is the main actor in assessment, it is important that the student be placed at the centre of focus when designing assessment and that the student is a partner in the assessment development process.

Student centred assessment

Barr & Tagg (1995) identify a shift in higher education from the instruction paradigm to the learning paradigm. This shift in turn causes the focus of education to move from being traditionally teacher-centred to being learner-centred. A focus on learner-centred education affects all elements of education, including assessment. Angelo and Cross (1993, p 4) define this shift as assessment, since the “focus is on observing and improving learning, rather than on observing and improving teaching”. In this context, the traditional role of assessment, with a primary focus on the evaluation of a students’ comprehension of factual knowledge somewhat gives way to a primary focus on fostering learning (Webber, 2011). Assessment that yields information for analysing, discussing and evaluating a learner’s performance against set learning objectives, and thereby generating results used to improve subsequent learning, can be defined as student-centred assessment (Huba & Freed, 2000). Even though student-centred assessment mainly focuses on the students, it also helps teachers to answer two key questions. First “What have my students learned and how well have they learned it?”, and second “How successful have I been at accomplishing the goal and objectives I have set [for a single class period, a particular skills set, or an entire course]?” (Huba & Freed, 2000).

Summative and Formative assessment

Assessment can be distinguished into two primary categories i.e. formative and summative assessment, on the basis of the function [purpose] each serves and the timing of its application (William & Black, 1996; Harlen & James, 1997).

Summative assessment is characterised by its main purpose of being conducted for ‘feedout’ (Knight, 2002), where ‘feedout’ is identified as assessment results that are aimed for accreditation of students, placement of students and also by administration for accountability and policy issues (Knight, 2002; Black, 1998a, Black & William, 1998a). Harlen & James (1997, p 370) describe the purpose of summative assessment as “to describe learning achieved at a certain time for the purposes of reporting to parents, other teachers, the pupils themselves and, in summary form, to other interested parties such as school governors or school boards”. The purpose of this ‘feedout’ could be for these objectives to make this assessment high-stakes (Glaser & Silver, 1994; Black & William, 1998a; Stiggins, 2002, Knight, 2002). Even though summative assessment does not consist of an aim of feedback for the purpose of learning, assessment inherently drives learning. The challenge is that this ‘drive’ to learn only occurs for some students, whilst others will ‘give up in hopelessness’ (Stiggins, 2002, p 2).

Furthermore, these objectives have driven summative assessment to be standardised and reliable in data collection (Glaser & Silver, 1994; Black, 1998a).

In contrast, formative assessment is characterised by its main purpose of being conducted for feedback (Knight, 2002). Black (1993) identifies that the characteristic that differentiates formative assessment from summative assessment is that formative assessment involves a close relationship between both teacher and student. In this process the assessment information is used by both the teacher and the student to modify their work in order to make it more effective. These outcomes of formative assessment fulfil the characteristics of a student-centred assessment.

The key feature of formative assessment is the feedback it provides for both the teacher and student (Black & William, 1998b; Black, 1998b; Sadler, 1989). This feedback is defined as “information about the gap between the actual level and the reference level of a system parameter which is used to alter the gap in some way” (Ramaprasad, 1983 cited by Sadler, 1989, p 120). This feedback is only effective if the students know what standards they have to reach, have the ability to identify the difference between their achievement and the standard, and are able to take measures to reach the set standard (Sadler, 1989, Taras, 2005). Therefore the effectiveness of formative assessment depends on the students being able to perceive the gap between where they should be and where they really are (Biggs, 1998). Taras (2005) points out the advantages of formative assessment as promoting two pedagogical practices conducive to teaching and learning. Firstly, discussing and understanding criteria, and secondly, providing feedback to learners on which they reflect. The importance in the case of feedback in formative assessment is whether the students perceive the gap between the standard they should be at and the standard they are at; and if they do, what they are willing to do about closing the gap (Biggs, 2002). Biggs also points out that self-assessment is still rarely used, even in tertiary classrooms.

The source of feedback in formative assessment for the students is not only from the teacher but is also from peers and through self-monitoring (Orsmond et al, 2002; Sadler, 1989 1998; Black & William, 2009). The roles and actions of different agents in formative assessment are reflected in Figure 2. The teachers receive feedback through their students and adapt their teaching and learning activities (Black & William, 1998a).

	Where the Learner is going	Where the learner is right now	How to get there
Teacher	1. Clarifying learning intentions and criteria for success	2. Engineering effective classroom discussion and other learning tasks that elicit evidence of student understanding	3. Providing feedback that moves learners forward
Peer	Understanding and sharing learning intentions and criteria for success	4. Activating students as instructional resources for one another	
Learner	Understanding learning intentions and criteria for success	5. Activating students as the owners of their own learning	

Figure 2. Aspects of formative assessment (William & Thompson, 2007, p 63)

e-Assessment

The process of e-Assessment is defined as “the end-to-end electronic assessment processes, where ICT is used for the presentation of assessment activity and the recording of responses (JISC/QCA, 2007, p 6). This includes the end-to-end assessment process from the perspective of learners, tutors, learning establishments, awarding bodies and regulators, and the general public”. This electronic assessment process could be diagnostic, formative or summative (BECTA, 2006). The use of ICT for assessment has also enabled flexibility in assessment. From uploading assignments as digital content for teacher and/or peer feedback to more innovative assessment where questions are dynamic through the incorporation of computer code and multimedia (Gonzalez-Barbone & Llamas-Nistal, 2007). The use of e-Assessment has also made it possible for the conduct of examinations independent of time and place, which provides more flexibility for the learner and the teacher (Graff, 2003).

Theoretical point of departure

This chapter describes the theoretical foundation on which this thesis is based. It argues for the decisions and assumptions that have been made during the study. Grix (2002, p 177) states, “ontology is the starting point of all research, after which one’s epistemological and methodological positions logically follow”. These are better explained by the questions they provoke. Firstly, the ontological question, “What is the form and nature of reality, and therefore what is there that can be known about it?” Secondly, the epistemological question, “What is the relationship between the knower or the would-be knower and what can be known?” Thirdly, the methodological question, “How can the inquirer go about finding out what he believes can be known?” (Guba & Lincoln, 1994, p 108). This means that the ontological positioning defines what questions can be asked in the domain of study, the epistemological position defines what can be known and if what can be known is dependant or independent of the knower, and finally the methodological positioning defines the methods that can be used for inquiry and the conditions to which they need to adhere. In order to respond to the problems relating to assessment in the BIT programme concerning both plagiarism issues and higher-order thinking, different perspectives, theories and methods were employed.

The first study of this research, the study of keystroke dynamics as a possible authentication tool, was carried with the ontology of realism. That is, with a belief that reality existed in ‘real’. This ontological belief epistemologically positions the researcher as an objectivist. This epistemological positioning dictates that the research questions asked are independent of the inquirer and would relate to ‘real’ subsistence or actions. The methodology that needed to follow was an experimental one with stringent control for confounding factors. As in this methodological practice, a hypothesis was forwarded and subjected to empirical testing in order to verify the validity of the tested hypothesis.

The later studies on the pedagogical perspective on plagiarism and design of assessment were carried out with the ontology of relativism. That is, with a belief that reality exists but is not independent of the subject. This ontological belief epistemologically positions the researcher as a subjectivist. This epistemological positioning views learning as related to the individual learner, and thus to the learners’ social and cultural world. This positioning is key to conducting research on more complex social phenomena in a real-world context that would not only have theoretical implications but also practical applications. Additionally, this stance insists that the researcher focuses on a learner-centric approach to the study. The subjectivist

epistemology and the social and cultural context of the learner it brings into focus closely relate to the theories put forward by Lev Semenovich Vygotsky.

Vygotsky's socio-cultural theory

The roles of social and semiotic mediation for learning and development were a focal point among the learning theories developed by Vygotsky (Dimitriadis & Kamberelis, 2006). Vygotsky differentiated between elementary mental functions and higher mental functions. This view is evident in referring to the three interrelated themes that run through his theories. Firstly, he claimed a genetic or a developmental method. Secondly, he viewed higher mental processes as having their origin in social processes, while thirdly, he claimed that mental process could only be understood if we understand the tools and signs that mediate them (Otero, 2004).

The second theme is a key concept that has direct implication on this study for reasons that are concerned with developing and assessing higher order thinking skills. This further influences the application of social constructivism and the use of collaborative learning and consideration of the role of the zone of proximal development in this study.

Zone of proximal development

Vygotsky (1978, p 33) defined the zone of proximal development [ZPD] as “the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult supervision or in collaboration with more capable peers”. According to Vygotsky, the zone of proximal development defines the functions that are not yet matured but are in the process of maturing. They are termed as “buds” or “flowers” rather than “fruits” of development. The ZPD characterizes the development prospectively. The most effective form of teaching-learning forms occurs within the ZPD (Dimitriadis & Kamberelis, 2006). As the term proximal implies, the provided assistance goes slightly beyond the learners’ current level of competence (Cole & Cole, 2001).

To understand the complexity of ZPD, it is necessary to take into account concepts such as social mediation of learning, tools of mediation, intersubjectivity and internalisation (Verenikina, 1998). With reference to these concepts in ZPD, collaborative learning with peers helping each other learn and collaborating in the social construction of knowledge, and thereafter internalising this socially constructed knowledge, justifies the use of this theory in the development of the study.

Methodology

Kothari (2006, p 8) defines research methodology as “a way to systematically solve the research problem. It may be understood as a science of studying how research is done scientifically”. The research methodology constitutes a set of research methods and logic behind those methods (Kothari, 2006). The logic is which methods and sources can be chosen to achieve the required knowledge. This leads to questions about knowledge itself. The queries ‘What’s out there to know?’, and ‘What and how can we know about it?’, are put forward. These are questions referring to ontology and epistemology. Therefore, the methodology is tied to the epistemology, and through it to the ontology of the researcher (Grix, 2002; Guba & Lincoln, 1994; Schwandt, 2000).

Different sciences have different methods of inquiry (Waltz, 2003). Furthermore, the research questions should be followed up by methods that are chosen in a way to best answer the questions being asked (Johnson & Onwuegbuzie, 2004). In this study, Part A puts forward two fundamental questions. 1] Are keystroke dynamics unique between individuals and across different writing tasks to be used as a biometric identifier? 2] What measures can be taken to minimise plagiarism? The first question lies in the field of Computer Science, and the most effective method to answer this question was a quasi-experimental approach. To answer the second question, which lies in the field of Educational Sciences, the most appropriate method was considered a literature survey. This part of the study required multiple methods that lay in different fields of science.

Part B of the study first required the development of an assessment model that meets the context, requirements and restriction of the problem domain of eAssessment in distance education. The available models lacked major components or would not support the context of the research problem. Moreover, the available models mainly concentrated on either the pedagogical or the technological perspective. As a result it was a requirement that the research methodology provided opportunities to design, evaluate and refine both technological components and pedagogical consideration in the assessment model. The design-based research methodology provided for this requirement and was therefore used to conceptualise the methodology in this study.

Design-based research

Laurillard (2002), in her book “Rethinking University teaching”, concluded that the complexities of learning demand that the instruction for achieving learning outcomes should be based on the results of contextualised factors and not on individual factors that are removed from context. Bell (2004), states that “learning is too complex a phenomenon to be the sole province of any one discipline, theoretical perspective, or research method” (p 243). LeBaron (2002) states that “technology does not exist independent of its use” (p 433), which implies that technology, especially in a social context needs to be implemented based on the results of the contextualised factors of its environment and its use. With this thesis positioning itself in the domain of learning and assessment and the domain of information and communication technology, it is important that the research methodology used is be able to incorporate all of the factors presented by this research context.

Bell (2004) puts forward three terms currently being used interchangeably. He attempts to create a clear distinction among the three terms that he describes as three different approaches. The first term of ‘design research’ is described as an approach without the theoretical underpinning and rigorous empirical research. This approach may produce useful outcomes but does not inform the nature of a particular educational phenomenon. The second term of ‘design experiment’ is defined as ‘design research’ with the theoretical underpinning. The third term is ‘design-based research’, which he argues to be “a high level methodological orientation that can be applied within or across different theoretical perspectives and research traditions” (p 245). The intention is to bring together design and research in order to create a better understanding of educational phenomena. In this thesis the term ‘design-based research’ is used with this definition.

Brown and Collins brought the concept of design-based research to the forefront in 1992 (Collins, 2004). The main motivation behind design-based research arose when early practitioners of design-experiments found it challenging to isolate all variables when they moved their research from the laboratory setting into the real world (Brown, 1992). Design-based research is a methodology used in education that uses interventions to provide an insight into educational phenomena in the real-world context (Joseph, 2004). This can be identified as the strength of design-based research, as education predominantly occurs in the real world and not in the controlled environment of a laboratory. Therefore, design-based research supports going beyond narrow measures of learning. Design-based research also supports the derivation of research findings from formative evaluation

(Collins, 2004) which permits for the continuous development of the design through multiple design cycles.

Design-based research is also defined as a series of approaches that aim to produce new theories, artefacts and practices and have a potential impact on real-world settings (Barab & Squire, 2004). Design-based research also requires an intensive literature review and theoretical generation and uses many data collection and analysis methods used in qualitative and quantitative research (Orrill, Hannafin & Glazer, 2004). Therefore, design-based research is a powerful tool that not only impacts upon education in the real-world setting but also contributes to the development of theory.

Design-based research in the domain of technology and education

With the rapid development of technology there has been a rise in enthusiasm amongst the design community. However, research about these technologies still follows design in a sequential manner and has a limited influence on the real world (Wang & Hannafin, 2005). Research based design, with its formative evaluation component, enables this problem to be addressed. The employment of design-based research provides opportunity for design and research to be parallel rather than sequential activities (Wang & Hannafin, 2005; Cobb, 2003).

Criticism of design-based research

The methodology of design-based research is not without debate. Inherent complexities of the real world, large amounts of data produced which call for ethnographic and quantitative analysis, and comparisons across different designs are some of the challenges that are faced in design-based research methodology (Collins, 2004). 'Lethal mutation' is a further challenge (Brown & Campione, 1996 cited in Collins, 2004). This is when the enacted design is different from the design envisioned by the designers and undermines the initial goals and principles. Furthermore, the inability of a design to specify all of the details along with the action of the participants in the research influences the decisions and can lead to them going beyond the design (Collins, 2004).

Design of this study

The problem domain was categorised into the two domains of technology and pedagogy. This was done in order to identify and address challenges of different components of the assessment model and the different components of the study on plagiarism. Even though the components of the assessment model and the plagiarism study were addressed separately, they were not considered independent of each other at any given time of the research. This was in order to maintain cohesion in the model. The research was carried out in three phases.

Part A: Addressing plagiarism

Plagiarism was a key issue under consideration in the development of an assessment model for the problem domain. It was decided to address plagiarism in the technological domain using a controlled experiment in order to be able to identify individuals in an online environment. To address the issue of plagiarism in the pedagogical domain, an extensive literature survey was carried out to bring together previous research and good practice to formulate a set of requirements that an assessment model should support in order to negate plagiarism. Both the technological and pedagogical inferences influenced the development of Part B of this study. This part of the study is presented in articles I & II.

Paper I

The first paper is entitled *Who is Who and doing What in distance education? Authentication and keystroke dynamics*, and was co-authored with Dr. Eva Lindgren. This paper focuses on the study of individuals' keystroke dynamics as possible biometric identifiers. This study was motivated by the notion that there was a requirement to identify individuals in an online text-based environment as well as authenticating texts that were developed remotely on a computer. The paper is based on a study that was carried out as a controlled experiment. Ten adult native English writers were given four writing tasks which they had to complete on a computer and in their native language. The writers' keystrokes were logged and a micro-level analysis was conducted. The article presents the findings whilst identifying possible weaknesses and suggesting improvements to the model. This paper contributes a possible way of addressing online authentication or authenticating computer text developed remotely in order to address issues of authentication and verification in assessment in distance education.

Paper II

The second paper is entitled *Plagiarism: Catalysts and Not so Simple Solution*, and was co-authored with Prof. Brian Hudson and Dr. Eva Lindgren. This paper was motivated by the requirement to address the issue of plagiarism within a holistic view of the domain. This paper is based on a review and analysis of one hundred literature sources. The article addresses plagiarism, taking into consideration all stakeholders in education, the socio-cultural perspective and the pedagogical and technological perspectives. The paper also discusses plagiarism in the domain of distance education and identifies challenges and methods of detection, and it forwards a series of good practices in an attempt to reduce plagiarism. This paper contributes a wider view of plagiarism, which needs to be considered in any educational system. The suggested series of good practices are taken into consideration in Part B of this study.

Part B: Design of an Assessment model

Identification of design requirements

This phase involved the design of the FADE model that would be researched in the real world context of the problem domain. During this phase, an investigation was carried out to analyse the students' perceptions and preferences of assessment in order to derive a set of features that the assessment model must support. These features were derived from the previous phase that addressed plagiarism issues. A review was carried out on existing tools and environments that supported online learning and assessment. These tools and environments were evaluated in order to verify whether or not they supported the features identified during the literature review, the students' perspective and plagiarism issues in the earlier part of this stage, and whether they adhered to the constraints of the research problem domain.

Evaluation of the design and assessment criteria of the FADE model

The initial step during this phase of the study was so investigate the students' perceptions and attitudes towards assessment and learning and their preferences in relation to assessment. This was conducted firstly to compare the students who were going to take part in this phase of the study to the students who offered ideas that were gathered in order to design the FADE model in the previous phase. Secondly, it was conducted in order to be able to evaluate and draw relationships between the assessment criteria of

the FADE model and the students' competencies, achievements, preferences, attitudes and perceptions. The technological tool of FADE, the online forum, was investigated to determine the impact it had on students' learning, their attitudes and their performance in the final examination.

Paper III

The third paper is entitled *Technology Enhanced Assessment for Learning in a Distance Education IT Degree Programme in Sri Lanka*, and was co-authored with Prof. Brian Hudson and Prof. Gihan Wikramanayake. The motivation for this paper was to create a complete understanding of the context, challenges, requirements and opportunities pertaining to the domain of the BIT programme. This paper presents an analysis of the BIT degree programme with respect to assessment practices and their impact on the learning process, students learning outcomes and students' perception on learning and assessment. The paper also focuses on the context of the study, the impact of the use of technology for learning, and the impact of future research in this domain of interest. This paper contributes to the overall study by being the foundation of Part B.

Paper IV

The fourth paper is entitled *Assessment for Learning: Designing Online Assessment to Promote Higher Order Thinking using Collaborative Learning in Distance Education*. The motivation for this paper is to present the design of the FADE model developed from input from Paper III, Paper II and prior research together with the theoretical foundation. This paper focuses on the development of the assessment model and the analysis of the different components of the model. In the analysis of the components, the FADE online forum was analysed first in order to ascertain the impact it has on students' learning and to discover the motivations and attitudes of students taking part in it. Secondly, students were rated in the assessment criteria for higher order thinking and collaborative learning skills, and these ratings were analysed to discover relationships between these criteria and students' competencies, achievements in examinations and attitudes.

Validity and Reliability

This study has used both quantitative and qualitative methods, and this section looks at the concepts of validity and reliability related to both of these approaches. The criteria for validity and reliability find their origins in quantitative research from within a positivist tradition (Maxwell, 1992; Morse et al, 2002; Winter, 2000). With regard to validity there are two key

issues of a general nature to be addressed. Firstly is the question of whether the means of measure are accurate, and secondly, whether they actually measure what they are intended to measure. The key issue emerging from definitions of reliability is that of replicability (Winter, 2000).

In relation to quantitative methods, the two primary validity measures are internal validity and external validity. Internal validity describes the ability of the research design to unambiguously test the research hypothesis (Watt & van den Berg, 1995, pp. 186). This allows for the ability to make causal inferences from the study (Ross & Morrison, 2004). The consideration of internal validity in design of a study dictates that all factors, including those that are not directly specified in the theory being tested, are accounted for. Since it is impossible to account for all possible factors in a single research design, it is important that the study is designed for higher internal validity as perfect validity is rarely achievable (Watt & van den Berg, 1995). History: intrusion by events between first measure and subsequent measures, maturation: maturing of subject over time, testing: the instrument affecting the process being investigated, instrumentation and human error: faulty instruments and errors caused by the measurer, statistical regression: when repeated measures are extremely high or extremely low, selection: when using a factor that is a classification variable, mortality: death or absence for further measures, and diffusion: when a group becomes familiar with the treatment of another group are identified as eight threats to internal validity (White, 2009). External validity refers to the generalizability of the findings to the population or 'real world' (Watt & van den Berg, 1995; Ross & Morrison, 2004). Externally valid research is more valuable than externally invalid research, as it predicts the behaviour of the theoretical constructs outside the laboratory settings. Interaction of testing and treatment: the affect of the pre-test may sensitise the subjects to treatments yet to come, reactive affect: when the research setting itself produces a response, multiple treatment interface: the risk of the observation being produced only when exposed to the series of treatments, and representativeness of the sample: when the sample is skewed or unique in relation to the population are identified as four threats to external validity (White, 2009; Watt & van den Berg, 1995).

Reliability, also identified with consistency and dependability, is commonly identified with four classes. Inter-rater reliability: used to assess the degree of consistency between raters, test-retest reliability: used to assess consistency over a period of time, parallel-forms reliability: used to assess consistency of the same variable when measured using different methods or instruments, and internal consistency reliability: used to assess the consistency of results across items within a test (Gabrenya, 2003).

However, when considering them in qualitative research, these definitions may be inadequate or not relevant for the purposes of more qualitative approaches to research (Golafshani, 2003).

Reliability as an instrument itself is not seen as relevant in qualitative research as it focuses on replicability (Golafshani, 2003; Winter, 2000), and therefore issues of reliability are not addressed in the context of qualitative methods. With respect to validity in qualitative research, this has been redefined in terms such as credibility, trustworthiness and transferability (Morse, 2002; Golafshani, 2003; Cresswell & Miller, 2000; Whittemore, Chase & Mandle, 2001). To be able to ascertain validity in qualitative research, Winter (2000) proposes that “validity is not a singular acid test that can be applied to the research process as a whole. The validity measure can be applied differently depending upon the researcher's beliefs as to what stage of the research process is in need of validation”. He further clarifies that validity can be viewed as resident in an individual stage of the research process or in a combination of stages. Whittemore, Chase & Mandle (2001, p 528) suggest credibility, authenticity, criticality and integrity as primary criteria and explicitness, vividness, creativity, congruence and sensitivity as secondary criteria of Validity. They (p 533) further suggest four types of techniques [1] design considerations [2] data gathering [3] analytic, and [4] presentation and set of accompanying techniques to demonstrate validity. Similar techniques are covered in the ‘Lens and Paradigm’ framework for demonstrating validity presented by Creswell and Miller (2000, p 126).

In this thesis, validity and reliability have been concerned in the different sub-studies as well as in the research as a whole. The first sub-study focussed on the use of keystroke dynamics as a means of identification and was in the form of an experiment where all possible measures were taken to control for almost all factors that may affect the phenomena being studied in an attempt to achieve high internal validity. With regards to external validity, the subjects selected for the study were a highly homogenous group in order to be able to control for factors that may affect the phenomena being studied, therefore no attempt was made to generalize the findings to the entire population. Tests previously used by other researchers to study text development were used in conjunction with internal consistency reliability results in order to establish reliability. The second sub-study that focussed on the development and evaluation of the FADE model used a mixed methodology. Therefore validity of the second sub-study was addressed through random sampling, data triangulation and the use of indicators previously used by other researchers to measure phenomena. Inter-rater reliability was used to establish reliability in the second sub-study study.

The overall thesis is presented using [1] triangulation: where corroborating evidence was collected through multiple methods such as questionnaires, observations, interviews, databases and documents to draw

inferences, [2] disconfirming evidence: where certain presumptions were disproved by the data, and [3] researcher reflexivity: where the researcher has disclosed his personal beliefs/assumptions, values and biases that may shape the inquiry. In addition [4] member checking: where findings were confirmed by participants, [5] prolonged engagement in the field, [6] audit trails: where all procedures are clearly documented, [7] rich description: where deep, dense and detailed descriptions of all aspects are provided, and finally [9] peer briefing: where the work was presented to and discussed with others familiar with the research phenomena.

Summary of results

Results Paper I

Who is who and doing what in distance education? Authentication and keystroke dynamics. (Usoof, H. & Lindgren, E., 2008)

The aim of this study was to determine if keystroke dynamics of an individual who develops text on a computer could be used as a biometric identifier. The purpose of this biometric identifier was to use it as a means of authentication of text developed by an individual for assessment purposes on a remote computer or an online environment. Similar studies had been conducted with repetitive tasks, but none of them considered different writing tasks and the different cognitive processes that are involved in different writing tasks.

The results of this study indicate that there are keystroke patterns for individuals that are stable within and across different tasks, which indicates that the biometric of keystroke dynamics may be used as an authentication means by which text developed on a remote computer or an online environment could be validated. This provides a powerful tool for the promotion of remote assessment in distance education, which currently is unable to cope with requirements of authentication of an individual who takes an examination or produces a write-up in an unsupervised remote location.

A disadvantage of the model developed to compare keystroke dynamics was that it not only recognised differences between writers but also similarities, and therefore this makes it problematic for it to differentiate between individuals in some instances. Furthermore, the length of the sample text also affected the performance of the model. A further issue to be addressed relates to the ethical implications of using behavioural-biometric identifiers to monitor individuals.

Results Paper II

Plagiarism: Catalysts and Not so Simple Solutions. (Usoof, H., Hudson, B. & Lindgren, E., in press).

The aim of this literature survey was to develop a holistic approach to dealing with the issue of plagiarism. The approach included taking into consideration the viewpoint of all stakeholders in education and pedagogical and technological approaches to deter and prevent plagiarism.

The results of the literature survey revealed that there was no single approach that could address the issue of plagiarism. The approach to plagiarism had to be multifaceted using both technological means and pedagogical practices. The literature survey also revealed that every single stakeholder in education had to play a role and needed policy, education and training in order to be able to successfully deal with the issue of plagiarism. The article identified situations that lead to plagiarism and suggested a set of good practices that can be used to complement each other in order to address the issue of plagiarism in education.

Results Paper III

Technology enhanced assessment for learning in a distance education IT degree programme in Sri Lanka. (Usoof, H., Hudson, B. & Wickramanayake, G., submitted)

The aim of the study was to analyse the problem domain with regard to assessment practices and their impact on both the learning process and students' learning outcomes. The study also took into consideration the impact of the continuous enhancement of the BIT degree programme through the use of technology enhanced learning. The aim was also to create a better understanding of the students' perception on learning and assessment in order to design assessment that is student centric and responsive to their ideas.

The results of this study showed that the careful design consideration in implementation of technology to enhance the learning in the BIT degree programme and the review and amendment of the assessment criteria had a significant impact on the improvement of the students' first-time pass rates and the reduction of withdrawal rates. The results further showed that students recognised formative assessment and the concept of feedback and understood its importance. The study also identified that students prefer continuous assessment in combination with a final examination. In addition, the study identified that students were of the opinion that multimedia would help them better express their competencies in an examination. With respect to study methods that students use in the BIT, it was found that the majority

use self-studying, and about 42 per cent of them had little or no interaction with other students.

The study also identified that the attempts to create learning communities and collaborative learning environments had failed, likely due to the lack of activity modelling that encouraged building learning communities.

Results Paper IV

Assessment for Learning: Designing Online Assessment to Promote Higher-order Thinking using Collaborative Learning in Distance Education. (Usoof, H., submitted)

The aim of the last study was to evaluate the impact of the FADE online forum and to explore the relationship between the assessment criteria of the designed FADE model and the students' competencies, their achievements in the final examination and their attitudes. The study was based on a comparison between two groups, those who took part in the FADE online forum and those who did not.

The results of the study showed that the impact of the FADE online forum on students' achievements was similar to that of attending group classes for the BIT degree programme. It was identified that the students who participated in the forum used it as a substitute for attending group classes, and this was where they formed their learning community. The students also preferred it if marks were given for participation and considered when calculating final grades. Furthermore, the students identified that many more students would participate if marks were given and considered for the final grades.

There was no observable relationship between the prior knowledge that students brought into the study programme and their participation in the FADE online forum. The main significant factor that affected participation in the forum was the attendance of group classes, with the majority of those not attending group classes participating in the forum.

There was no observable relationship between the students' prior knowledge and their observed higher order thinking and collaborative learning skills in the forum. However, the rating of students in relation to the assessment criteria for higher order thinking in the FADE model showed a positive relationship with achievement in the final examination. The rating of students in relation to the assessment criteria for collaborative learning skills related to both their purpose of use of the forum and their experience on the social web. Students with the intention of sharing knowledge and helping peers and those with more experience on the social web showed stronger collaborative skills.

The results of the study indicated that the attitudes of the students varied according to motivation, employment status and social situation. Students

with extrinsic motivation were more focussed on gaining qualifications compared to students with intrinsic motivation who were focussed on learning. In this study, students with extrinsic motivation showed higher levels of higher order thinking and collaborative learning skills and also achieved higher grades in the final examination. Students who were unemployed or recently employed showed higher levels of higher order thinking and collaborative learning skills as well as they obtained higher grades in the final examination. The students who had been employed for a longer period showed more interest in learning than gaining qualifications. The study results also suggested that the amount of time students spend on the course due to work and other responsibilities might also have an effect on the achievements of students. As per age, it was observed that the younger students were more interested in higher grades and qualifications compared to older students.

Ethical considerations

The necessary ethical requirements of the university as defined by the Swedish Research Council (2001) were adhered to. Accordingly, the aspects of beneficence, non-maleficence, informed consent and anonymity were taken into consideration throughout all phases of the research. In every phase, the research subjects were provided with a written document that stated that their participation was voluntary and that they could withdraw from the study at any stage and request their data be destroyed. Furthermore, verbal consent and/or written consent were obtained from each individual. The data was securely stored and coded to protect confidentiality and anonymity. In addition, permission was obtained from the Board of Study of the BIT to conduct the research study with the students following the BIT degree and to access the learning and assessment systems in consideration.

Discussion

The purpose of this study was to contribute to the area of knowledge in the field of technology and education. The core focus was on creating an understanding of the effective pedagogical use of technology for the purpose of enhancing students' learning, in particular higher order thinking and collaborative learning skills through assessment. The intended outcome was a FADE model which could be used in context for discussing key assessment design considerations in the domain of distance education. The study also intended that these design considerations should include pedagogical and technological approaches to addressing the issue of plagiarism.

These aims have been approached by addressing two main dimensions in parallel, which are the assessment practices and the identification and prevention of plagiarism. This chapter focuses on presenting a synthesis based on insights gained through the integration of theories and methods. The discussion is structured so that it presents an individual analysis related to the research questions before drawing on connections between the interrelated analyses in order to reconceptualise them into the overall outcome of this thesis.

Assessment Practices

The key factors that need to be taken into consideration when designing an assessment in an online distance education setting are identified and discussed in this section.

The students' perspective

The students' perspective is identified as one of the most important factors that should be considered when designing approaches to assessment. The perspective of students is important from a constructivist assessment focus as it promotes the opportunity for one to understand how students see the assessment and how they construct it. For example, in this particular study context a large majority preferred formative assessment coupled with an end semester summative examination (Papers III & IV), which was contrary to the initial assumption that the majority of students would not prefer a summative assessment. This is key, as it is the students who take the assessment and also have to manage the time and resources that they dedicate to the study programme, which is especially important in a distance education context (Paper IV).

Another important factor is that design based on the students' perspectives builds students' sense of ownership of the environment. This

factor is important in two ways. Firstly, the sense of ownership provides students with confidence in the system. Paper IV showed that the students' sense of ownership of the FADE online forum is clearly demonstrated by 1] their voluntary participation, 2] the majority of the contributions to the forum focus on peers and a very limited number are aimed at the facilitator, 3] the freedom they use to express themselves in a culture where public speaking in the presence of a 'more knowledgeable' individual is uncommon, and 4] the support they give and dependence they have on peers for knowledge building and moral support. Prior interventions in the BIT using the Elgg social networking environment and phpBB forums failed (Paper III) as the students viewed them as "creepy tree houses" (Harris, 2009, p 59) and they did not take ownership of these environments. Secondly, as discussed further in the section *Plagiarism: detection and prevention*, the students' sense of ownership of an environment creates a barrier against plagiarism.

Text-based versus multimedia content

A major advantage of text-based environments is that they offer the potential to promote reflection on learning. Speech (spoken or written) can be seen as a semiotic tool that acts as a meditational means for cognitive development. When putting ideas into writing, students create objects that can be reread (silently or aloud) either by themselves or by others, and objects that can be discussed or revised which form the basis for further reflection and reformulation (Flower & Hayes, 1981; Hayes, 2012). This creation of objects of contemplation acts to promote the development of conceptual understanding through the process of internalisation (Wells, 1994). Even if students have not managed to develop any conceptual understanding, this process helps them to reflect on how much they know (or do not know) and what more they need to learn. This was evident through the assessment model as some of the students' posts had a component of what they had done to solve the problem, but where they had reached their limit of competency to solve it on their own. On the contrary, some students' posts consisted of questions without any indication of prior effort to solve them. The likely cause for this was how they viewed the forum. The students who viewed it solely as a place to get answers to their questions posted their questions online without indicating their prior effort to solve them (Paper IV).

Environments that support multimedia content also give students the opportunity to be creative by using media that they are comfortable with. The observation of the posts in the FADE online forum showed that text dominated the content followed by images. In this study, the participants posted other document types such as PDFs, Word files and PowerPoint presentations, but no audio or audio-visual files were posted. The learning

task on the forum mainly defined the type of media most suitable for use to communicate a response. Additionally, this could be influenced by the students' competency in using different media, the willingness or unwillingness to create self-video or self-audio productions, and the amount of effort they wanted to put into a task. The study also identified that the online environment had to function under different bandwidths, provide for asynchronous dialogue to eliminate Internet accessibility issues, and be able to cope with limitations in students' computer skills.

In the context of plagiarism in online environments, the text-based environment allows the possible integration of biometric keystroke dynamics (Paper I) for the purpose of the authentication of individuals participating in the assessment model.

Factual knowledge and higher order thinking

A key consideration in the process of assessment is that of identifying what to assess and how to do so. As mentioned previously, higher order thinking is an important trait identified in the quality assurance of higher education. However, in order to function at a higher cognitive level, individuals must be able to function at the lower levels of cognition which include remembering, understanding and applying. Factual knowledge is acquired at these lower levels of cognition. Therefore it is important that assessment covers factual knowledge and higher order thinking along with other skills deemed as important for quality assurance.

Factual knowledge is relatively easy to assess through standardised testing. However, the assessment of higher order thinking, creativity, collaboration skills, communication skills and interpersonal skills requires more innovative approaches. These approaches demand new forms of assessment tasks that promote and provide opportunity for students to demonstrate these competencies. The assessment design needs to support these approaches and assessment tasks. This study found that multiple assessment methods can be used to assess both factual knowledge and higher order thinking. In the context of this study, the end of semester examination that consists of multiple-choice questions is effective in assessing factual knowledge. Therefore, FADE could be used to focus on promoting and assessing higher order thinking, collaborative learning skills and other skills identified as important. This implies that multiple assessment methods can be integrated to form a cohesive assessment model that spans the entire spectrum of the assessment focus. Moreover, the wide focus of assessment allowed students to make more meaning of the assessment as it related to the real-world context. This making of meaning helped to change the methods they employed to learn from surface to deep approaches to learning. This study also found that these assessment methods

can be used for either formative or summative purposes or in order to achieve both.

From the point of view of plagiarism, as discussed in the section *Plagiarism: detection and prevention* the assessment of factual knowledge is more prone to plagiarism as it is based on knowledge regurgitation and does not require more advanced skills such as creativity, reflection, or synthesis. In contrast, the assessment of higher order thinking therefore seems less prone to plagiarism.

Collaborative learning

It is important that opportunities are provided for collaborative learning, particularly in a distance education setting. The theoretical framework provided by Vygotsky (1978) provides a rationale for the promotion of collaborative learning. As higher mental processes have their origins in processes of social interaction, the collaborative environment provides opportunities for fostering these skills in the distance education context. Another factor that promotes the use of collaborative learning is the student recognition of peer support in helping each other learn.

In this study, strong peer contributions were seen towards assisting learning and also for moral support. Furthermore, as they progressed students changed from simply posting questions to engaging in more dialogue and a collaborative construction of knowledge. The same shift was observed from the point of view of higher order thinking demonstrated by the students. Peer feedback and tangible measures of their learning through comparison with other students most likely influenced students to shift to participating in collaborative learning and developing and demonstrating higher order thinking. Collaborative learning environments can also provide opportunities to act as informal assessment environments, although the study found that they provided opportunities for using them as a formal assessment tool as well.

Technology use

Threaded discussions can mimic the physical worlds' conversations in an electronic environment. The origin of the discussion may be a question, a learning artefact, a task, or some other common point of interest. Chats, forums, email conversations and social networks all follow the concept of threaded discussions and are familiar to most students. In order to be readily available to students, technology-aided environments that support collaboration could also be based on threaded discussions. A further consideration for the environment selection was synchronous and asynchronous conversation, which were defined by the structure and

delivery method of the study programme. Real-time online assessment will imply that the environment will have to support synchronous exchanges, while time-independent assessment could employ asynchronous exchange environments.

Plagiarism: detection and prevention

This section reports on those aspects of the study that explore both technological and pedagogical solutions to address the issue of plagiarism in the area of assessment.

Whether the assessment is in the form of a paper document or a digital document or is a real time e-assessment in class or at a remote location, technology can play a role in the prevention and detection of plagiarism. The technological solution considered in this study is a comparison of keystroke dynamics in order to determine if the author of a text is the said individual or not. This approach provides an identifier with any text developed for the purpose of assessment that can be compared with a known copy of a biometric identifier of the author of the text (Paper I). This approach broadens the scope of assessment to include online forums, short-answer online examinations, wikis, digital reports and essays. This flexibility in assessment types allows for more creative e-assessment going beyond the traditional online multiple-choice test. It also permits the assessment to move from assessing factual knowledge to assessing higher order thinking and collaboration skills.

Considering the deterrent factor of technological tools such as keystroke dynamics as biometric identifiers used to authenticate the author of the text, plagiarism detection services and software, comparisons in web searches and library subscriptions are all considered to be extrinsic deterrents. In a similar way that extrinsic motivation is weak compared to intrinsic motivation, extrinsic deterrents are weak compared to intrinsic deterrents. These technological tools also have ethical and legal implications. Keystroke logging invades the privacy of students. Guaranteeing the security of these biometric data and guarding against misuse is a challenge for any educational institute. There are also legal issues with regard to plagiarism detection services or software as these services may violate the students' copyright on occasion, leading to legal issues. There may also be added financial costs to the budgets of educational institutions.

Another way of deterring and preventing plagiarism is through the use of pedagogical practices. The literature review in paper 2 indicates that pedagogical approaches towards dealing with plagiarism consist of three aspects. Firstly, there is the implementation of an institution-wide policy on plagiarism and the education of students about this policy, including the consequences of breaching it. The uniform implementation of such a policy

across the institution is also identified as important. Secondly, the design of assessment is a key to minimizing opportunities for plagiarism. There is a need to move away from surface assessment practices that focus on factual knowledge and quantitative outcomes to deep assessment approaches that focus on unique responses and on the development of higher order thinking which require creativity and originality on the part of students. The development of constructivist approaches to the assessment of learning outcomes can be one of the most effective methods to reduce plagiarism (Rovai, 2004). Also, educating students about plagiarism and providing students with the required skills to avoid plagiarism are important. This can be achieved through educating students about plagiarism and academic conventions and fostering students' language proficiency and writing skills. Thirdly, the promotion of the students' sense of ownership of, and belonging to, a learning environment creates a situation in which the student is more likely to see plagiarism as illogical and counter-productive. The third approach can be considered as potentially the strongest as it involves the intrinsic motivation of the student.

This thesis concludes that the use of biometric keystroke dynamics is an effective way to authenticate text developed on computer-based environments. Coupled with other technological tools, this can act as a deterrent of plagiarism. This thesis also forwards the conclusion that the most effective and efficient way of deterring and preventing plagiarism is through a combination of technological tools and pedagogical practices which act as deterrents and as incentives for the development of ethical approaches to learning and assessment.

Evaluation of design

The designing of the FADE model presented in this thesis has been based on feed-forward from the findings from Part A of this study concerning plagiarism and from the findings outlined in Article III. The design suggests the greater use of an online forum, which is predominantly a text based dialogic asynchronous environment. The authentication module using biometric keystroke dynamics was not incorporated into the FADE model but was considered in the design as the FADE model was primarily text-based. The pedagogical practices of negating plagiarism were also considered in the model design. The requirements brought in by the research problem, research context, student perspective and technological limitations were considered in the design of the model. This section discusses the design and the FADE assessment criteria in relation to the learning process and students' learning, competencies and attitudes.

Learning

Assessment is the means by which it is verified if learning has occurred (Kozma, 2009). To clarify the effect of the FADE online forum on the students' learning of factual knowledge, a comparison was conducted between two student groups, the students who took part in the FADE online forum and the students who did not take part in it. Here the emphasis is on factual knowledge as the final examination, and the two assignments do not measure higher order thinking or collaborative learning skills. The results of paper IV indicated that there was no significant difference in the results in the final examination and the two assignments between the two student groups. Since paper IV also concluded that there was no significant difference between the two groups in the prior knowledge they brought into the BIT course and that the primary difference between the two groups was attending or not attending group classes, a conclusion was drawn that the effect of the FADE online forum on student's learning of factual knowledge was most likely similar to attending group classes.

The FADE online forum provided opportunities for students to develop higher order thinking and had collaborative learning at the core of its design. In contrast, comparing the format of group classes where the teacher stands in front of the class and teaches the content with no formative assessment tasks or group learning tasks, it can be stated that there is no organised activity for students to develop higher order thinking or collaborative learning skills. However, there could be an informal interaction between these students that may promote higher order thinking and collaborative learning in a group class, but this was not investigated in the study. The lack of measures for higher order thinking and collaborative learning skills of those who did not take part in the FADE online forum did not allow for a comparison between the two groups in relation to these sets of skills.

The FADE online forum also had an impact on the type of student activity in it. This was clearly defined by observing the change in patterns of students' activity. This was likely due to the influence and responses [or lack of such] from other members of the learning community. The students who were initially using the forum as a place to have their questions answered rather than learn collaboratively changed their approaches to become collaborative learners. Those who initially viewed the FADE online forum as a social community changed their focus to making their contribution more towards a learning community and a learning related discussion. It was also observed that when the content being discussed became more complex, the engagement became more focussed on subject content than content that was of lesser interest or related to community building. The levels of demonstration of higher order thinking varied between students, as some showed a high level of critical analysis and used justification, whereas some

posted questions or answers without any critical analysis of justification. This indicates that the students' intentions for the FADE online forum varied at the inception, but later changed and reached a status of equilibrium. In the sense of a community, a balance was reached between the students' viewing the FADE online forum as a social community and a learning community. In the sense of taking part in the learning community, a balance was reached between the students merely posting questions or responding to questions and the collective constructing knowledge through discussion.

Students competencies

In relation to the competencies of participants in the FADE online forum, the prior knowledge (English language grade and advance level results/upper-secondary final examination results) brought in by the students did not demonstrate any relationship to their activity in the model or the higher order thinking and collaborative learning skills demonstrated by them through their online forum posts (Paper IV). Also, this prior knowledge did not show any relationship to the achievements in the formative assessment tasks during the course and they did not show any relationship to achievements in the final examination. This raises a question regarding shifts of competencies between the time of leaving school and taking examinations in the BIT study programme. This was beyond the scope of the study and was not considered in this research. With regard to the course results obtained by students in the two assignments during the course and at the final examination, they showed a positive relationship to the measure of higher order thinking ratings obtained in the FADE assessment criteria. In contrast, these course results did not show any relationship to the measure of collaborative skills obtained in the FADE assessment criteria.

As mentioned earlier, the FADE model can also assess factual knowledge which is relatively less complex than assessing higher order thinking or collaborative learning skills. A student's response to a question on the FADE model that only requires a factual knowledge response can easily be graded and feedback can be provided to the student. However, in the context of this particular study, the measurement of students' factual knowledge was not an issue as the final MCQ examination of the BIT degree programme fulfilled this requirement.

Attitudes

The attitudes of the participants and non-participants in the FADE online forum varied according to their attitude towards learning. Most students were of the view that the online forum served as a learning tool and they preferred if they were given marks for their contributions and participation.

They identified that there were active and passive [lurking] (Jahnke, 2010; Bucy & Gregson, 2001) participants in the FADE online forum, and clearly identified that not posting did not necessarily imply that they did not use the online forum. They were of the opinion that giving marks would most likely motivate others to actively contribute to the learning community and thereby discover the strength of it as a learning tool. In contrast, there were some who stated that their participation in the online forum would change according to the criteria set for allocating marks for participation and contributions. They considered that a continuous focus on the BIT study program was not practical for those who were involved in other activities such as other degree programmes and those who were in full time employment. Some who identified the fact that students do not all have equal access to the Internet and viewed the requirement of regular access to the Internet as a drawback. As identified in paper IV, one of the key factors of whether someone actively participated in the FADE assessment environment was whether that individual had a requirement of being a part of a learning community. However, factors such as lack of time, lack of Internet access, and already being involved in a learning community seemed to diminish interest in students from participating in the FADE assessment environment. In addition, the students' motivation of whether they wanted to learn or merely fulfil the requirements needed to pass examinations would seem to have an impact on the way they would participate in the FADE assessment, even if participation was made mandatory.

When asked about how reflective the forums were of the students' knowledge and skills, most agreed that the forums provided the freedom to express their real ability and knowledge. It also provided the freedom to expand their knowledge beyond the course syllabus and to discuss things with others who had common interests. This agrees with the findings in paper III and paper IV, where students not only stated that they believed formative assessment was important but also that the BIT examinations needed to change from MCQ to a different form where they could show more of their skills. The students also saw the forums as reflective of their peers' knowledge and stated that it was possible to make this judgement after following the posts of a peer. They would then make a judgement on who was the most knowledgeable on a particular subject, and that person's posts carried more weight during their participation. They also mentioned that even though they did not consider the English language proficiency of peers, it did matter on some occasions when it was required to clearly express their ideas. This shows that students created their own scheme for the evaluation of their peers in the online environment.

Key considerations in designing assessment

The synthesis of findings from the study leads to some key considerations for the design of assessment for developing the higher order thinking of undergraduate IT students in collaborative online learning environments. This highlights the way in which the studies on assessment and plagiarism and their sub-studies are highly interrelated. That is, a single, stand-alone component will function below its potential, but if integrated with each other these components provide the most effective and efficient outcome.

The analysis reiterates that in order to be a valid tool for the accreditation of an individual, an assessment instrument has to restrict possibilities for plagiarism and cheating. This study indicates that both technological tools and pedagogical practices have to be used in conjunction in order to limit the possibility of plagiarism. Furthermore, the assessment task itself seems to be a key tool in preventing plagiarism. The type of task, the type of knowledge or skills being assessed, tasks that motivate students and promote real-world relevance, and tasks that give students ownership of their learning are all keys to addressing the issue of plagiarism through assessment.

With reference to assessment for learning with a focus on the development of higher order thinking, the synthesis of the study indicates that assessment is not only about what to assess and how to assess it, but also requires a strong foundation based on the student's perspective, the purpose and aim of the assessment, the assessment environment, and especially in distance education where students are isolated, the use of collaboration as a tool to support learning and assessment. In addition, it is also important that measures are taken to influence students' attitudes to the assessment as a means of learning rather than merely a requirement to pass an examination.

Contributions

This section discusses the contributions to the field of research from this thesis. The primary contribution is a set of considerations when designing assessments for higher order thinking in distance education based on online collaborative learning environments. The design considerations are based on the students' perspective, previous research and theoretical foundations. The design process used is predominantly focused on designing technological requirements driven by pedagogical requirements identified in previous research, theory, and policy that place priority on requirements derived from the students' perspectives.

This thesis also contributes to the field of computer security through the work focussed on keystroke dynamics for the purpose of the authentication of text developed on computers. The results add to previous research on

keystroke dynamics by highlighting the possibility of the identification of a micro-level keystroke pattern that is unique across different cognitive writing tasks.

Methodologically, this thesis contributes to research by being another example of the application of design-based research in the field of Information and Communication Technology and Education.

This thesis also promotes the possibility of blending two different science streams, Computer Science/Information & Communication Technology and the Educational Science in designing models that are more efficient in solving issues faced in the domain of Education. The advantage of this approach is that Education does not follow Computer Science/ICT but instead goes in parallel with it or drives its development.

Implications for the BIT degree programme

The large-scale implementation of an assessment model based on the findings of this thesis if implemented in the BIT degree programme could have a strong impact, not only on the students' learning but also on the quality of the BIT degree programme itself. This would also be a potential tool to create learning communities that in turn will help reduce isolation on the part of students and increase learner support. This could thereby have an impact by reducing dropout rates.

There are two particular challenges in implementing such a model. The first would be to convince the Board of Study of the BIT degree programme to adopt this model. Currently there are four learning facilitators monitoring the BIT VLE, and implementing a new model would need to include training in the use of the model and possibly increasing the number of facilitators. The time and cost for implementing this would be a concern.

A second challenge would be to motivate students to take part in such an assessment model. As an initial step I intend to propose that the BIT programme run this model to complement the current MCQ formative assessment tasks and not as a contributor to the final grades. As the current formative assessment is considered when awarding certification at end of each year, this should be a motivation for students to take part in the assessment model.

Future research

The next cycle will be a real-life large scale implementation of the model that assesses students and provides them formative feedback for learning.

Three key topics have been identified for future research in relation to the assessment model. The first is student-centric feedback. This is for a feature in the model that is based on self-assessment and reflective practice on the

part of the students. This would help students to reflect on every post they make in the implemented assessment model. The students' higher order thinking and collaborative learning skills ratings would be made visible to students who would be provided with feedback. This aims to provide students with a tangible observation of their current skill levels and to help them reflect on their learning.

The second is a new method of measuring collaborative learning. Currently the model uses a method of counting phenomena that are observable as skills required for collaborative learning. Stahl (2006) and Dillenbourg et al (1996) point out the need for more research in the domain of collaborative learning, especially in the domain of computer supported collaborative learning.

Finally, with regard to the biometric keystroke dynamic authentication model, a further development and study will be carried out in order to create a more accurate comparison model. Firstly, the software used to log keystrokes, InputLog, (Leijten & Van Waes, 2006), during the experiment has been developed to include more features that provide more detailed data. Features that could be unique to individuals such as frequent mistypes, the typing of common words, mouse movements, and even revision patterns could help increase the accuracy of the model.

Reference

- Andersson, A. (2008). Seven major challenges for e-learning in developing countries: Case study eBIT, Sri Lanka. *International Journal of Education and Development using ICT*, 4(3). Retrieved from <http://ijedict.dec.uwi.edu/viewarticle.php?id=472>.
- Angelo, T. A., & Cross, K. P. (1993). *Classroom assessment techniques: A handbook for college teachers* (Second Ed.). San Francisco: Jossey-Bass
- Barab, S., & Squire, K. (2004). Design-based research: Putting a stake in the ground. *Journal of the Learning Sciences*, 13(1), 1-14.
- Barr, R. B., & Tagg, J. (1995). From teaching to learning - a new paradigm for undergraduate education. *Change Magazine*, 27(6), 12-25.
- Bath, D., Smith, C., Stein, S., & Swann, R. (2004). Beyond mapping and embedding graduate attributes: bringing together quality assurance and action learning to create a validated and living curriculum. *Higher Education Research & Development*, 23(3), 2004.
- BECTA (2006). Coventry, Becta's view of e-assessment and e-portfolios. UK: BECTA.
- Bell, P. (2004). On the theoretical breadth of design-based research in education. *Educational Psychologist*, 39(4), 243-253.
- Biggs, J. (1998). Assessment and Classroom Learning: a role for summative assessment?, *Assessment in Education: Principles, Policy & Practice*, 5(1), 103-110.
- Black, P., & Wiliam, D. (1998a). Assessment and classroom learning. *Assessment in Education: Principle, Policy and Practice*, 5(1), 7-74.
- Black, P., & Wiliam, D. (1998b). Inside the Black Box: Raising Standards through Classroom Assessment. *Phi Delta Kappan*, 80(2), 139-148.
- Black, P., & William, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability*, 21(1), 5-31
- Black, P. J. (1993). Formative and summative assessment by teachers, *Studies in Science Education*, 21(1), 49-97.
- Black, P. J. (1998a). Evaluation and Assessment. In A. Tiberghien, L. E. Jossem & J. Burojas (Eds.), *Connecting Research in Physics Education with Teacher Education*: ISPE.
- Black, P. J. (1998b). Formative assessment: raising standards inside the classroom, *School Science Review*, 80(291), 39-46.
- Boud, D. (1995). Assessment and learning: Contradictory or complementary?. In P. Knight (Ed.), *Assessment for Learning in Higher Education* (p. 35-48). London, UK: Kogan Page.

- Boud, D. (2000). Sustainable assessment: Rethinking assessment for the learning society. *Studies in Continuing Education* , 22(2), 151-167.
- Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions. *Journal of the Learning Sciences*, 2, 141-178.
- Brown, R. E. (2001). Design of a virtual community based interactive learning environment. *Journal of Asynchronous Learning Networks*, 5(2), 18-35. Retrieved from http://spot.pcc.edu/~rsuarez/rbs/school/EPFA_511/articles/fromErica/communitybuilding.pdf
- Brown, S. (2004). Assessment for learning. *Learning and Teaching in Higher Education*, 1, 81-89.
- Bruner, J. S. (1978). *Human growth and development : Wolfson college lectures 1976*. (J. S. Bruner & A. Garton, Eds.). Oxford, UK: Clarendon Press.
- Coates, H. (2005). The value of student engagement for higher education quality assurance. *Quality in Higher Education*, 11(1), 25-36.
- Cobb, P., Confrey, J., diSessa, A., Lehrer, R., & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher*, 32(1), 9-13.
- Cole, M., & Cole, S. (2001). *The development of children*. (4th ed.). New York, NY: Scientific American Books.
- Collins, A., Joseph, D., & Bielaczyc, K. (2004). Design research: Theoretical and methodological issues. *The Journal of Learning Sciences*, 13(1), 15-42.
- Collins, F., & Lynch, J. (2001). *ICT education and the dissemination of new ideas: Channels, resources and risks*. Paper presented at the Australian Association of Educational Research, Freemantle, Australia. Retrieved from <http://www.aare.edu.au/o1pap/colo1092.htm>
- Conole, G., & Warburton, B. (2005). A review of computer-assisted assessment. *Research in Learning Technology*, 13(1), 17-31.
- Creswell, J. W., & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory into practice*, 39(3), 124-130.
- Davies, P. (2002). "There's no Confidence in Multiple-Choice Testing,". In *Proceedings of 6th CAA Conference*. Loughborough: Loughborough University.
- Doherty, W. (2006). An analysis of multiple factors affecting retention in web-based community college courses. *The Internet and Higher Education*, 9(4), 245-255.
- Elman, C., and Elman, M.F. (2003). Lessons from Lakatos. In C. Elman & M.F. Elman (Eds.), *Progress in International Relations Theory: Appraising the Field*, (pp.21-68). Cambridge: MIT Press.

- Farrell, G., & Leung, Y. (2004). *Comparison of two student cohorts utilizing black board CAA with different assessment content: A lesson to be learnt*. In *Computer Assisted Assessment Conference Proceedings* (pp. 103-114). Loughboroug : UK.
- Flower, L., & Hayes, J.R. (1981). A cognitive process theory of writing. *College Composition and Communication*, 32(4), 365–387.
- Gabrenya, W. K. Jr., (2003). *Research skills for psychology majors: everything you need to know*. Melbourne, FL: Florida Institute of Technology.
- Galusha, J. M. (1997). Barriers to learning in distance education. *Interpersonal Computing and Technology Journal*, 5(3-4), Retrieved from [http://168.144.129.112/Articles/Barriers to Learning in Distance Education.rtf](http://168.144.129.112/Articles/Barriers%20to%20Learning%20in%20Distance%20Education.rtf)
- Garrison, D. R. (1987). Dropout prediction within a broad psychological context: An analysis of Boshier's congruence model. *Adult Education Quarterly*, 37, 212-222.
- Garrison, D. R., Anderson, T., & Archer, W. (2000). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education*, 2(2-3), 87-105.
- Garrison, D. R., & Vaughan, N. D. (2008). *Blended Learning in Higher Education – Framework, Principals and Guidelines*. San Francisco, CA: Jossey-Bass.
- Gipps, C. (1994). Developments in educational assessment: what makes a good test?. *Assessment in Education: Principles, Policy & Practice* , 1(3), 283-292.
- Glaser, R., & Silver, E. (1994). Assessment, Testing, and Instruction: Retrospect and Prospect, *Review of Research in Education*, 20, 393-419.
- Gokhale, A. A. (1995). Collaborative learning enhances critical thinking. *Journal of Technology Education*, 7(1), Retrieved from <http://scholar.lib.vt.edu/ejournals/JTE/v7n1/gokhale.jte-v7n1.html?ref=Sawos.Org>
- Golafshani, N. (2003). Understanding validity and reliability in qualitative research. *The qualitative report*, 8(4), 597-607.
- Gonzalez-Barbone, V., & Llamas-Nistal, M. (2007), *E-assessment trends in content reuse and standardization*. Paper presented at 37th ASEE/IEEE Frontiers in Education Conference, Milwaukee, WI.
- Graff, M. (2003). Cognitive styles and attitudes towards using online learning and assessment methods, *Electronic Journal of e-Learning*, (1)1, 21-28.
- Grix, J. (2002). Introducing students to the generic terminology of social research. *Politics*, 22(3), 175–186.

- Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 105-117). Thousand Oaks, CA: Sage.
- Halpern, D. F. (1998). Teaching critical thinking for transfer across domains: Disposition, skills, structure training, and metacognitive monitoring. *American Psychologist*, 53(4), 449-455.
- Harlen, W., & James, M. (1997). Assessment and Learning: differences and relationships between formative and summative assessment, *Assessment in Education: Principles, Policy & Practice*, 4(3), 365-379.
- Harris, F. J. (2009). Ethics from web 1.0 to web 2.0: Standing outside the box. *Knowledge Quest: Journal of the American Association of School Librarians*, 37(3), 1094-9046.
- Hayes, J.R. (2012). Modeling and re-modeling writing. *Written Communication* 29(3) 369–388
- Hewagamage, K.P. (2005). *Baseline Information of BIT*. (p. 18). Colombo: UCSC
- Hopso, B., Simms, R. L., & Knezek, G. A. (2001). Using a technology-enriched environment to improve higher-order thinking skills. *Journal of Research on Technology in Education*, 34(2), 109-120. Retrieved from http://eec.edc.org/cwis_docs/Vivians/Hopson_et_al.pdf
- Huba, M. E., & Freed, J. E. (2000). *Learner-centered assessment on college campuses: Shifting the focus from teaching to learning*. Boston: Allyn & Bacon.
- Hudson, B. (2011). Didactical Design for Technology Enhanced Learning. In B. Hudson and M. Meyer (Eds.), *Beyond Fragmentation: Didactics, Learning and Teaching in Europe*, (pp. 223-238). Opladen and Farmington Hills, MI: Verlag Barbara Budrich.
- Internet World Stats. (2012, February 15). *Internet usage statistics*. Retrieved from <http://www.internetworldstats.com/stats.htm>
- Jin, Q. (2002). Design of a virtual community based interactive learning environment. *Information Sciences*, 140(1-2), 389–393.
- JISC/QCA (2007). Effective Practice with e-Assessment, Retrieved from <http://www.jisc.ac.uk/media/documents/themes/elearning/effpraceassess.pdf>
- Johnson, R. B. & Onwuegbuzie, O. J. (2004). Mixed Methods Research: A Research Paradigm Whose Time Has Come. *Educational Researcher*, 33(7), 14-26.
- Joseph, D. (2004). The practice of design-based research: Uncovering the interplay between design, research, and the real-world context. *Educational Psychologist*, 39(4), 235-242.

- Kehoe, J. (1995). Writing multiple-choice test items. *Practical Assessment, Research & Evaluation*, 4(9). Retrieved from <http://PAREonline.net/getvn.asp?v=4&n=9>
- Kendle, A., & Northcote, M. (2000). The struggle for balance in the use of quantitative and qualitative online assessment tasks. Paper presented at ASCILITE conference, Coffs Harbour, Queensland, Retrieved from <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.17.9678&rep=rep1&type=pdf>.
- Kirkup, G. & Kirkwood, A. (2005). Information and communications technologies (ICT) in Higher Education teaching - a tale of gradualism rather than revolution. *Learning, Media and Technology*, 30(2), 185-199.
- Knight, P. T. (2002). Summative Assessment in Higher Education: practices in disarray, *Studies in Higher Education*, 27(3), 275-286.
- Kothari, C. R. (2006). *Research methodology: methods and techniques*. India: New Age International Publishers.
- Kozma, R. (2009). Transforming education: assessing and teaching 21st century skills - assessment call to action. In F. Scheuermann & J. Björnsson (Eds.), *The Transition to Computer-Based Assessment: New Approaches to Skills Assessment and Implications for Large-scale Testing* (pp. 13-23), Luxembourg: Office for Official Publications of the European Communities.
- Laurillard, D. (2002). Rethinking university teaching: A conversational framework for the effective use of learning technologies. New York, NY: RoutledgeFalmer.
- LeBaron, C. (2002). Technology does not exist independent of its use. In T. Koschmann, R. Hall & N. Miyake (Eds.), *CSCL 2: Carrying forward the conversation* (pp. 433-439). Mahwah, NJ: Lawrence Erlbaum Associates.
- Lewis, A., & Smith, D. (1993). Defining higher order thinking. *Theory into practice*, 32(3), 131-137.
- Lipman, M. (1988). Critical thinking: What can it be?. In W. Oxman-Michelli & M. Weinstein (Eds.), *Institute of Critical Thinking. Resource Publication Series* (pp. 4-15). Upper Montclair, NJ: Montclair State College.
- Leijten, M. & Van Waes, L. (2006). Inputlog: New Perspectives on the Logging of On-Line Writing. In K.P.H. Sullivan & E. Lindgren (Eds.), *Studies in Writing: Vol. 18. Computer Key-Stroke Logging and Writing: Methods and Applications* (pp.73-94). Oxford: Elsevier.
- Lombardi, M. M. (2008). Making the grade: The role of assessment in authentic learning. In D. Oblinger (Ed.), *EDUCAUSE Learning Initiative White Papers* Retrieved from <http://www.educause.edu/ir/library/pdf/ELI3019.pdf>
- Lui, Y., Lavelle, E., & Andris, J. (2002). Experimental effects of online instruction on locus of control. *Journal of United States Distance Learning Association*, 16(6), Retrieved from http://www.usdla.org/html/journal/JUNo2_Issue/article02.html

- Macan Markar, D., Madurapperuma, A. P., & Maroulis, J. (2006, November). *Problem-based learning - is it right for sri lanka?*. Paper presented at APERA conference, Hong Kong.
- Maxwell, J. A. (1992). Understanding and validity in qualitative research. *Harvard education review*, 62(3), 279-300.
- Mazza, R., & Dimitrova, V. (2004). *Visualising student tracking data to support instructors in web-based distance education*. In *Proceedings of the 13th international World Wide Web conference*.
- McDowell, L., & Brown, S. (2001). Assessing students: cheating and plagiarism. *The High Education Academy*, Retrieved from http://www.le.ac.uk/teaching/assets/mcdowell_and_brown.pdf
- McLachlan, J. C. (2006). The relationship between assessment and learning. *Medical Education*, 40(8), 716-777.
- McLoughlin, D., & Mynard, J. (2009). An analysis of higher order thinking in online discussions. *Innovations in Education and Teaching International*, 46(2), 147-160.
- Melissa, R. O. (2002). Ethics and distance education: Strategies for minimizing academic dishonesty in online assessment. *Online Journal of Distance Learning Administration*, 5(3), Retrieved from <http://www.westga.edu/~distance/ojdla/fall53/olt53.html>
- Miri, B., Ben-Chaim, D., & Zoller, U. (2007). Purposely teaching for the promotion of higher-order thinking skills: A case of critical thinking. *Research in Science Education*, 37(4), 353-369.
- Moisey, S. D., & Hughes, J. A. (2008). Supporting the online learner. In T. Anderson (Ed.), *The Theory and Practice of Online Learning*, second edition (pp. 419-439). Retrieved from http://www.aupress.ca/books/120146/ebook/17_Anderson_2008-Theory_and_Practice_of_Online_Learning.pdf
- Morse, J. M., Barrett, M., Mayan, M., Olson, K., & Spiers, J. (2002). Verification strategies for establishing reliability and validity in qualitative research. *International Journal of Qualitative Methods*, 1(2), 13-22.
- Nanayakkara, G. (2010, November 7). Reforming higher education for economic development. *Sunday Observer*. Retrieved from <http://www.sundayobserver.lk/2010/11/07/fea02.asp>
- Neo, M. (2003). Developing a collaborative learning environment using a web-based design. *Journal of Computer Assisted Learning*, 19, 462-473.
- Newman, F. M. (1987). *Higher order thinking in the teaching of social studies: connection between theory and practice*. Madison, WI: National Center on Effective Secondary Schools.

Orrill, CH, Hannafin, MJ, & Glazer, EM (2004). Disciplined inquiry and the study of emerging technology. In D. H. Jonassen (Ed.), *Handbook of research on educational communications and technology*, (2nd ed., pp. 335-353). Mahwah, NJ: Lawrence Erlbaum.

Orsmond, P., Merry, S., & Reiling, K. (2002). The use of exemplars and formative feedback when using student derived marking criteria in peer and self-assessment. *Assessment & Evaluation in Higher Education*, 27(4), 309-323.

Parker, A. (1999). A study of variables that predict dropout from distance education. *International Journal of Educational Technology*, 1(2), Retrieved from <http://www.ascilite.org.au/ajet/ijet/v1n2/parker>

Parker, A. (2003). Identifying predictors of academic persistence in distance education. *Journal of United States Distance Learning Association*, 17(1). Retrieved from http://www.usdla.org/html/journal/JAN03_Issue/article06.html

Paxton, M. (2000). A linguistic perspective on multiple choice questioning. *Assessment & Evaluation in Higher Education*, 25(2), 109-119.

Reeves, T.C. (2000). Alternative assessment approaches for online learning environments in higher education. *Journal of Educational Computing Research*, 23(1), 101-111.

Roschelle, J. & Teasley, S. D. (1996). The construction of shared knowledge in collaborative problem solving. In C. O'Malley (Ed), *Computer-Supported Collaborative Learning*. (pp. 69-97), Berlin: Springer.

Ross, M. S., & Morrison, G. R. (2004). Experimental Research Methods, In D. J. Jonassen (Ed). *Handbook of Research on Educational Communications and Technology*, (2nd Ed., pp.1021-1043). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Rovai, A. P. (2002). Sense of community, perceived cognitive learning, and persistence in asynchronous learning networks. *The Internet and Higher Education*, 5(4), 319-332.

Rovai, A. P. (2004). A constructivist approach to online college learning. *Internet and Higher Education*, 7, 79-93.

Rowe, N. C. (2004). Cheating in online student assessment: Beyond plagiarism. *Online Journal of Distance Learning Administration*, 7(2), Retrieved from <http://www.westga.edu/~distance/ojdla/summer72/rowe72.html>

Sadler, R. (1989). Formative assessment and the design of instructional systems. *Instructional Science*, 18, 119-144.

Shadish, W. R. (2000). The empirical program of quasi-experimentation. In L. Bickman (Ed.), *Validity and social experimentation: Donald Campbell's legacy* (pp. 13-35). Thousand Oaks, CA: Sage.

- Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental design for generalized causal inference*. Boston: Houghton-Mifflin.
- Scouller, K. (1998). The Influence of Assessment method on Students' Learning Approaches: Multiple Choice Question Examination versus Assignment Essay. *Higher Education*, 35, 453-472.
- Scouller, K., & Prosser, M. (1994). Students' experiences in studying for multiple-choice question examinations. *Studies in Higher Education*, 19(3), 267-279.
- Simon, H. A. (1996). *The sciences of the artificial*. (3rd ed.). Cambridge, MA: MIT Press.
- Simpson, O. (2004). The impact on retention of interventions to support distance learning students. *Open Learning: The Journal of Open and Distance Learning*, 19(1), 79-95.
- Stahl, G. (2006). Group cognition: Computer support for building collaborative knowledge. Cambridge, MA: MIT Press.
- Stahl, G., Koschmann, T., & Suthers, D. (2006). Computer-supported collaborative learning. In R. K. Sawyer (Ed.), *Cambridge handbook of the learning sciences*. Cambridge, UK: Cambridge University Press.
- Stiggins, R. J. (1999). Assessment, student confidence, and school success. *The Phi Delta Kappan*, 81(3), 191-198.
- Stiggins, R. J. (2002). Assessment Crisis: The Absence Of Assessment FOR Learning. *Phi Delta Kappan*, 83(10), 758-765.
- Strijbos, J., & Fischer, F. (2007). Methodological challenges for collaborative learning research. *Learning and Instruction*, 17(4), 389-393.
- Schwandt, T. A. (2000). Three epistemological stances for qualitative inquiry: Interpretivism, hermeneutics and social constructivism. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (2nd ed., pp. 189-214). Thousand Oaks, CA: Sage.
- Taras, M. (2005). Assessment – summative and formative – some theoretical reflections, *British Journal of Educational Studies*, (53)4, 466-478.
- UGC (2011a). Educational Indicators 1980-2009. Retrieved from <http://www.ugc.ac.lk/en/statistics/educational-indicators.html>
- UGC (2011b). *Sri Lanka University Statistics 2010*. (pp.63-79). Colombo, Sri Lanka: Management Information Systems Division, UGC.
- Underwood, J. (2004). Research into information and communications technologies: where now?, *Technology, Pedagogy and Education*, 13(2), 135-145.

- Usoof, H., Hudson, B., & Wikramanayake, G. (in press). Technology enhanced assessment for learning in a distance education it degree programme in sri lanka. *The International Journal on Advances in ICT for Emerging Regions*, 5(1).
- Usoof, H. & Wikramanayake, G. N. (2008). *Improving student learning through assessment for learning using social media and e-Learning 2.0 on a distance education degree programme in Sri Lanka*. Paper presented at The European Conference on Educational Research, Vienna, Austria.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, (Eds.). Cambridge, Massachusetts: Harvard University Press.
- Wang, F., & Hannafin, M. J. (2006). Design-based research and technology-enhanced learning environments . *Educational Technology Research and Development*, 53(4), 5-23.
- Watson, D. (2006). Understanding the relationship between ict and education means exploring innovation and change. *Education and Information Technologies*, 11(3), 199-216.
- Watt, J. H., & van den Berg, S. (1995). Research methods for communication science. Boston: Allyn & Bacon.
- Webber, K. (2011). The use of learner-centered assessment in US colleges and universities, *Research in Higher Education*, 53(2), 201-228.
- Wells, G. (1994). *Learning and Teaching “scientific concepts”: Vygotsky’s ideas revisited*. Paper presented at Vygotsky and the Human Mind, Moscow, Retrieved from http://people.ucsc.edu/~gwells/Files/Papers_Folder/ScientificConcepts.pdf
- White, L. (2009). Internal and external validity. Retrieved from http://www.suu.edu/faculty/white_l/research%20design/chapter%20notes/chapter%208.pdf
- Whittemore, R., Chase, S. K., & Mandle, C. L. (2001). Validity in qualitative research. *Qualitative health research*, 11(4), 522-537.
- Wickramasinghe, V., & Perera, L. (2003). Graduates’, university lecturers’ and employers’ perceptions towards employability skills. *Education Training*, 52(3), 226-244.
- William, D., & Black, P. (1996). Meanings and consequences: a basis for distinguishing formative and summative functions of assessment, *British Educational Research Journal*, 22(5), 537-549.
- Wiliam, D., & Thompson, M. (2007). Integrating assessment with instruction: What will it take to make it work? In C. A. Dwyer (Ed.), *The future of assessment: Shaping teaching and learning* (pp. 53-82). Mahwah, NJ: Lawrence Erlbaum Associates.

Winter, G. (2000). A comparative discussion of the notion of 'validity' in qualitative and quantitative research. *The qualitative report*, 4(3), Retrieved from <http://www.nova.edu/ssss/QR/QR4-3/winter.html>

World Bank. (1999). *World development report. Knowledge for development*. New York, NY: Oxford University Press Inc.