Improving the interfaces of online discussion forums to enhance learning support

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Abstract

This thesis describes a research work aimed at improving the interfaces of online discussion forums (ODFs) in relation to their functional support to enhance learning. These ODFs form part of almost all Learning Management Systems (LMSs) such as WebCT, Moodle and Blackboard, which are widely used in education nowadays. Although ODFs are identified as valuable sources to learning, their interfaces are limited in terms of providing support to students, such as in the areas of managing their postings as well as in facilitating them to quickly locate and obtain specified information. In addition, these systems lack features to support inter-institutional cooperation that could potentially increase knowledge sharing between students and educators of different institutions. The interface design objective of this study therefore was to explore and overcome the limitations identified as above, and enhance the effectiveness and efficiency of ODFs' support to learning. Using a task centered design approach; the required features were developed, and implemented in a working prototype called eQuake (electronic Question answer knowledge environment). eQuake is a shared online discussion forum system developed as an add-on to a well-known open source e-learning platform (Moodle). This system was intended for use among inter-institutional students in New Zealand tertiary institutions that teach similar courses. The improved interface functionalities of eQuake are expected to enhance learning support in terms of widening communication among users, increasing knowledge base, providing existing matching answer(s) quickly to students, and exposing students to multiple perspectives. This study considers such improvements to ODF interfaces as vital to enable users to enjoy the benefits of technology-mediated environment. The perceived usefulness and ease-of-use of improved features in eQuake were evaluated using a quantitative experimental research method. The evaluation was conducted at three tertiary institutions in New Zealand, and the overall results indicated positive response, although some suggestions for improvement have been made in the evaluation. This thesis presents a review of the related literature, describes the design and development of a user interface, followed by its implementation in eQuake, and a description of the evaluation. The thesis concludes with recommendations for better interface design of ODFs and provides suggestions for future research in this area.

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Chapter 1: Introduction

1.1 Introduction

Interactions or collaborations among students have long been identified as key elements for successful learning outcomes (Anderson, 2003; Heather & Terry, 1999; Laurillard, 2002; Moore, 1989). The Internet has enabled educational institutions to use web-based computer mediated communication (CMC) technologies as pedagogical tools to extend classroom-based learning and promote student centered flexible learning communities in the online environment. Research studies indicated the wide spread use of this medium since 1990s (Goodfellow, 2005; Wallace, 2003).

Online discussion forum (ODF) is one of the CMC tools widely used in educational institutions to promote learning. Research studies have indicated that although discussion forums are capable of fostering "effective academic debate" (Jones, Scanlon, & Blake, 2000), the interface functionalities limit users (educators and students) from taking full advantage of the benefits that the online discussions promote (Reyes & Tchounikine, 2003). This thesis describes a study in which improvements were made to the interface functions of the online discussion forum (ODF) model. The improved model was implemented and tested for ease-of-use and usefulness of the features to enhance learning support.

The next section provides background and sets the context of the current study. It includes a brief overview of the technology developments, and the consequent influence of these on the educational institutions to extend learning support.

1.2 Background

The improvements in human interaction facilities following the advances in technology, and the resultant increase in learning opportunities at every technological breakthrough have been well documented by researchers (Frick, 1991; Molnar, 1997). For example, describing the progress in human communications, Frick, in a fastback series, "Restructuring education through technology," pointed out how the invention of printing press increased access to the written words and books leading to widespread literacy,

causing revolutionary changes in the classroom structure and the educational system. Later advances in computer technologies have opened great opportunities for educational institutions to extend learning facilities to students in the online environment.

Computer history in education dates back the use of computers in 1940s, with their early design and use meant primarily for specialist groups to meet their research needs in the areas of mathematics, science and engineering problem solving (Cudd & Oskouie, 1996; Molnar, 1997). Later on the availability and use of personal computers spread into other areas of learning in1960s resulting in the creation of an information-rich society. While the use of computers in educational institutions became apparent in 1970s, an increased use of these was noticeable in 1980s when the high-bandwidth communication network capabilities emerged (Molnar, 1997). The emergence of personal computers along with the availability of increased computing power has influenced the way in which people work, communicate, and learn.

The introduction of the Internet and the World Wide Web has further increased the interaction opportunities enabling educational institutions to promote education to reach more number of students globally, and also satisfy their learning needs (Rubens, Emans, Leinonen, Gomez, & Simons, 2005). The networked computers allowed educational institutions to explore the use of web-based communication technologies such as mailing lists, online forums, groupware and commercial online services to promote group interactions in two modes: i) *synchronous* (real time video conferencing; and instant messaging systems, e.g., Microsoft's Windows Live Messenger), ii) *asynchronous* (time delayed discussions on networks, e.g., by email, a mailing list, Usenet newsgroup, and online discussion forums settings). The use of these technologies has become common phenomenon in many fields to support group activities (Berge & Collins, 1995; Matsubara, Ohguro, & Hattori, 1998).

In education, the communication technologies to support interactions in both synchronous and asynchronous modes are available as components of Learning Management Systems (LMSs). Of the two forms, the asynchronous communication has been identified as the most convenient and appropriate means for educators to explore

their use in promoting learning in the online environments as it allows multi-participant interactions unrestrained by formal class time, geographical boundaries, and the immediate presence of participants (Chickering & Ehrmann, 1996; Herring, 1999).

The use of LMSs is becoming a popular cost effective means to support learning for a large number of tertiary educational institutions worldwide (OECD Public Affairs and Communications Directorate, Public Affairs Division, 2005). Among the wide range of LMSs that are available, *FuseTalk* (http://livedocs.fusetalk.com/), Blackboard (http://blackboard.com), *WebCT* (http://WebCT.com), *Moodle* (http://moodle.com/), and DiscusPro (http://www.discusware.com/) appear to be the popular choice in New Zealand educational institutions. For example, Massey University uses *WebCT* for more than 1200 courses (http://owll.massey.ac.nz/te_webCThomepage.htm), and The Open Polytechnic of New Zealand uses *Moodle* to support more than 35,000 students (Richard, 2006).

LMSs enable educational institutions to extend centralised classroom-based education towards an online environment. Education research on web-based computer-supported cooperative work highlighted technologies as one of the contributing factors in: fostering meaningful interactions, exposing students to multiple thinking perspectives as well as allowing them to seek advice from educators to help them learn better (Heather & Terry, 1999; Hoadley & Kilner, 2005; Siragusa & Dixon, 2005; Topper, 2005). Although tools and technologies to bring students and educators together across time and place are readily available, the nature of communication facilities that these technologies support does however pose challenges to users in managing interactions.

A vital research question involving collaborative interaction in the online environment is: Are the communication technology interfaces pedagogically useful, and easy to use in supporting learning conversations?

This thesis illustrates how the current study addressed the question within the learning environment framework provided by online discussion forums (ODFs) commonly available in typical LMSs, such as *WebCT*, *Blackboard* and *Moodle*. Based on the limitations found in the review of literature carried out for this study, improvements to

the interface have been made. The enhancements were then implemented in a discussion forum called electronic Question answer knowledge environment (eQuake) described later in this thesis.

1.2.1 Online discussion forums (ODFs)

The online discussion forums (ODFs) are a form of text based CMC technologies used in the online environment to foster collaboration among users for various purposes. These are described as, "areas of the Internet that provide a common meeting place where participants can contribute to a dialogue and access information asynchronously" (Caswell, 2001, p.26). Examples include: Web-based scientific digital journals (http://www.nature.com/nature/debates/e-access/index.html), digital libraries (http://www.diglib.org/forums.htm) where ODFs are used as meeting places and market places to share experiences and practices with one another; and dedicated platforms (http://www.programmersheaven.com) where programmers come together to discuss their views on different programming techniques, software design methods, project management concepts, etc. The utilisation of these tools in education shares similar perspective.

In tertiary education, the ODFs have gained high consideration as learning tools to support interaction (Bradshaw & Hinton, 2004), and are currently fast growing for providing interactive learning environment. Available as part of Learning Management Systems (LMSs), ODFs are widely used as an add-on to extend campus-based learning or as main teaching and learning tool in online courses (Waltonen-Moore, Stuart, Newton, Oswald, & Varonis, 2006). These have been recognised as: collaborative learning tools for demonstrating critical thinking and interaction that could lead to better teaching and learning outcomes (Wickersham & Dooley, 2006), as well as promising pedagogical tools in developing competencies and confidence in self-regulated learning and social interaction (McLoughlin & Luca, 2002). The use of ODFs is becoming critical in education as in other areas of society.

ODFs provide additional opportunity for multi-participant interactions to share information outside the classroom discussions (Herring, 1999). As an agent of

socialisation the use of ODFs can bring students and educators a number of benefits. For example, educators can design flexible type of interactive learning environment to explore the collaborative opportunities among students for effective learning to take place. Students can have more chances for interaction with educators and peers in the class, share knowledge, viewpoints, ask questions, and seek advice regardless of time, place and pace to reinforce their learning (Gunawardena, Lowe, & Anderson, 1997).

A clear advantage of online discussions facilitated by the ODFs is the convenience, flexibility and the increased interaction opportunities among students and the educators even when they are physically not present together. It also makes the conversation available for access to learners all the time unrestrained by time, place and pace. Having such conversation availability would mean less dependence on educators for a response, and increased exposure to multiple perspectives.

While online discussion environment provides students with great potential for collaborative learning, continuous knowledge generation, and access to conversation, the asynchronous and the text-based discussions do however mark the beginning of problems. For example, the open access to the learning environment unhampered by time and place can affect the interaction pattern. As large number of students could use the environment at the same time or different time there is a great potential for information overload, overlap of similar messages, and sifting through large number of messages to get the required information could become an issue.

One of the common problems identified with online discussions in the reported research (Armani, 2004; Govindasamy, 2002) is the lack of adequate forum interface support to handle the text mediated and asynchronous conversational modes of learning leading to the difficulty of identifying which messages contain the needed information. Discussion generated in the forum would be useful to students if the required information is easily located and quickly retrieved. This problem apparently arises because of the vast, unstructured and mixed amount of information available in the forum messages, and the inadequacy of the forum interface to support them. Research on improving the technology support capabilities is increasingly on the raise but addressing natural language processing to make the technology understand human communication still

remains a question requiring satisfactory answer. Some of the issues discussed later in this thesis include: managing large number of messages, overlap of similar messages that could lead to delay in response and difficulty in access to answers in the pile of mixed messages.

Furthermore, the interfaces of the existing ODFs lack features to support inter-institutional cooperation. Improving the forum interface to widen interaction between users of various institutions sharing common courses could potentially increase efficient resource sharing for individual and collaborative learning. This suggests that ODFs are useful resources for people looking to find information, discuss ideas, and get advice but the interfaces need improvement to make these resources pedagogically more useful.

The next sections present the research purpose and questions, as well as the method used to address them.

1.3 Research purpose

The main aim of the study was to improve the effectiveness of ODF interface with add-on functions to:

a) facilitate users from multiple tertiary institutions to communicate and manage discussions in a widened shared dynamic learning environment,
b) enable students to quickly obtain existing answers to their questions, and
c) assist students in getting notified of replies to a specific message they are interested in.

1.3.1 Research questions

The following research questions were analysed in this research:

a) Can the interfaces of online discussion forums be improved to increase knowledge sharing opportunities between users?
b) Can the interfaces of online discussion forums be improved to assist users in easily finding existing answers to questions?

c) Would students perceive the add-on interface functionalities to the forum, such as: (i) widened communication, (ii) obtaining existing answers, and (iii) notification facility useful and easy to use?
d) Would educators perceive the improved interface functionalities helpful, and whether they would prefer to use the system in their courses?

1.4 Study method

The interface design process was guided by the two complementary issues: ease-of-use, and usefulness. These were drawn from the research of Novick and Douglas (2002). General web design guidelines could be useful when the communication pattern is pre-determined, particularly when establishing a delivery. However, in web-based learning, the guidelines do not exist, as the communication pattern in the learning environment is not pre-determined and varies according to the course requirements (Zaharias, Vassilopoulou, & Poulymenakou, 2002). The following steps have been used to achieve the study aims.

The first step involved gaining an understanding of the inadequacies in existing discussion forum interface functions. This was achieved by conducting a literature review of forum related research studies. A key objective of the review was to examine the effectiveness of characteristic interface features of discussion forums in existing LMSs in terms of their functional support to learning.

The second step involved gathering functional requirements. This was based on: a) limitations identified in step one; b) discussions (face-to-face and online) among the project team members including students and educators of participating tertiary educational institutions; and c) an examination of the recent research studies that were relevant to the study.

The third step involved modelling requirements. This was done through examining the communication needs for the system's tasks that the interface has to support. This included a case approach and the use of case diagram.

1.5 Study context

The results of the study were implemented in the system called electronic Question and answer knowledge environment (eQuake). Developed under the official name “agent based intelligent help system for New Zealand student community”, eQuake is a shared web-based discussion forum intended to support learning among distributed groups of students in New Zealand tertiary institutions.

The next section provides an overview of the eQuake goals, and introduces project team members and their tasks.

1.5.1 Aims of eQuake project

The main goal of the project has been to design, implement, and evaluate a learning system with the following objectives:

a) Providing enhanced educational experience to priority groups such as Maori.
b) Providing wider student interaction across various institutions hence increasing exposure to multiple perspectives.
c) Reducing workload on teachers by reducing repetitive explanations and creating a long-term archive of core student questions and answers.
d) Alerting teachers to problem areas in students’ understanding process.

The online discussion forum developed in the project was an add-on to *Moodle*. The various interface improvements implemented in the system are extensions to current ODFs and are in regular use. The reason for this choice was due to the aim being to improve the existing ODFs interface to enable users take full advantage of the potential benefits that the system can offer rather than to create new interface as such. Therefore, although targeted at the New Zealand tertiary institutions, eQuake by design is usable by other tertiary educational institutions that use ODFs to complement their courses.

1.6 Project team

Lalitha Jonnavithula, the author of this thesis and Masters student was responsible for the design and development of the user interface of the system. Other members of the team included: Yuejun Zhang, a PhD student in charge of student and tutor proxy agents

and notification module; Jingyu Yang, PhD student in charge of query monitoring agent; Jianbo Cui, a part time programmer in charge of target selection agent and study group related functionality; and Øyvind Smestad, a Masters student and part time programmer in charge of plug-in development.

The team conducted face-to-face meetings, used a discussion forum hosted at a Massey University server, and an instant messaging system to communicate with each other to ensure that the tasks were properly aligned to the proposed system's goals.

1.7 Scope of the Thesis

This thesis mainly reports on the user-interface part of eQuake system. Although reference to the eQuake architecture is made, a detailed discussion of system design and technological considerations are beyond the scope of this research and therefore are not covered.

1.8 Potential benefits of enhanced interface

The intended benefits of the improved interface facilities implemented in eQuake for both students and educators were identified as follows:

a) A richer environment where students would have an opportunity to engage in interaction with peers and educators of multiple New Zealand tertiary institutions, and access to multiple perspectives.

b) The wider interaction could allow for an increase in the knowledgebase, and also increase the potential for students to find answers to their questions. This could result in the improved learning process.

c) Both students and educators would be exposed to different expert viewpoints on issues. This outcome was expected to raise the level of learning across nationwide institutions.

d) The task of inputting a question is the same as posting a message. This approach helped students in quickly finding existing answers (if available) to their questions without having to perform a separate search.

e) In addition to the commonly available facility of subscribing to an individual topic to receive email notifications when new messages are posted, students could subscribe to a particular question and receive email notifications of replies to that question.

f) Educators could get notification of unanswered postings when several similar questions are unanswered, so that they could create a Frequently Asked Question (FAQ) entry.

g) Creating a long-term archive of FAQs could reduce repetitive answers that could potentially decrease educators' workload, and could also reduce students' waiting time for a response.

1.9 Evaluation

The formal evaluation was conducted using a quantitative experimental research approach based on the Technology Acceptance Model (TAM) method proposed by Davis, Bagozzi and Waerhaw (1989). This included testing the perceived usability, and ease-of-use of the extended functions implemented in eQuake to predict the future user acceptance of the eQuake system. About 200 users volunteered to evaluate eQuake. These volunteers included both male and female staff and students from Massey University, Eastern Institute of Technology (EIT), and Auckland University of Technology (AUT), as well as researchers from Massey University.

1.10 Organisation of the thesis

The next chapter presents a review of literature with a focus on aspects relevant for this study. Chapter 3 describes design and development of add-on interface functionalities. Chapter 4 provides screenshots illustrating the enhanced interface support functions implemented in eQuake. Chapter 5 describes the evaluation and its results. The last Chapter summarises the study followed by directions for future research.

Chapter 2: Literature Review

2.1 Introduction

Interaction among students and with the educators has been a key element in learning since a long time (Chou, 2003; Laurillard, 2002; Moore, 1989). Given the focus on interactions, a central concern of research in the technology use therefore has been to encourage interactions for successful learning outcomes. This can be seen in the increased attention being given to the integration of technology into designing learning environment for making user interactions in computer supported learning environment a non-issue (Hoadley & Kilner, 2005; Jonassen, 1998; Lakkala, Lallimo, & Hakkarainen, 2005; Li, 2004; McLoughlin, 2002; Teo & Gay, 2006). The main idea underpinning the focus of researchers on the application of technology in combination with pedagogy enhances the potential to create an effective student-engaged learning environment.

Online discussion forums (ODFs) are web-based communication technologies widely used in education to support students in promoting "interaction, engagement and communication" (Topper, 2005, p.56). The literature review presented in this chapter looked at the ease-of-use and overall effectiveness of existing ODFs' interface functionalities in supporting and enhancing the learning process. The purpose of the review was to identify the scope for improvements that could be implemented.

This chapter is organised into four sections, and is guided by the main question: "How can we improve the interface of existing ODFs to increase their support to learning?"

Section 2.2 briefly covers the concept of learning as perceived in tertiary education with a focus on the attributes that constitute effective teaching and learning. This was done to better appreciate the ease-of-use and the usefulness of ODFs' support to learning. Subsequent Sections 2.3, 2.4 and 2.5 cover: the use and functional support facilities of ODFs to students in their learning process, the limitations of existing ODFs' interface functional support, and the consequent problems faced by students. Lastly, Section 2.6 covers related research efforts for directions in improving the interface functionality of ODFs to enhance learning support.

2.2 Perception of learning in tertiary education

Learning has been identified as a multidimensional and multi-process activity (Webster, 2001) that happens best through social interactions (McKenzie & Murphy, 2000). Research considers that helping students to enhance their learning experience is best achieved through the creation of effective learning environments using the social constructivist model (Hoadley & Kilner, 2005). This model emphasises learning as an active cognitive process that occurs through interaction and leads to knowledge building over a period of time. Advocates of constructivism therefore emphasise the need for providing students with an effective environment where individual and collaborative knowledge construction through meaningful interactions can take place (Brown, Collins, & Duguid, 1989; Jonassen, 1995; Roehler & Cantlon, 1996). Lack of students' exposure to such environment where students could share multiple perspectives has often been claimed by educators to explain the low retention rates in online courses (Sheard, Ramakrishnan & Miller, 2003; Williamson & Nodder, 2002).

An increasing interest of tertiary educational institutions in developing a conversational or discussion type of environment to support socially co-constructed learning could be gathered from Collis's (1998, p.375) observation. Commenting on what constitutes good learning and teaching practices in tertiary education Collis stated:

> *"Scaffold the learner's increased self-responsibility for learning. Stimulate active engagement. Elicit articulation and reflection. Lecture less and give feedback more. Encourage more frequent and targeted communication."*

The above view of learning underpinned a constructivist approach to teaching stressing individual and collaborative construction of knowledge. It also suggested a move in the pedagogical thinking from a teacher-centered instructional environment towards a student-centered environment. In this environment students are considered as active participants working together to construct knowledge and educators as facilitators encouraging interactions.

2.2.1 Interaction among students as key factor to effective learning

The emphasis on knowledge construction through conversations in a cooperative environment leads to the belief of interaction as an important issue in learning, whether it is in face to face or in distance education. As McDermott (as cited in Smith, 2003, Conclusion section, para. 2) puts it:

> *"Learning traditionally gets measured as on the assumption that it is a possession of individuals that can be found inside their heads…Learning does not belong to individual persons, but to the various conversations of which they are a part*."

The above perception implied:

Firstly, learning is a dynamic cognitive process, and there is nothing 'systematic' about how learning is processed or knowledge is constructed (Spiro & Jehng, 1990 as cited in Heather & Terry, 1999). Such a view implies that the technology interface supporting learning must accommodate the unsystematic characteristic feature of learning.

Secondly, "learning most naturally occurs not in isolation but by teams of people working together to solve problems" (Jonassen, 1998, p.2). Learning as such results from a shared activity, and exposure of students' thinking to a number of perspectives is critical to learning.

2.2.2 Students exposure to multiple perspectives

Learning from multiple perspectives in a co-operative environment through interaction has been regarded as one of the key variables associated with valued educational outcome for students (Agostinho, Lefoe, & Hedberg, 1997; Laurillard, 2002; Wang, Dogan, & Lin, 2006). Students interact and learn from each other based on varying needs, knowledge, and perspectives. The interaction could be in the form of questions and answers among students, or guidance, instruction and feedback from educators (Webb, Jones, Barker, & Schaik, 2004). Students might respond to the same learning topic differently, and therefore might need to discuss information to clarify their understanding of the topic being learnt. Explaining the topic to other students helps them

identify missing links in understanding, and increases opportunities to make better decisions.

Collaborative environment has the potential to provide new interaction possibilities for enabling students to learn and shape their understanding of a concept. Therefore good teaching and learning whether in face-to-face or distance mode should consider developing and enhancing the learning environment that promotes learning and help students to shape their thinking process.

In terms of creating an effective learning environment, research identified four common attributes as important. These included: providing opportunities to foster personal *construction* of knowledge; setting an appropriate *context* for learning; and facilitating *collaboration* among learners; through the use of *conversation* (Agostinho et al., 1997). Hoadley and Kilner's (2005) C4P model (content, conversation, connections, context, and purpose) shown in Figure 2.1 also suggested a somewhat similar view.

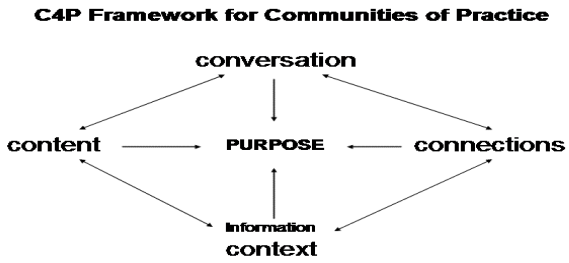


Figure 2.1: C4P Frame, adopted from Hoadley and Kilner (2005, p.34)

According to the C4P model, knowledge is produced when there is a purposeful conversation around content in context, and connections are primary for conversation to occur.

2.2.3 Interactivity dimensions in relation to learning

The three types of interaction relationships proposed by Moore (1989) have been influential in forming a framework for learning. These are:

a) Learner - content interactions, which refers to the ability of students to interact with the study material and engage in self-dialogue;
b) Learner - educator interactions, which refers to the ability of students to interact with their educator with or without the presence of educators. In this type of interaction, instructors are responsible for stimulating and continuously maintaining learners' interest in the topic, motivating students to learn, assessing students' progress, and finally providing support and encouragement to them; and
c) Learner - learner interactions, which refers to the ability of students to interact with other students. This type of interaction represents the communication between one learner with another learner, or with a group of learners, and takes place either synchronously, through instant messaging chats, or asynchronously, through the exchange of electronic e-mail or posting of messages in discussion forums.

The three types of interaction relationships proposed by Moore provide a useful framework in understanding the interaction dimensions. However, the fourth relationship type that is the learner–interface added Hillman, Willis and Gunawardena (1994) provided yet another important interactivity dimension emphasising the importance of user interaction with the technological medium. Hillman et al. argued that in a technology supported environment the success of the other three interaction types depends on the users' (educators and students) effective interaction with the technology interface, and failure to interact with the interface successfully could inhibit learning.

Interaction has a variety of functions in the educational process. It provides additional opportunities that students could use to "reconsider prior views, distinguish among alternatives, develop new insights linking prior and introduced ideas, seek new information, promote some ideas over others, coalesce previous distinct notions, or restructure ideas to enhance connections" (Hoadley & Linn, 2000, p. 840). Therefore, pedagogies or teaching and learning strategies that integrate communication technologies could extend learning possibilities and engage students in ways not possible in classroom-based education (Collis & Moonen, 2001).

In the environment mediated through technology both educators and students are seen as users of the learning environment. Interaction can facilitate learning, and technology has the potential to simplify access by providing interface for user interactions. Given the emphasis on cooperative learning in tertiary education, and the importance of technology interface to support user interactions, there is a need to examine the effectiveness of existing ODF interface support facilities to encourage the learning process.

The next section discusses the educational opportunities facilitated by ODFs to enhance learning support.

2.3 Computer supported collaborative learning (CSCL)

The use of technology into teaching and learning for enhancing learning outcomes is not a new concept. Communications via computers have been around since 1970s. However, it was in 1980s that the use of these technologies along with the face-to-face classroom discussion became more apparent and common for fostering such collaboration (Althaus, 1997).

The Internet supported by various communication technologies made the use of technology for facilitating open, flexible, and distributed online learning (Khan, 2005). In a study on exploring the interactivity and interactive functions in web-based learning systems for the purpose of recommending a technical framework for interface designers, Chou (2003) identified the following interactivity dimensions:

a) ease of accessing and adding information,
b) facilitating inter-personal communication,
c) viewing information in chronological and non-chronological way,
d) responsiveness to users in a non-delayed way,
e) monitoring information use, and
f) adaptability in terms of learner-interface.

Technology interfaces with the above dimensions integrated could make the environment a richer source for students and promise great potential in terms of their responsiveness to the information needs of students. The development of computer-

supported collaborative learning (CSCL) systems with tools such as email and ODF were seen to fall in this range of supporting collaboration (Lipponen & Lallimo, 2004). Grounded in the wide framework of learning theories, the research on technology use mainly focused on how collaborative learning could enhance peer interaction and work in groups.

Learning Management Systems (LMSs) are one kind of CSCL systems used in education to support collaborative learning. These are available as commercial packages (e.g., *Blackboard* and *WebCT*) and as an open source software packages (e.g., *Moodle*) with communication tools as component parts to provide an online learning environment.

Most LMSs provide synchronous (instant messaging system [IM]) and asynchronous (discussion and mail) communication tools to allow interaction among students. Unlike the IM tool, which requires students to be present at the time of communication, the asynchronous tools do not require such presence. Furthermore, synchronous communications could be difficult for educators to manage with a number of students communicating at the same time. Asynchronous tools can facilitate learning environments that allow users to exchange information at their own pace without the limitations of time and place. Compared to the e-mail tool, which allows communication to be visible only to selected students, the discussion tool allows communication to be visible to all students having access to the forum environment.

2.3.1 Online discussion forums (ODFs) in educational context

ODFs are one of the widely used communication tools in an LMS. Many educational institutions use them with different pedagogical aims – as an add-on to classroom teaching in face-to-face institutions or as a teaching/learning tool and a communication medium among students, and students and educators in distance education.

The asynchronous and written medium of the ODF environment provide great potential for promoting building learning communities where students could interact with groups of students and engage in mutually exchanging messages about the content (Torrisi-

Steele, 2002). This has the potential to create new kinds of exciting possibilities for collaboration and satisfying the communicative needs of those who use them.

The one common point that binds ODFs with learning is their potential to provide efficient ways of interconnecting students. Students interact with each other based on varying needs, expertise (knowledge and skills) perspectives and opinions. Unlike in traditional classroom discussion where the shared information is lost when the discussion ends, ODFs provide opportunity for reflection that can lead to deeper processing of information, and the creation of messages of reusable value (Hillman et al., 1994; Li, 2004). A reason for this could be attributed to the uniquely distributed and asynchronous nature of communication, which gives students open access to the environment (Vat, 2001).

2.3.2 Online discussion forums (ODFs) as learning tools

ODFs offer several possibilities to explore and take advantage of the pedagogical benefits to support learning (Goodfellow, 2005). They provide convenient and flexible medium to extend interactions in the online environment. This is in sharp contrast to traditional setting where opportunities for group working are constrained by time and place.

ODFs can be used within a course to serve several purposes ranging from providing a forum for social networking through to facilitating the construction of knowledge (McLoughlin & Luca, 2002). The typical uses of ODFs as identified by researchers include: a) providing flexible medium for students to make their perspectives, and questions visible and support collaboration or competition (Allan, 2004; Barker, 2003; Helic, Maurer, & Scerbakov, 2004; Hoadley & Linn, 2000; Thaiupathump, Dawant, & Bourne, 1998), b) “develop critical thinking skills and teamwork”(Lawhead et al., 1997, p.31), and c) enable “communities of learners to negotiate and co-construct meaning for problem solving and knowledge construction”(Reushle et al., as cited in Barker, 2003, p.54).

ODFs have great potential to support collaborative learning. The potential benefits of online discussions to students, and the social aspects of student learning facilitated by

the ODFs have been documented in the literature. For example, the study of Durham (1990) suggested that student - student exchanges with low tutor involvement allow the creation of a very 'immediate' environment for the exchange of information and for increasing students' sensitivity to their own and others' writing. In a study conducted by Wu and Hiltz (2004), 78% of the students from three online courses reported that they learnt a great deal from their peers through online discussions. The availability of the discussion also assisted the students in monitoring their progress as it allowed them to see what they have already done and what else needs to be accomplished (Chernobilsky, Nagarajan, & Hmelo-Silver, 2005).

Some research studies suggested the educational use of ODFs as limited to completing learning activities or as help desks to get answers for their questions. For example, Ng and Murphy (2005) in an analysis of students' contributions to the discussion board found students' use of forums to seek clarification about course concepts, and exchanging views or personal comments on management issues. Students normally used forums to find existing answers to their questions, or read postings regularly to obtain tips as they appear (Bull, Greer, McCalla, & Kettel, 2001). Likewise, a study conducted by Barker (2003) to analyse the use of ODFs indicated positive response from students. 90% of the students indicated that the discussion board was an extremely efficient method of communicating answers to the questions asked.

Students' interest in seeking responses however could stem from different reasons. For example, in a study Webb et al. (2004) found that students, particularly those studying at basic level, tended to ask similar questions repeatedly, as they tried to understand and clarify the content of a module. Another example was the study conducted by Wang et al. (2006) to investigate the difference between English and non-English speakers' perception on seeking multiple perspectives. The results suggested the native English speakers' use of ODFs to seek others' perspectives because they wanted to confirm their thinking, while non-native English speakers wanted other perspectives more because they wanted to understand the scenarios better.

The next section looks at the interface support facilities provided by ODFs.

2.3.3 ODF interface support functions

The interface design accommodates the browsing of existing messages and the submission of new postings. They offer basic facilities (such as add new thread, reply and edit message) for communication exchange among users. Once users enter the discussion board environment, the interface features allow users to read previous messages, post new messages, reply to existing messages posted earlier by other users, and edit or delete their own postings (Barcellini, Détienne, Burkhardt, & Sack, 2006; Farmer, 2004). Table 2.1 gives a general idea of the interface support facilities offered by some of the commonly used ODFs.

Table 2.1: Summary of interface support functions of existing systems

Interactive functions in ODF systems	*Moodle*	*DiscusPro*	*Fusetalk*	*Blackboard*	*WebCT*
Reply feature to allow postings to the forum	√	√	√	√	√
Edit/ delete	√	√	√	√	√
Add new topic	√	√	√	√	√
Allow subscription to topics	√	√	-	-	-
Highlight/set to normal	√	√	√	√	-
Allow attachment	√	-	-	-	-
Allow ratings	√	-	-	-	-
Tracking (Mark read/unread)	√	-	-	-	-
Post threshold warning	√	-	-	-	-
Allow anonymous posts	-	-	-	√	-
Display new message	Separate forum as part of the platform	Text icon	Highlights topic folder by colour	Highlights thread	√
Move messages to relevant folders	Messages can be split and moved	√	√	-	-
Allows the display of selected messages	-	-	√	√	√
Show parent/see in context	√	-	-	-	-
Quote	-	-	√	-	√

Some commercial ODFs, (e.g., *WebCT* and *Fusetalk*) provide a ‘quote’ facility, when replying to preserve context of the message and keep track of the information flow, and

to notify users of posts from a topic the users are subscribed to through the email facility (e.g., *Moodle*). Users can keep track of read and unread discussion by choosing the appropriate read/unread option features (e.g., *Moodle* and *WebCT*). Educators can split messages, and also move messages to appropriate discussion thread (e.g., *Moodle*). In general, most ODFs provide "a very simple and highly usable user interface which can be easily operated by a wide range of users with very different and even non-technical backgrounds" (Helic et al., 2005, p. 2).

2.3.4 Display options to visualise discussion

The discussion thread normally starts with a new topic, and new messages are added to it as the discussion continues to show the reply relationship. Messages are normally displayed in a tree form with the titles of the messages shown, and new messages are indented as they are added to the original message. Some ODFs, such as *Moodle,* allow some variation in the display format. These include:

a) Linear (full messages are displayed flat in a list form with new messages added either on to the top or at the bottom); and
b) Nested (full messages are displayed indented as they are added to the original message).

Some ODFs facilitate users to keep track of the read and unread messages. Looking at a discussion thread, it is possible to identify how many replies there are, and what was the most recent reply. For example, new postings are identified by a coloured folder icon in *FuseTalk*, and displayed in side bar with a hyperlink in *Moodle*. Often, threaded discussions are expandable and collapsible to allow users to manage the number of posts shown on their screen at once and to facilitate browsing groups of posts (Barcellini et al., 2005; Neal & Miller, 2005).

ODFs allow discussion messages to be searched by date, author or keyword or by specific topics defined by the educator or other participants. *Moodle, Blackboard* and *WebCT* contain a tracking function that allows an educator to track student usage of forums (e.g., number of times accessed, last access time of the forums, and the number

of messages posted or viewed). Table 2.2 provides a list of the various search facilities offered by different ODFs.

Table 2.2: Summary of search functions of existing ODFs

Search functions in ODF systems	*Moodle*	*DiscussPro*	*Fusetalk*	*Blackboard*	*WebCT*
Words appearing anywhere in the post	√	Keyword options: And, And Not, Or)	√	√	√
Exact phrase match	√	(match case)	√	√	√
date/author	√	√	√	√ Drop down list of the authors' names)	√
Words appearing in the subject line	√	√	Recent posts specified by date	√	√
Specific or all forums	√		Recent posts specified by date		
Specific or all forums			And /AndNot or OR	(And, And Not , Or)	

The next section describes the pedagogical issues in the existing ODFs interfaces.

2.4 Limitations of existing ODFs' interface support

Asynchronous, written medium and self-paced learning predominantly distinguish the ODF environment from the traditional class-based environment. This special feature of the ODFs opened up possibilities for educators to support a variety of interactions in ways that were not possible in the traditional approach (Kurkovsky & Whitehead, 2005; Swan, 2004).

While the use of existing ODFs provides students the benefits of interacting than ever before, learning in an online environment has specific challenges as it increases dependency on the technology that students are working with.

The next section describes some of the issues in the use of ODF environments for learning.

2.4.1 Delay in response to students' questions

The questions posted to the forum, as Feng, Shaw, Kim, and Hovy (2006) pointed out, are often time critical to the learning process, and a slow response to students' questions can cause frustration to them (McPherson & Nunes, 2004; Murphy & Coleman, 2004). The results of the study conducted by Murphy and Coleman (2004) to explore the challenging experiences encountered by the pre-service teachers in a web-based graduate program found that the delay in response to questions or message supports the need for a quick response from educators. 13.9 % of the students complained about having to wait for responses on some ideas they wished to clarify urgently. Therefore, it is important for educators to quickly respond to student queries posted in the forums.

2.4.2 Concealed knowledge

Interactions involve providing explanation, reflection, and verification in the form of questions, answers and comments. As such messages posted in the ODF environment may contain useful information. Re-using this information can be advantageous to students to enhance their learning. However, as the interfaces of existing ODFs are not designed to distinguish messages by their type, valuable information may get obscured in the pile of mixed messages. Sorting through the pile of the mixed messages to find required information has already been identified as a difficult task for students (Arnt & Zilberstein, 2003; Lui et al., 2005).

2.4.3 Identifying existing questions and answers

Educators and students depend on the written medium of communication that the ODFs support to engage in a variety of interactions (Marra, 2006). Creating effective learning places for collaboration empower learners to construct knowledge in meaningful ways. Furthermore, educators might use forums to answer questions and allow all students taking the course to view those answers. Such an approach could be advantageous to

students who may have similar questions. However, implementing such an idea is not an easy task.

Several factors contribute to the difficulty. Some of these are as follows: Firstly, the asynchronous nature of a forum conversation makes it possible for a number of students to pose several questions at the same time or at different times; Secondly, questions in the forums can often be complex, running into multiple lines (Feng et al., 2006); Thirdly, questions could be vague (Barker, 2003); and Fourthly, the questions posted in the forum may not necessarily be in a question format (Shrestha, & McKeown, 2004).

Such aspects of the forum postings make it difficult for educators to identify and respond to questions.

2.4.4 Following discussion context

A number of researchers noted that while the asynchronous nature of conversation that the interfaces of existing ODFs allow users the advantage of replying to any message at any date in the forum, such facility might cause breakdowns in conversations and separate discussion from the context of the learning activities (Arnt & Zilberstein, 2005; Hewlitt, 2005; Lui et al., 2005; Maurer, Rozenich, & Sapper, 1999; Reyes & Tchounikine, 2003). The existing ODF features shown in Table 2.1 are of limited help to identify the type of message. For example, subject line facility of existing forums has the potential to improve the potential accessibility of the discussion, but the success of it depends on the use of this feature as desired by the system, that is, users must remember to change the subject line to reflect the content type of their message. In addition, as researchers noted students' tendency to reply to a part of the posted message result in developing several types of threads, and thus making the discussion disorderly. Therefore, by investigating the subject headings or contents of earlier postings in a message thread, one may not be able to guess the message type (Jijkoun & De Rijke, 2005; Kim, Candan, & Dönderler, 2005).

Researchers have suggested a number of solutions to improve the online discussions. For example, Li (2004) suggested organising discussions into separate folders to keep the threads useful. Organising threads in separate folders might be helpful to keep related

messages to particular thread together, but the problem of quickly finding answers to questions still remains.

Including a short segment of the message being responded to as ‘quote’ in the reply message was suggested in the study of Barcellini et al. (2005). This might address the problem of preserving the context of a message but there is a potential problem of breaking up the topic, and multiple overlaps of message exchanges (Ellis & Dringus, 2005; Helic et al., 2004; Maurer et al., 1999; Reyes & Tchounikine, 2003).

The most common way of searching for information has often been limited to traditional keyword searching. Many forums support the capability to sort messages by date, subject, author, read status, and other attributes as shown in Table 2.2. The problem with such a search mechanism is that the results returned are often mixed. Students may have to examine all of the retrieved results to find specific type of information, for example, an answer type to a specific question (Helic et al., 2004). Thus, the lack of interface functionality to distinguish messages by type heighten the problem of students in finding existing answers, and consequently leads to posting similar questions repeatedly (Ebner, Scherbakov, & Maurer, 2006).

Quoting message facility offered by some ODFs (e.g., *Blackboard, WebCT,* and *FuseTalk*) might preserve context of message in the discussion space. Barcellini et al. (2005) in their study of an open source software project reinforced this view. The problem of sifting through large number of various types of messages to find answers to the questions and/or the unanswered questions that students might have posted remains an issue.

The use of forums is as much a benefit as a problem. They provide easy way to contribute information; however the interface functionalities of these systems are inadequate and create some usability issues limiting the benefits they promise to offer. As technology becomes increasingly integrated into the teaching and learning strategies at tertiary levels, the need to look at the effectiveness of the ODF support becomes important. The common concerns in the use of forums as noted in the above discussion include: information overload, overlap of similar messages, and sifting though large

number of messages to get to the required information. As messages are exchanged between the participants in asynchronous settings, a great need exists to enhance the information flow.

Furthermore, the interfaces of the existing forums lack features to support inter-institutional cooperation that could potentially increase knowledge sharing between users of various institutions that share common courses. Although the current organization and presentation of information is useful, users have to invest much of their time and effort in accessing the required information. Forums can be valuable tools, but require many improvements.

There is a great need to enhance the organisation of messages so that the required information is located quickly. It is also desirable to allow students to be notified if an answer to their query is posted in the forum. Such an approach could potentially reduce the number of duplicate questions and answers. Consequently this could save both students' and educators' time besides exposing students to multiple perspectives.

Tracking students' usage of ODFs is a feature of many courseware packages (http://www.marshall.edu/it/cit/webct/compare/index.htm). For example, *Moodle* provides statistics to allow educators to view the number of messages posted and viewed by students along with time and access date. The numeric data of frequency and time of participation (e.g., number of original posts, number of replies, etc.) can assist educators to get an overview of students' participation in the ODFs. However such data offers little assistance in assessing the quality of students' performance. This also does not help in identifying if students have questions. The number of postings cannot be a measure of students' understanding level.

The next section examines related research in relation to enhancing learning support in the technology mediated online learning environment.

2.5 Recent research

Educational use of ODFs is wide spread in various contexts, and as their use increased so did the research in this area. Recent research provides important insights into some of

the techniques developed by researchers to enhance learning support. Even though the focus of the frameworks varied depending on the purposes and their interest, a number of studies supported the use of question and answer approach in enhancing learning outcomes.

The following section provides an overview of some models developed by the researchers.

2.5.1 Identification of the context of discussion

A threading structure can lead to disassociation in the chronological order of the messages, leading to the discussion forum posts being separated from the context of the learning activities. Students have to manually rebuild the context of their questions before posting, and this can result in the failure to grasp the context of discussions.

Researchers (Baker, De Varies, & Lund, 1999; Ebner et al., 2006; Hatzipanagos, n.d; Hewitt, 2005; Reyes & Tchounikine, 2003) have identified the issues of disassociations and loss of order and attempted to improve the logical connections between messages using different techniques. A review by Reyes and Tchounikine (2003) gives an insight into the development of several tools that encourage the "defined types of conversation" using approaches based on labelling participant's contributions for the purpose of establishing context between messages. Examples include:

a) The CONNECT tool developed by Baker et al. (1999) where students were encouraged to categorize their opinions with respect to sentences of their fellow participants to sustain context; and
b) The Speakeasy interface developed by Hoadley and Linn (2000) that provided predefined set of links (such as "And", "Or", "But", "Question" and "Summary") to enable users indicate the link relationship between messages

Wei, Lee and Chen (2004) proposed a contextual question and anchors interface and an online e-book annotation interface that enables students to identify difficult passages and post the marked content as a question directly in the forum using anchors. A mentor recommender, based on the preference and knowledge level of the students is also

provided to recommend appropriate capable peers to answer the issued questions. The preliminary evaluation results showed that the discussions increased significantly and about 80% of students indicated that they benefited greatly by adaptive peer help. The interfaces are designed to receive timely adaptive mentoring in the place and context where students have difficulty. Such mechanisms may be useful for students in clarifying any textbook related issues from a mentor but do not expose students to multiple perspectives.

2.5.2 Identification of the contribution type

A study by Helic et al. (2004) reports the results of implementation of a virtual discussion room implemented as part of a web based education system called Web-based Training Master (WBT) to address problems related to information retrieval in ODFs and to allow the reuse of the forum content as new learning resources by students. The virtual discussion room has been designed to support both the standard functionality of a Web-based discussion forum, as well as to provide means for modelling contributions from that discussion forum. To allow students to assign their contribution to a concept or concepts, this tool provided taxonomy of pre-set concepts to select. The results of the evaluation conducted to evaluate the perceived usefulness of this tool by students indicated a positive response in terms of enabling students to better understand concepts in a particular subject.

The WBT system was an improvement over the existing standard ODFs in as much as it facilitated explicit analysis of discussion forum activity. Students could retrieve information based on a particular concept as opposed to the standard search mechanisms that the existing ODFs offer. The interface of this tool could be useful in navigating or searching contributions by a particular concept. However, the flexibility of this tool in allowing students to assign contributions to more than one concept increases workload on educators, as it requires the constant monitoring to assess the correctness of assigning contribution.

A study by Sugimoto, Hori and Ohsuga (1998) provides a novel approach to present information in a help model developed by them. The model was designed to

automatically elicit and visualise different viewpoints of authors concerning certain topics from a text database of journal and conference papers. The benefits noted with such a model were that one can arrive at new understandings and build personal concepts creatively that could not have been possible through discussions with other persons alone.

A somewhat similar approach can be seen in the study of Ebner et al. (2006), which proposed a novel approach to support semantic modelling of discussion forums. The proposed model allowed classifying and categorising contributions around a number of interrelated concepts, such as, assigning contributions to these concepts, and thus providing them with explicit semantics. Information retrieval from such a semantic model would make it easy to access a particular contribution, and the resulting discussion would be concise and clear for its readers. This could also be easily reused as a new learning resource.

An analysis of a study by Barcellini et al. (2006) intended to show quotation based approach as a mechanism to maintain the design-oriented online discussion context showed positive results. In order to facilitate the participants to keep track of a major Open Source Software (OSS) project design related past discussion in the online environment Barcellini et al. explored the technique of displaying sequences of quotations and comments that are linked to argumentation. This has been done to enable project participants to reconstruct the logical flow of information. This study proposed the use of two approaches. The first approach was to allow users to tag messages to categorize the content and design rationale expressed in the messages. The second approach was to construct an automatic discourse tagger to analyse automatically the themes of discussion and patterns of argumentation to develop this kind of tool. The shortcomings with the use of the first approach, as identified by Barcelli et al. was an added task for users, while the second task although useful might be difficult to achieve due to parsing problems.

2.5.3 Facilitation of the content analysis

The study by Reyes and Tchounikine (2003) was an attempt to address the research issue of supporting learning conversations. They developed a tool, the interface of which supports the development of learning conversations in two ways. The interface of this tool allows students to first select the parts of a message based on the "what you answer is what you link" (WYAIWYL) criteria. Second, it allows visualisation of selected messages in a single view by time order and the thread order. The preliminary results of the use of this tool showed that the ability to select parts of messages helped to the topic visibility and definition, over the conventional approach. But some interface usability problems associated with the graph-like visualisation were found. This was in terms of the dispersion of conversation into smaller units; adding up to the already existent fragmentation problem of conventional threaded conversations. Another example in a similar area is the study of Ellis and Dringus (2005), which described the development of tool called SCAFFOLD (scale for forums/online discussion assessment) for categorising and describing contributions.

2.5.4 Improvements in the re-use of information

ODFs provide space for students to develop both ideas and questions, as well as to store these for future use. Further, the questions that students ask may already have been answered. Therefore, providing a searchable knowledge base of questions and answers to find existing answers to a question would not only reduce waiting time to students, but also enhance the potential to reduce duplication of questions and answers in the ODFs (Lytinen & Tomuro, 2002; Thaiupathump et al., 1998).

The study by Patel and Aghayere (2006) presented an improvement over traditional method of creating frequently asked questions (FAQ) web page by manually selecting popular questions from an earlier semester. The authors maintained a FAQ page in the form of a "living" document called "Past Discussion Forum Answers and Questions" that was continuously updated based on the questions posted in the discussion forums.

Even if providing such a facility allows students to refer to the existing answers, the issue of finding answer would be an issue when the FAQ document becomes large with many questions and answers added to it. In such situation, it would be nice if the interface of such systems displayed answers directly to a user's query.

2.5.5 Question-Answering (QA) Systems

QA can be defined as "the task of automatically finding concrete answers to the precise and arbitrary questions formulated by users" (Vicedo & Molla, 2001, p.4). Even though research in QA systems can be traced back to the 1960s, the demand for systems that respond in a precise way to users' information needs has increased in their importance in recent times (Vicedo & Molla, 2001; Zheng, 2002).

2.5.6 ODFs as QA platforms

QA systems are helpful to users because they quickly provide the required information without having to search through a large number of messages (Lin, Quan, Sinha, Bakshi, Huynh, Katz et al., 2003; Lytinen & Tomuro, 2002). The results of the exploratory study conducted by Schuck (2003) on the use of a Question and Answer section of a discussion board in a first year mathematics subject for school children indicated positive response. Further support to the use of this QA facility can be found in the following studies:

a) The Dynamic Frequently Asked Questions environment (DFAQ)

Ng'ambi and Hardman (2004) in their study developed a web discussion space called Dynamic Frequently Asked Questions environment (DFAQ). This environment is designed to allow space where students' consultations for each FAQ result in the generation of knowledge resource. The dynamic nature of the environment creates FAQ lists as questions are posted. As such this system stands in contrast to the many FAQ lists where questions and responses are predetermined and the users are limited to 'read only' material. As questions asked by individual learners were made available to the whole class, learners could choose the ones to which they wanted to respond. Both the questions and responses were posted anonymously. Such a system could help a student

community with questions and responses that they might not have generated by themselves. An additional advantage of using this approach is that it allowed educators to identify students having difficulties with understanding. However, as the system was designed to post anonymous messages by students, this facility might perhaps encourage posting of negative or insensitive comments, and require constant monitoring by educators.

b) Discussion-bot

Feng et al. (2006) reported the results of an experimental study of the implementation of an intelligent agent (discussion-bot). They conducted this study in the context of an undergraduate computer science course. The discussion-bot was designed to identify and retrieve suitable answers from a manually annotated speech act (speaking in a conversation for action) based on its role in the thread. The response also included a hyperlink to the discussion thread from which the answer was extracted. The tool implemented within the ODF used natural language processing techniques to automatically find answers to the student's questions. Although the approach is novel, the system processed first messages only, i.e., messages posted when a student started a new thread and did not include questions that arose mid-thread, and lengthy, complex contexts.

c) Automated FAQ (AUTOFAQ)

The study of Thaiupathump et al. (1998) described the development of an automated FAQ database called AUTOFAQ to improve the facilitation of the on-line workshops for the asynchronous learning network (ALN) Web group. The system was based on a relational database of questions and answers that allowed the knowledge base to be rapidly searched and was easily maintained. The search result page of the system was designed to present questions related to the search criteria with hyperlinks, number of records found, and search scores. The hyperlinks were meant to encourage users to look for further information associated with the question. A key feature of the FAQ system developed was the capability for anyone, anywhere to add to the FAQ information. While reviewing the question, users can easily modify or add other relevant information

by using a form. Such systems could be of use in educational context to strengthen the learning process.

d) Message organizer

Lui et al. (2005) developed an advanced organizer called SmartTag to identify relevant messages in ODFs. The proposed system worked based on assumptions about the relevancy of discussion messages. In this system a user of SmartTag was first required to create tag categories and then attach a tag to any message the user considered relevant as well as replace them with their user-defined tags (the white tags) as a confirmation.

e) I-Help system

The I-Help system developed by Bull et al. (2001) provides both asynchronous and synchronous help facilities, and was designed to support peer help in university classes through matching people with appropriate helpers depending on various criteria such as, knowledge level, and relationships with other people. Although such systems can be of help for students to get answers from the people they prefer, the questions are static and not initiated by students as in DFAQ system developed by Ng'ambi and Hardman (2004).

f) The open-domain Question Answering (QA) system

Although not directly related to ODFs, the study of Jikoun and Rijke (2005) provides a useful approach in presenting relevant answers to users' questions. The open-domain Question Answering (QA) system proposed by Jikoun and Rijke (2005) retrieved a ranked list of answers to user's questions from a database of Frequently Asked Questions automatically collected on the Web. The task involved three steps: (1) fetching FAQ pages from the web; (2) automatic extraction of question/answer (Q/A) pairs from the collected pages; and (3) answering users' questions by retrieving appropriate Q/A pairs.

2.5.7 Systems addressing the needs of specific student groups

Venables and Haywood (2003) in their study described the development of a user-friendly interface to improve the quantity and quality of feedback to specific user groups, such as, students studying introductory Java programming by providing automatic and instant feedback to a student's programming efforts. Using this system, the students received instant feedback for the work they completed, but it did not offer them a chance to view multiple ways of working out the solution.

Similarly, Baker and Lund (1996) in their study described the design and preliminary experimentation of two communication interfaces by developing a tool called C-CHENE for solving physics problems in the CSCL environment. The first interface was designed to manage text-based interaction using 'chat-boxes', while the second interface was designed using flexible structure approach. The authors described flexible structuring as comprising of two aspects: (1) providing some specific types of communicative acts, but without enforcing their use in given contexts; and (2) providing negotiated automatic guidance on the domain, communication and the form of the collaborative interaction (flagged for future research). Results obtained from analysing interactions with the two interfaces indicated that flexible structuring might facilitate and encourage more knowledge-based and explanatory interactions. These interfaces were also found to be more productive to learning in collaboration since they could create a 'space' within which educationally preferred forms of collaborative interaction could emerge.

All the systems discussed above are useful in learning context in different ways. None of them provided the capability to achieve the full potential of reuse of the valuable resource generated in the process. Furthermore, these systems do not provide inter institutional interaction capabilities, which could be crucial in the present educational setting. These systems do however provide important insights into some of the techniques developed to improve the usability of ODFs and a direction to the development of ideas to enhance the interface functionality.

2.6 Summary

The concept of learning as perceived in tertiary education underpins constructivist approach to teaching. Constructivism is a psychologically oriented approach to learning emphasising individual and collaborative knowledge construction by students through interaction with their peers and educators.

The introduction of the Internet has opened up new possibilities for the use of online communication tools to promote interaction. An ODF is one such tool that serves a number of functions, as mentioned below.

Interactivity: ODFs by virtue of their unique distributed and asynchronous nature present a whole new context for interaction opportunities to create a dialogue and reflective learning network beyond the physical classroom settings. The various forms of interaction: learner-content, learner-learner, learner-teacher, and learner-interface promise to foster significant improvements in accessibility and opportunity to learn. Educators could use ODFs to support various communication needs of the courses.

Accessibility: Exchanges of information and interactions are more easily captured, stored for retrieval and re-use. This is in contrast to the traditional classroom discussion where the ideas and questions generated in-group discussions are lost once the discussion session end.

Searchability: ODFs are searchable to an extent that students can retrieve information. However the search facility results are limited because of inadequacies in the interface functionality to distinguish messages by type.

In the technology-mediated environment, both educators and students are seen as users of the learning environment. The common point that binds ODFs with learning is the network it provides between users. The value of creating ODFs is two-fold: firstly, in shifting the emphasis from teacher-centered learning to student-centered learning environment in which students can communicate and share ideas; and secondly, by

providing a forum that not only enhances classroom learning but also extends the learning space beyond it.

ODFs can be valuable tools, but require improvement. Improving learning support in the online environment will however require efforts to achieve the benefits and limit or overcome the challenges. As educators tend to focus on promoting learner-centered ways through integrating ODFs with the pedagogy, the existing interface functionalities of ODFs do not make the task of re-using information easy. Part of the problem arises from the lack of interface facilities to distinguish messages by type. Continuation of such problem undervalues the usefulness of ODFs to support learning.

Written discussions could be a useful resource if the required information is easily found. While non-technological factors play an important role for forums' success, ensuring the usefulness of the technology tools that could help both educators and students to effectively interact and enable them to use information is important for forums' success (Maurer et al., 1999; Murphy & Coleman, 2004). Improvements to the interface of ODFs therefore are needed to enhance their efficiency to allow students enjoy the potential benefits resulting from the use of ODFs.

As user interactions are mediated through technology, the specific targets for improving learning support could include assisting users in managing the flow of information between many-to-many interactions, and also to assist them to easily access information generated from interaction. It would also be a desirable option to let users be notified if an answer to their question is posted. Overall, ODFs require improvements to the existing functions to support the effective identification, organisation, use and re-use of discussion. Another aspect that would also be helpful to look at is in widening the scope of interactions to increase knowledge base.

In conclusion, there is a need for better design of ODF interfaces that would assist users to:

a) Externalise the type of information generated by the interactions occurring throughout ODF to help users manage data and perform their tasks effectively;

b) Easily obtain unanswered questions for educators and be able to provide students with relevant, and well-informed feedback;
c) Easily obtain existing answers in order to reduce waiting time for answers, and expose students to more than one answer to enhance their learning;
d) Easily obtain unanswered questions for students to avoid posting of repeated questions; and
e) Enjoy the possibilities of sharing more knowledge resources by having ODFs shared by multiple courses across institutions.

The review of recent research studies presented in section 2.4 of this chapter indicated the current research trend towards enhancing the efficiency of technology to effectively support learning. These studies provide valuable insight into how technology-rich learning environments could be designed to enhance the experience of learners in the learner-centered open discussion environment. Although most of these studies are at the research level, they are welcome additions to the research field in enhancing the learning process.

Based on the knowledge gained from the literature review, the next chapter looks into the interface design process by investigating the ways to effectively support user tasks of interacting with the interface and accessing required information identified as valued attributes for successful learning.oucomes.

Chapter 3: Interface design and development

3.1 Introduction

This chapter describes the method used in the design and development of proposed solutions to overcome the problems identified in the interface functional support of typical online discussion forums (ODFs) that are in regular use; and also an examination of the recent research studies that were relevant to the study discussed in Chapter 2.

Educators have noted interactivity and co-operation among learners as important to knowledge acquisition and the development of cognitive skills (Laurillard, 2002; Moore, 1989). Therefore the environments in which interaction and collaboration is facilitated and encouraged could lead to positive learning outcomes (American Psychological Association [APA], 1997).

Researchers concerned with the computer mediated learning environment have emphasised technology interface as an important factor as it provides link to the social interactions identified as important by the educators in enhancing learning outcomes (Hillman et al., 1994; Swan, 2004). Therefore, given the importance of social interactions as well as discussion in the learning process (Hubona, 1995), there is a need to examine the adequacy and effectiveness of existing interface functional support of online discussion forums (ODFs) for social interactions.

The review of research studies in Chapter 2 suggested that ODFs are useful in facilitating collaborative learning environments. For example, they provide interface for users to: explore new interaction possibilities, communicate and engage in critical thinking, externalise their understanding of the content they are studying in written words, and make connections to construct a meaningful and powerful learning experience in their own time and place unavailable in the traditional approach to interactions (Kurkovsky & Whitehead, 2005). However, the review also suggested inadequate ODF interface functional support for users to take full advantage of the collaborative learning environments. The inadequacy was found especially in the area of re-using the knowledge generated in the forum environment.

The next section provides an overview of user interface design as perceived in Human Computer Interaction (HCI), and highlights its position in the system's development process. It is then followed by the interface design method used for this study.

3.1.1 User-interface as perceived in Human Computer Interaction (HCI)

A system that is modeled upon the users' requirements can better facilitate the completion of the tasks performed by the users and could result in a greater likelihood of user acceptance (Habernann, 1991). In designing a system, the interface design could be seen as an "artifact" standing between users and the system with which they interact (Bodker, 1991, p.77). While the software must match the users' tasks it supports, the interface must support the system's functionality.

3.1.2 Designing usable and easy to use interfaces

'Usability' and 'productivity' have been identified as two complementary issues that guide the user-interface design process of a software system (Newman,Lamming, & Lamming,1995). In the context of HCI, these terms are associated with 'ease of use', and 'usefulness' in relation to user satisfaction (Novick & Douglas, 2002). Therefore, for a system to be useful, its interface must be both functionally powerful as well as easy to use for those who use the system (Habernann, 1991). This is where the design of user interface blends into the design process of the system.

The next section provides an overview of a general framework of the design process used in this study.

3.1.3 Flexible interface design framework

The review study by Brown (1997) on HCI methodologies for building user interfaces suggested the absence of standard design principles for effective pedagogically usable technology interface design. The reason for the lack of standard methodology can be attributed to the fact that each design approach comes from a different discipline/subject. As the design approach of interface differs with purpose of its use, a useful comparison between approaches could not be drawn to standardise the direction for successful design (Bødker, 1991; Habernann, 1991).

Standard system interface design approach that suits different disciplines cannot be prepared. However, the HCI design literature provided a general design framework that can be adapted to explore the design space for creating effective user interfaces (Lewis, Brand, Cherry, & Rader, 1998; Lytinen & Tomuro, 2002; Newman et al., 1995; Nielsen, 1993). In this general design framework, the interface design and development process involves managing information through carrying out a set of activities, and then use relevant methods to achieve successful design. The types of information to manage include both: a) abstract, such as goals; and b) physical expression of abstract information in the form of representations.

Overall, the main aspect in designing user interface for a system could be seen as having an understanding of the tasks the system supports and how the interface should support those tasks (Hartson, 1997; Jacobson, Christerson, Jonsson, & Overgaard, 1993). To be able to design effective user interface for the system, the design process must consider the interactivity objectives. Based on the HCI generic design model, the improvements to the user interface were viewed as a process of carrying out a series of steps to support the system's goal.

The next section describes the user interface design method followed in this study.

3.2 User interface design method

The interfaces of the existing ODFs support the use of the system by a single institution. The architectural design idea for improvements of user interface incorporated allowing ODF use by multiple institutions. This would enable students of several courses (with overlapping course content) at different tertiary institutions to share a common platform of the improved system for learning purpose.

The following section describes the steps involved in the user interface design process of a working prototype system called electronic question and answer knowledge environment (eQuake).

3.2.1 Gathering interface design functional requirements

The add-on functional requirements for the eQuake in terms of how the interface should support them were based on: a) the limitations identified, and an examination of the recent research studies that were relevant to the study, as described in Chapter 2; and b) discussions (face-to-face and online) among the project team members including students and educators of participating tertiary educational institutions.

In addition to the already available basic set of functions (*add new thread, reply*) to facilitate communication exchanges between users; and the existing presentation structure of multiple ordering options (by sender, subject, and date) the following add-on interface functions and facilities have been identified as improvements.

Firstly, provide opportunities for bigger and broader knowledge base to increase the discussion forum's ability to retrieve existing answers to students' questions. For this purpose the ODF interface should:

- Facilitate inter-institutional knowledge sharing among students and educators teaching similar courses;
- Provide customised interfaces to educators to view posting of messages by students of the institution they belong to; and
- Retain the identity of postings by students and educators of several institutions.

Secondly, provide better ways to allow students to manage discussion in the ODF environment, an area identified as weak in existing discussion forums. A desirable function would be to facilitate externalisation of the message type, for example, by: extending the simple reply feature by providing a list of categories (*information gathering question, solution seeking question, answer, comment*) in a dropdown box listing the possible types of posts to allow students select the type of 'post' they wish to contribute.

This add-on feature was based on the assumption that students know the type of message they wish to post. Such an approach might help educators and students view the message type they want from available messages in the forum.

Thirdly, improve ways to enable students quickly view existing answers when a question is posted, and also view unanswered questions.

Some possible approaches to avoid the potential posting of similar questions suggested were to:

- Split the page that displays answers into sections, such as: FAQ, other answers, or unanswered similar questions;
- Allow students to mark their questions as similar to one of existing unanswered questions;
- Allow educators to be notified when several similar questions are unanswered in the system;
- Allow educators to create long-term archive of students' valuable contributions as well as their responses in the form of frequently asked questions (FAQ); and
- Allow students to be notified when answers are posted to their or others' questions.

After gathering the interface functional requirements, the next step involved discussion (face-to-face and online discussion) about the feasibility of add-on functions among the project team members, including students and educators of participating tertiary educational institutions. For the purpose of online discussions a forum was set up on a Massey University server.

Following the discussions, the next step involved modelling requirements. This was done through examining the communication needs for the system's tasks that the interface has to support. This included a case approach and the use of case diagram.

3.2.2 Use Cases describing user requirements

Following Nielson's (1994) methodology, use cases were used to represent users and their tasks. A use case is a description of a course of events initiated by an actor and interaction between the actor and the system. "Actors" are "users" and what the users do are called "use cases". Interaction between an actor and a use case describes the interactive functional requirements of the system. Its purpose has been to establish user interaction design requirements, and how the interface supports users' tasks. The user classes of the system were students and educators of the participating institutions. The following section describes the application of the use-case modelling technique to identify and specify the user requirements.

1. *Use case*: To login

Actor: Student and/or educator

Goal: User authentication

Description: students and educators provide the user name, and password to access the discussion forum environment. The system checks for user authentication. The user-interface was intended to integrate with heterogeneous online learning management systems (LMS) used by individual institutions. With this approach students and educators are not required to use separate login and password to access the system.

2. *Use case*: To post messages

Actor: Student and educator

Goal: Allow students and educators to post messages in the specified areas of the forum

Description: Interface to post messages, the students and educators have to first select the type of message based on the nature of their message. Within the existing interface "Reply" use case, a range of sub processes has been identified. These included *solution seeking questions, information gathering questions, answers and comments.*

3. *Use case*: To view forum messages

Actor: Student and educator

Goal: To view messages

Description: Interface to enable students and educators to view different types of messages posted in the forum.

4. *Use case*: To edit messages

Actor: Student and/or educator

Goal: To review and make changes to messages

Description: Interface to enable students and educators to review their posted messages.

5. *Use case:* To delete topics and/or messages

Actor: Educator

Goal: To allow educators delete unwanted messages

Description: Interface to enable educators to delete topics and/or messages unrelated or out of context to the discussion. This allows educators to manage and keep the forum environment tidy.

6. *Use case*: To move messages

Actor: Educator

Goal: To maintain forums

Description: Interface to allow educators to move topics and/or messages to relevant topic

7. *Use case*: To alert users of all new messages in the topic

Actor: Student and educator

Goal: To display the total number of new messages in the topic

Description: Interface to enable students and educators to view the new messages in the forum.

8. *Use case*: To subscribe to message

Actor: Student

Goal: **E**nsure students to get quick feedback

Description: Interface to enable students to get notified of answers to questions. These could be the questions they have posted or answers to any unanswered questions.

9. *Use case*: To get notified of unanswered questions to create frequently asked questions (FAQ) entry.

Actor: Educator

Goal: To ensure all questions are answered

Description: Interface to set a timeframe to answer questions. Monitor the unanswered questions and notify educator.

10. *Use case*: To add FAQ entry

Actor: Educator

Goal: Interface to enable educators to add quality answers for the most commonly asked questions to FAQ

*Description***:** Interface to **c**reate an archive of the educator's responses to students' questions and also the valuable contributions made by students in the forum.

11. *Use case*: To search existing answers to new questions

Actor: Student

Goal: Enable students to view existing answers, or similar unanswered questions.

Description: Interface to display existing answers that match students' questions, and unanswered similar questions. Also allow students to mark their question that they want to be notified when an answer is posted.

12. *Use case*: To notify student's forum participation to educator

Actor: Educator

Goal: Educators to be notified of students' participation frequency to ensure that all students receive the required help

Description: Interface to identify student participation and notify educator on a weekly basis a summary of students' messages.

13. *Use case*: To notify students of their participation in the forum

Actor: Student

Goal: To ensure students are active in their learning.

Description: Monitor student participation, and send reminder when the participation is rare.

14. *Use case*: To rate messages

Actor: Student

Goal: To assist students in identifying better-quality answers quickly.

Description: Interface to display star sign along with the messages as an indicative of the quality.

3.2.3 Use Case diagram showing users and processes involved

After describing the list of requirements, the next step involved checking the functional aspects that were planned to achieve with the system interface. A use case diagram has been used to show basic and added interface functionalities. It includes the actors and use cases that have been described in the previous step. *Use cases* are represented by *ovals* and the *actors* are represented by *stick figures*. Figure 3.1 illustrates which actors (students and educators) interact with each use case (process). The box shows the boundaries of the eQuake system (electronic Question answer knowledge environment), a shared discussion forum to which the add-on functions of interface have been implemented.

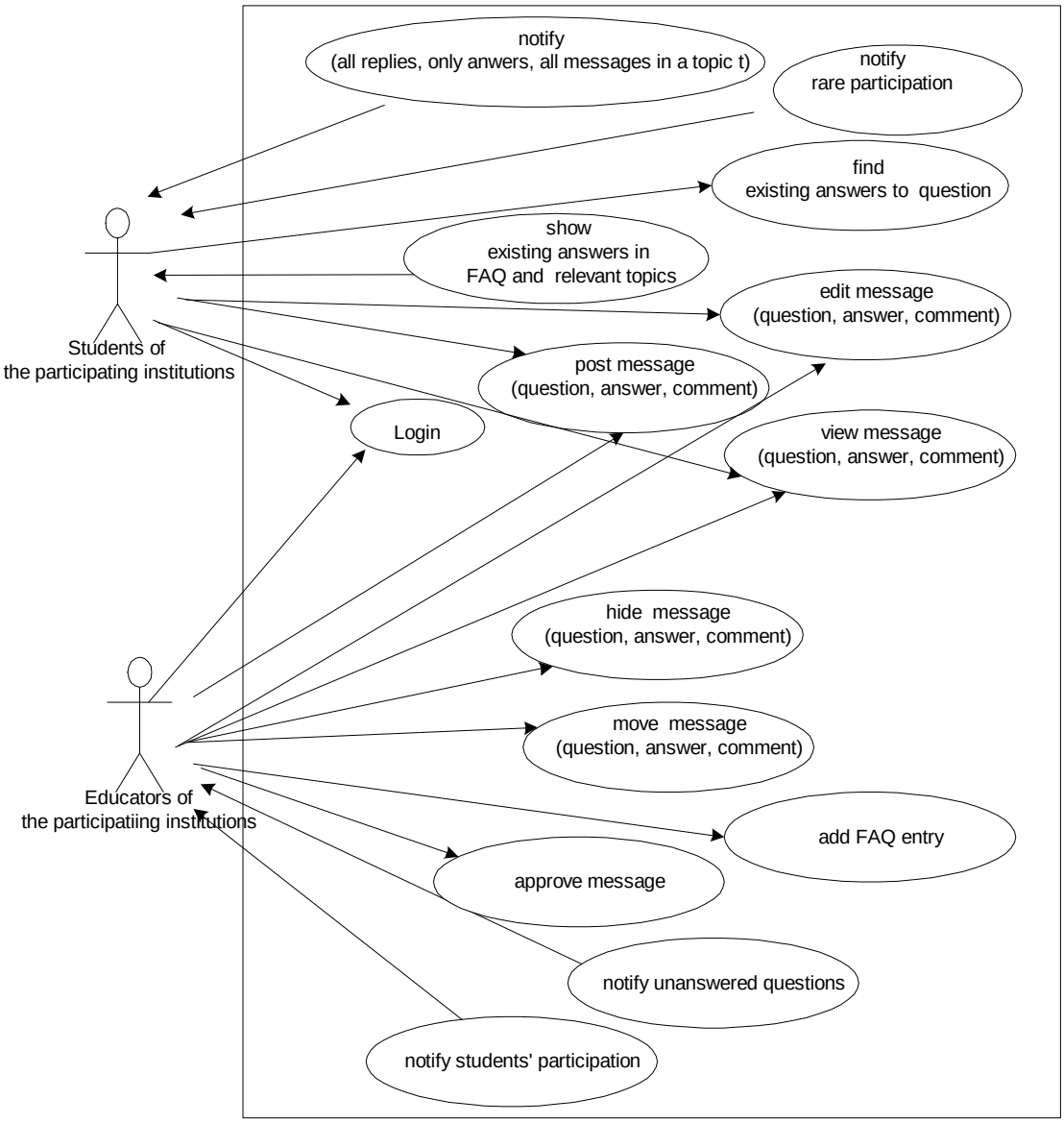


Figure 3 1: Use Case diagram identifying elements and processes

The tasks and the proposed interface design requirement supporting those tasks are summarised in Table 3.1.

Table 3.1: Summary of the add-on interface functions

Tasks	**User interface design requirements**	**Existing ODF systems' interface support**
Allow inter-institutional knowledge sharing among students and educators in a common dynamic learning environment	Facilitate interaction between students and educators from multiple institutions to mutually communicate and share knowledge.	Not available
Allow students to manage discussion in the ODF environment	Organise knowledge sharing by extending the "reply" feature to incorporate message types to allow students to describe the type of contribution being made to the discussion forum	Not available
Enable students to quickly find answers to their questions	a) Notify educators of sets of similar unanswered questions, so they can create an FAQ entry. b) Improve existing ODFs' interface presentation structure to display messages by type	Not available
Reduce duplicate questions posted in the forum.	Allow students to view unanswered questions and provide them option to mark their question(s) as similar to one of the existing questions	Not available
Allow students to receive answers to a particular posting they are interested in.	Enhance subscription facility to allow students to subscribe to specific posting they want to be notified when an answer is entered. Notify students of answers to questions	Students can subscribe or unsubscribe to the entire thread but do not allow subscription to individual posts

The next step following the identification of tasks involved a description of users' tasks that the interface should support.

3.2.4 Integration of interface in eQuake and testing

To create a system that is actually useful, Nielsen (1994) suggested the development of a working prototype of an interface that is tested by a user community test and refined until a suitable interface has been designed as a final product. This is shown in Figure 3.2.

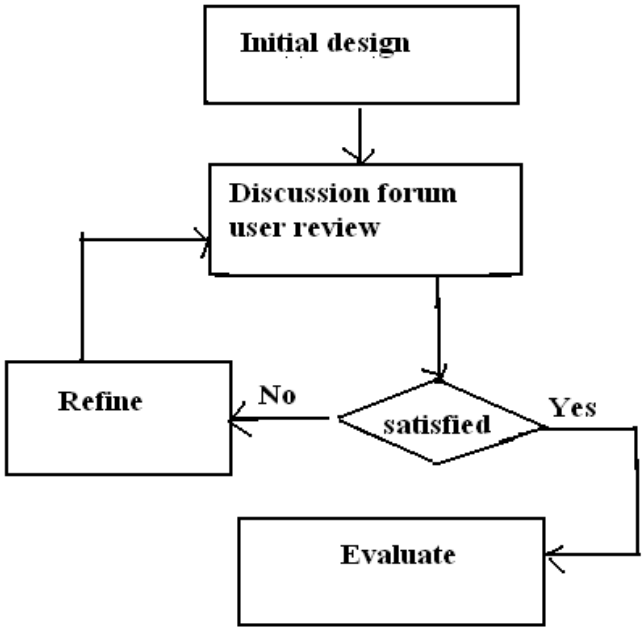


Figure 3.2 :Prototype testing

Based on Nielson's suggestion as a guideline the requirements gathered and illustrated in Figure 3.1 have been transformed into working prototype. This was done in a test environment where a user community (the project team along with some volunteers interested in using the system) examined the performance of the prototype. A forum was set up in the Massey University website to discuss the users' (educators and students) perspectives on the design issues. All documentation related to the discussion could be accessed in the Massey forum.

Figure 3.3 shows the prototype testing cycle. The iterative process continued until the prototype developed into a fully functional system ready for evaluation.

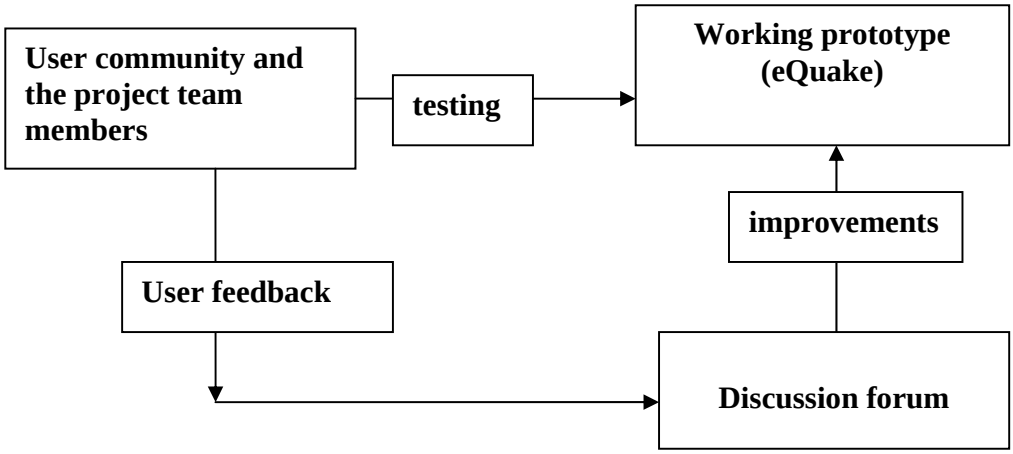


Figure 3.3 System testing and improvement cycle

Feedback was obtained on the difficulties to the users. This helped in making modifications to the features to meet the user needs. As the user community who provided feedback on various aspects continuously used it, the evaluation step was taken as acceptance testing, rather than the first exposure of the product to real users. As a large number of features planned were mainly enhancements to the *Moodle* forum, no major changes were required to the basic design structure.

3.3 Rationale for using Moodle platform

The extended functions have been designed and implemented in a well-known open source-learning platform (*Moodle*). This section describes the rationale for using *Moodle*.

Commercial ODF vendors do not normally provide the source code access to the client institutions to customise the software to meet their specific needs. Client institutions only get to rely on the features made available by the software providers. One of the problems with commercial systems as researchers noted was that these systems are a “pull” medium and that the users (students and educators) have to make a point of visiting them regularly to find out if new postings have been made or if their questions have been answered (Ellis & Dringus, 2005; Young & McSporran, 2004). Furthermore, they do not show the recent discussion forum postings on the homepage of the course

website. However, the current advances in open source online learning environments are a response to the shortcomings of commercial products like *WebCT* and *Blackboard*. One example of the open source-learning environment is *Moodle*. However unlike *WebCT* or *BlackBoard*, where the opportunity to modify features to suit the needs of the users is minimal, *Moodle* opens almost limitless capabilities for users to customise the application and change the feel and functionality that they might want to meet the objective.

Moodle differs from many systems in that its messages are not only archived in the course but are also sent as e-mail to the student's registered e-mail address as long as the student has subscribed to that specific forum. This overcomes one major problem with commercial messaging systems. With *Moodle*, students would always get to know when new, relevant messages have been posted without logging on to the ODF.

3.4 Summary

In this chapter the design approach used in identifying and accomplishing the add-on interface functionalities have been described. The add-ons included: (1) widening communication facilities to allow students and educators belonging to multiple institutions (with similar or overlapping course content) to share a common forum; (2) assisting students to quickly find existing and new answers to questions; and (3) better tracking solutions with automate notification facilities to both students as well as to educators. Apart from getting notified of unanswered questions for possibly creating an FAQ, educators also get system generated weekly notifications about students' activities. Similarly, students also get reminders, if their participation in the forum is low.

The chapter concluded with a brief account of the rationale for using open source platform (*Moodle*) for implementing the prototype called electronic question and answer knowledge environment (eQuake).

The next chapter illustrates and explains through screenshots the add-on interface functions implemented in the working prototype.

Chapter 4: Implementation of interface improvements

4.1 Introduction

This chapter demonstrates the improved interface functionalities that were implemented in eQuake, a shared discussion forum prototype. This was developed as an add-on to existing *Moodle* forum (Calvani, Fini, Pettenati Sarti, & Masseti, 2005), an open source Learning Management System (LMS). The foremost improvement to the forum interface design architecture is multiple institutions user (educators and students) access. This and the rest of the enhancements to the interface are described and illustrated with the help of screenshots in the next section.

4.2 Multiple institutions user access

Allowing students of different institutions enrolled in similar courses gain access to each other's forums would help in efficient resource sharing for promoting individual and collaborative learning. This could be by increasing the knowledge base, and/or exposing students to a range of different perspectives. However implementing such an idea is a difficult task because ODFs are available as component of LMSs and their interface functionality is limited to single institution's use. This can be seen in Figure 4.1(a). While Massey University uses *WebCT*, Eastern Institute of Technology (EIT) uses *Moodle*.

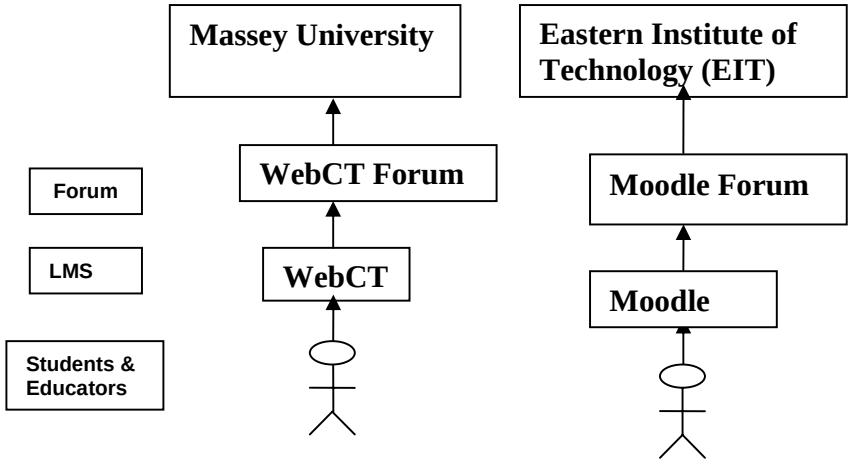


Figure 4.1 (a) Existing ODFs' interfaces

If the institutions in Figure 4.1(a) intend to collaborate and increase the interaction opportunities to their students, it becomes a cumbersome process for them to manage. This is because institutions have to allow each other's students to subscribe and join their forums. Furthermore the LMS that the institution uses needs: a) to store the login information of each student of the collaborating institution, b) constantly monitor their enrolment status, and c) remove access to those who cease to be the students of the collaborating institution. There could be financial implications also if the LMSs are commercial ones. It may lead to privacy issues, and also loss of valuable commercial information to the collaborating institution.

Figure 4.1 (b) illustrates the broadened eQuake interface design architecture for overcoming the barrier of single user interface. The improved interface provides a common forum platform access to multiple New Zealand tertiary institutions allowing their students to engage in interaction with peers and educators.

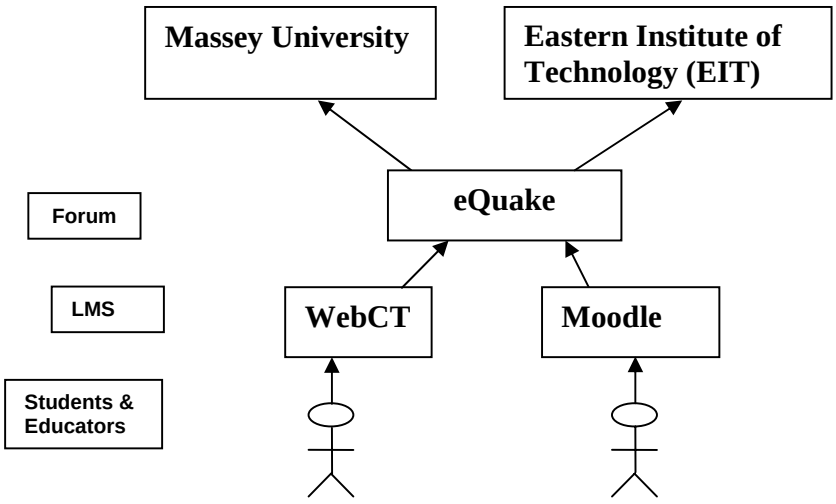


Figure 4.1 (b): Broadened interface structural design

Students of participating institutions can access eQuake by logging onto the LMS of their institution. This is illustrated in the screenshots shown in Figures: 4.2 (a) and 4.2 (b) where two institutions - EIT and Massey University –accessed eQuake through their LMS respectively.

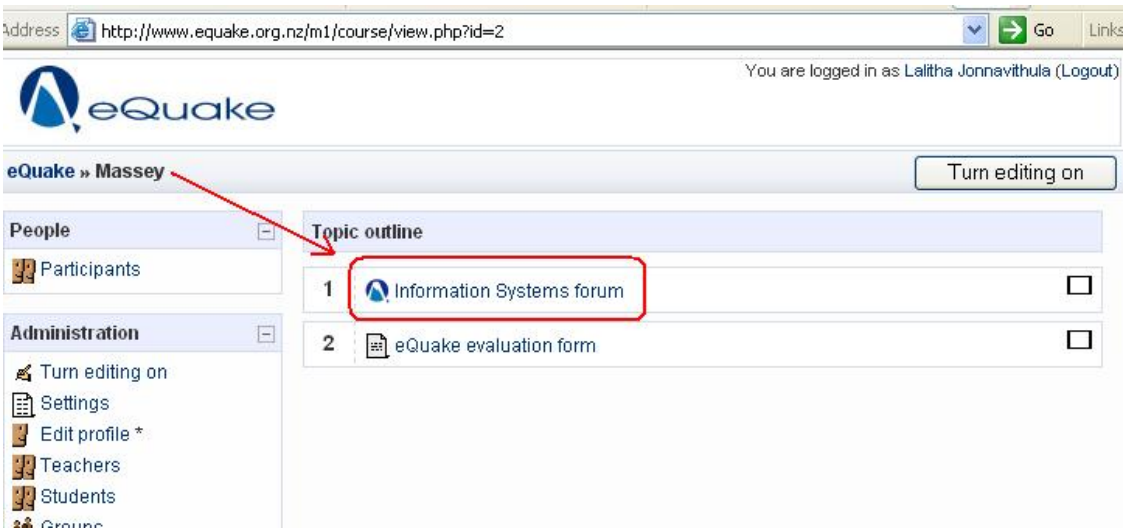


Figure 4.2 (a): Forum access via Massey University's LMS (*WebCT*)

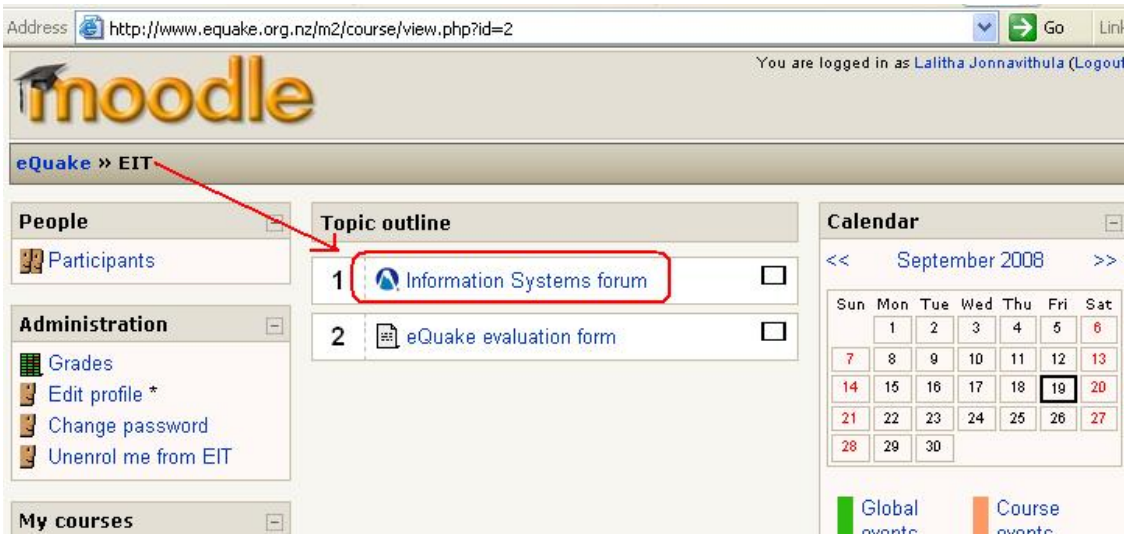


Figure 4.2 (b): Forum access via EIT 's LMS (Moodle)

4.3 Customised interface for educators

Once logged in, educators could view the main page as shown in Figure 4.3. This page shows a range of features available for educators' use and is organised into five columns.

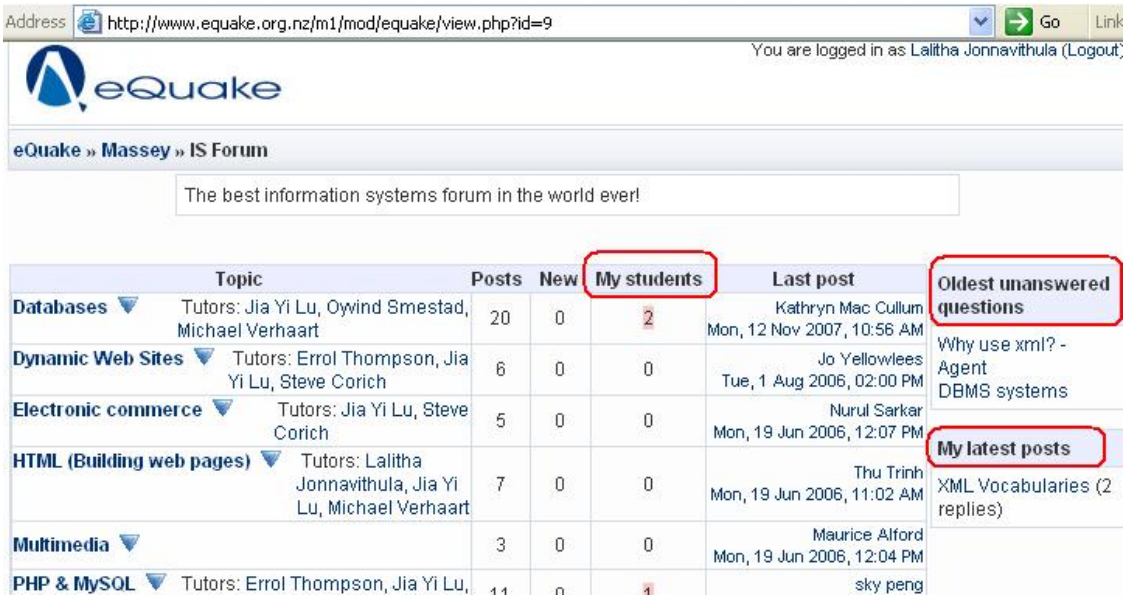


Figure 4.3: Customised interface for educators

The first column is the *Topic*, showing the Topic name and the educators involved in the course. The topics listed under this column have hyperlinks that allow educators to navigate into the desired topic, where they would be able to read, and respond to the posts.

The next 5 columns are as follows:

1. *Posts:* Shows the total number of posts.
2. *New*: Shows the number of new messages posted.
3. *My students:* Shows messages posted by students assigned to the educator.
4. *Last post:* Shows the last posting in the topic.
5. *Unanswered questions:* Shows unanswered questions at one place without having to search for them in the forum to respond.

Additionally, the interface of the system is configured to send an automatic email containing a list of unanswered questions so that they could create a Frequently Asked Question (FAQ) entry. This add-on facility allows educators to view the new questions without logging into the forum. Besides this facility, educators also get weekly email notifications relating to their students' participation in the forum and respond to the situation accordingly.

4.4 Customised interface for students

The main page visible to the students once they login to their institution's LMS is shown in Figure 4.4 screenshot.

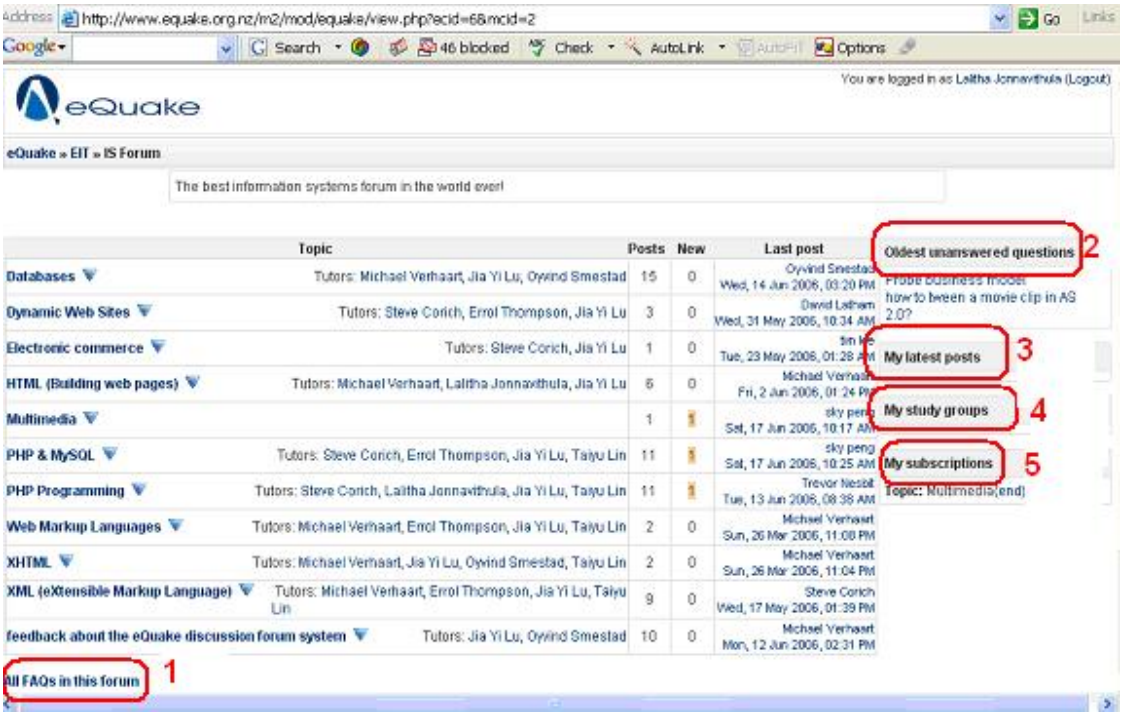


Figure 4.4: Customised interface for students

This interface has all the columns available on educators' main page with the exception of *My students* column. In addition, the interface design also provides students the following features:

1. *All FAQs in this forum:* FAQs (Frequently asked questions) link to view commonly asked questions and answers.
2. *Oldest unanswered questions*: Displays questions yet to be answered. This functionality allows students to respond to any known questions. In addition it also reduces the potential posting of similar type of questions.
3. *My latest posts:* Messages posted by the student, and the replies received.
4. *Study groups*: Shows all the study groups in which the student is participating.
5. *My subscriptions:* Shows replies from student subscribed messages or topics.

4.5 Composing messages by type

Identifying required information in the large number of varied messages posted by the students has been noted as one of the problems in online discussions (Arnt & Zilberstein, 2003; Lui et al., 2005). The reason for this could be attributed to the lack of interface functional support in the existing ODFs, such as *WebCT* and *Blackboard* to distinguish messages by type.

A label showing message types is added to the *reply* feature of the existing ODFs as a strategy to overcome the limitation. The screenshot in Figure 5.5 shows a range of options made available to students in a dropdown list that students could make use of when posting new messages or responding to existing messages.

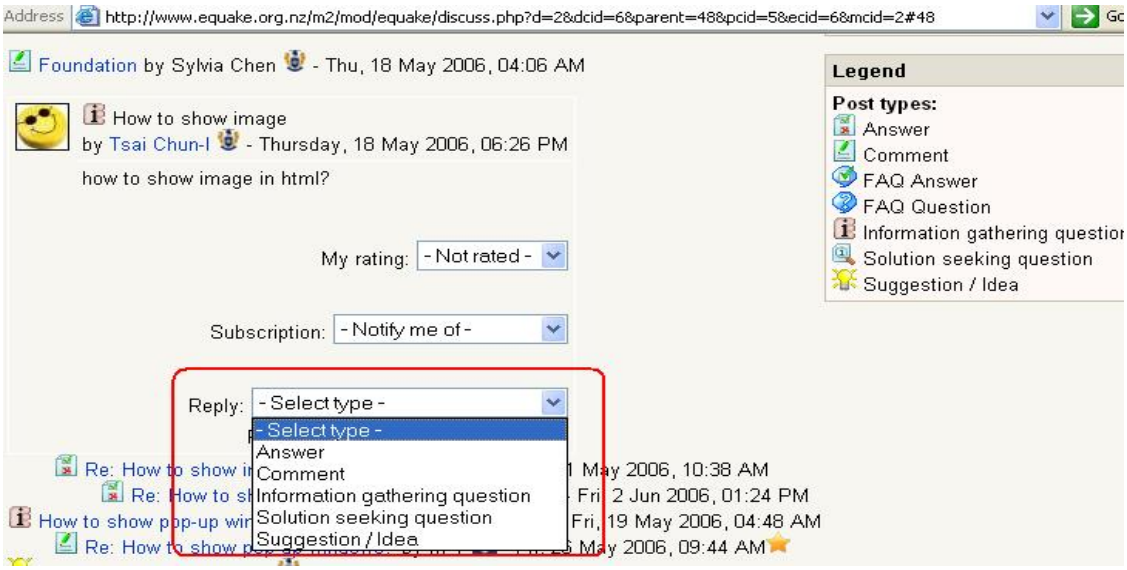


Figure 4.5: Options for students to select the message type

The various message types provided are based on the assumption that students use the appropriate message type label when posting messages. From the system's point of view, the message types enable it in retrieving answers to students' questions.

The screenshot in Figure 4.6 shows a range of label options available in a dropdown box for educators' use when responding to messages.

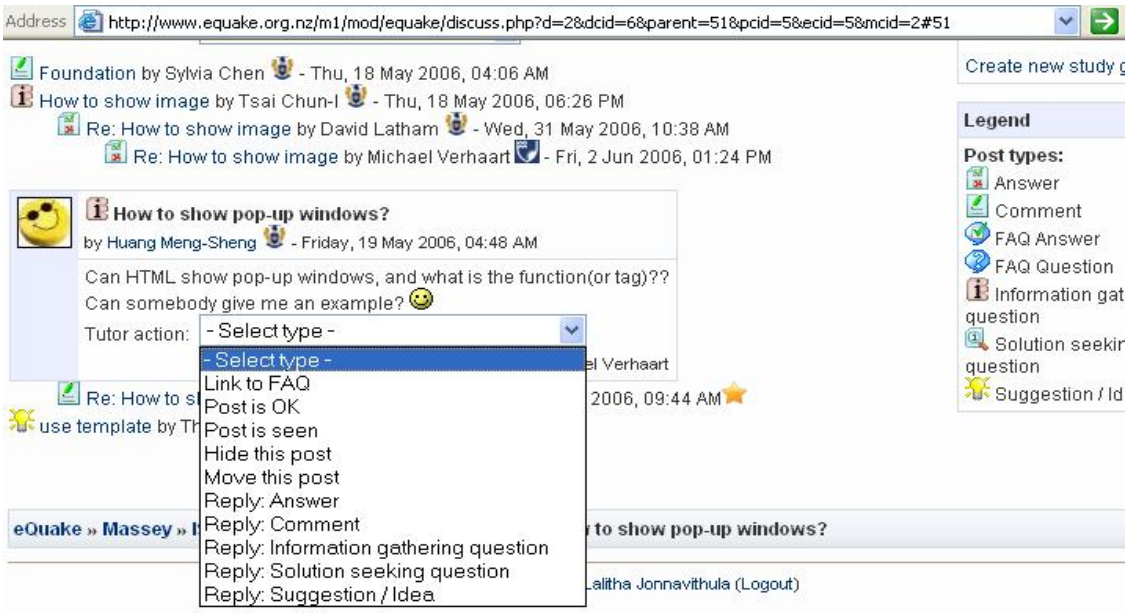


Figure 4. 6: Options for educators to select the type of reply

One of the label options available for educators is the *link to FAQ* as shown in the following Figure 4.7.

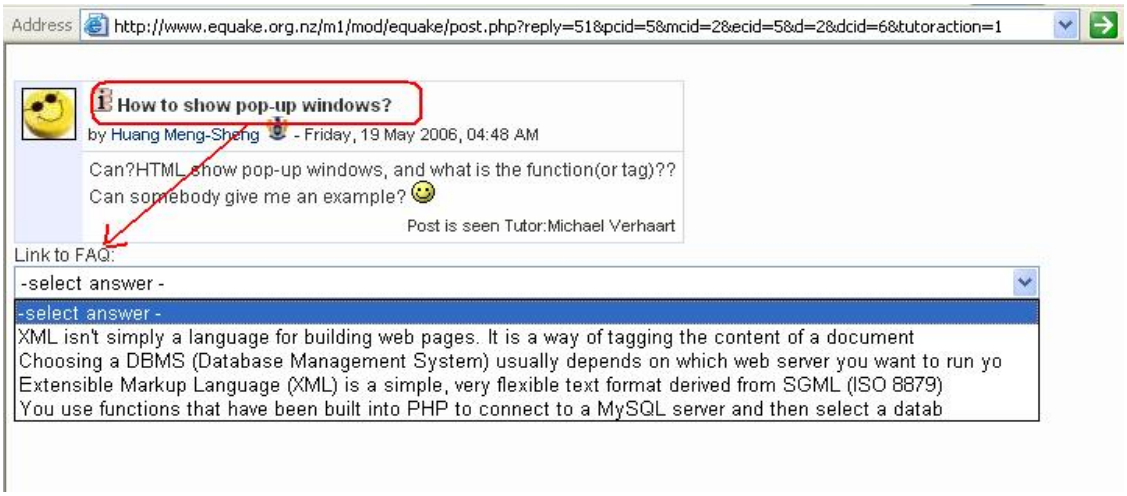


Figure 4.7: Option for educators to link to FAQ

The link to FAQ option allows educators to attach questions to the existing matching answers in the frequently asked questions (FAQs) database for enabling students to have quick access to answers.

The Figure 4.8 illustrates *new FAQ* feature that educators could use for adding questions and answers to the FAQs. This would allow students get answers to wider range of questions in their search.

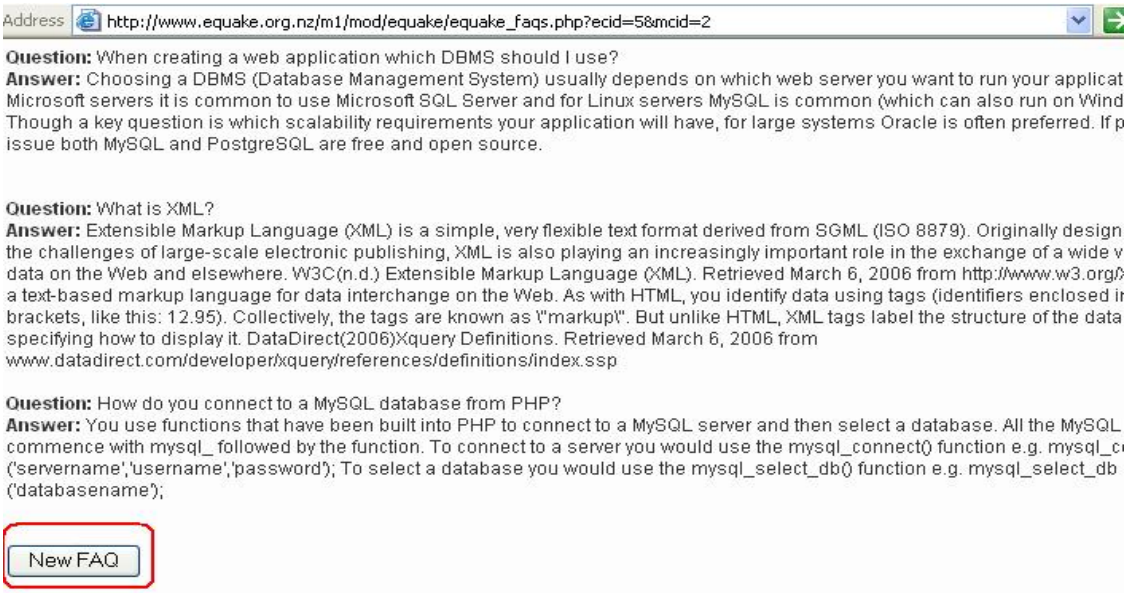


Figure 4.8: Option for educators to create FAQ

Creating a long-term archive of FAQs could reduce repetitive answers that could potentially decrease educators' workload, and could also reduce students' waiting time for a response.

The other label options for educator in the reply feature are *post is seen* and *post is OK.* The Figure 4.9 shows the use of *post is seen* option by the educator.

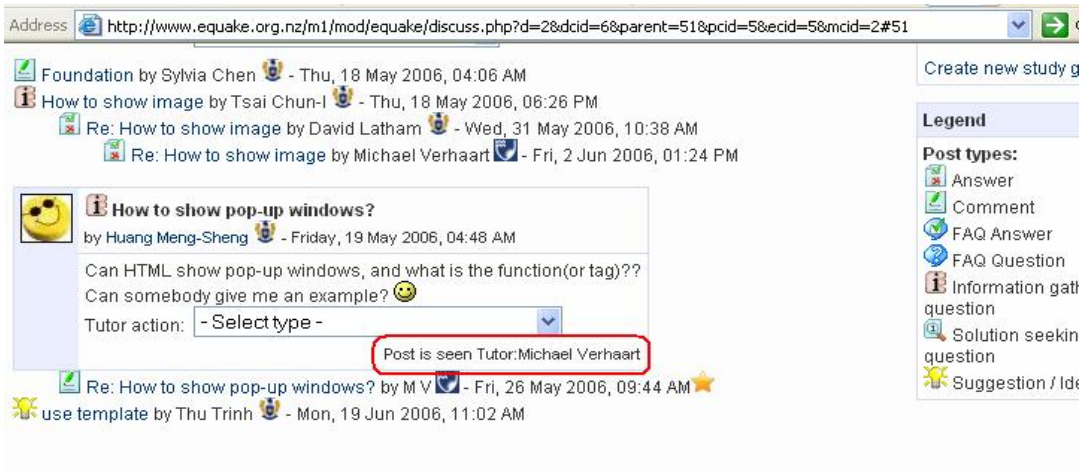


Figure 4.9: Message marked as seen

The purpose for including these options was to enable educators to quickly acknowledge students' contributions to the forum. Providing immediate feedback has been identified as an important determinant in maintaining the continued interaction among students (McLaughlin, as cited in Herring, 1999). However quickly responding to students' postings may not always be possible for educators. Therefore having this feature would assist educators to indicate their presence and also acknowledge their contributions.

4.6 Enhanced threaded discussion appearance

Figure 4.10 illustrates modifications made to the typical method for visualising the threaded structure of messages.

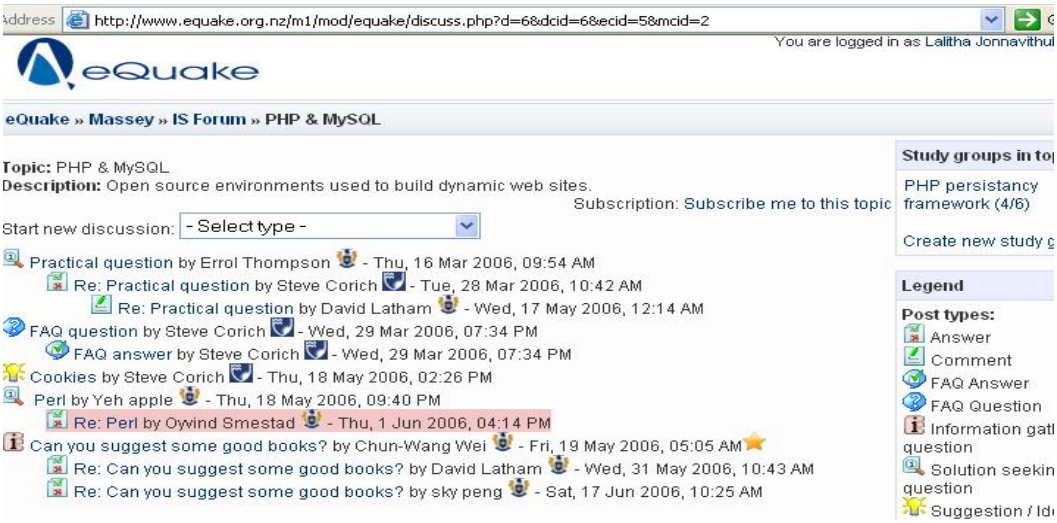


Figure 4.10: Illustration of threaded discussion structure

Similar to existing ODFs all messages in the eQuake appear under one thread. The messages are in the order of posting with the earlier one at the top of the list. While keeping within the threaded structure and its default *Reply* abbreviation (RE:) associated with several reply levels the difference could be seen in the self-descriptive icons added to each message suggesting its type. For example the icon  prefixes solution seeking category message. Having categorised messages in the discussion allows both students and educators to easily identify the message type. This approach overcomes the issue of fragmented messages associated with students' tendency to reply to a part of messages as noted by Reyes and Tchounikine (2003). Further improvements could be seen in the colour code used to highlight new posts. Students and educators of different institutions are identified by the logos of the institution they belong.

Although the idea of labeling messages was drawn on the concept of *thinking types* used by (Calvani et al., 2005) in *Forum Plus,* the purpose for which these have been used in the current study was different. In Forum Plus, these were used for the purpose of increasing the visual presentation of discussion thread by making the type of message explicit to users. In eQuake, *thinking types* were used to address some natural language understanding problems to be avoided at the system level to enable the system to search the existing knowledge base for matching FAQs and other answers in the forum to students' questions.

4.7 Notifying students of answers

Existing forums provide a subscription option for students to receive email messages of all postings in a topic. Although this functionality is helpful for students to view messages without logging into the forum, the lack of facility to choose messages by type for subscription makes the tracking of messages a cumbersome process. Figure 4.11 shows the enhancements in the subscription facility in addressing this issue.

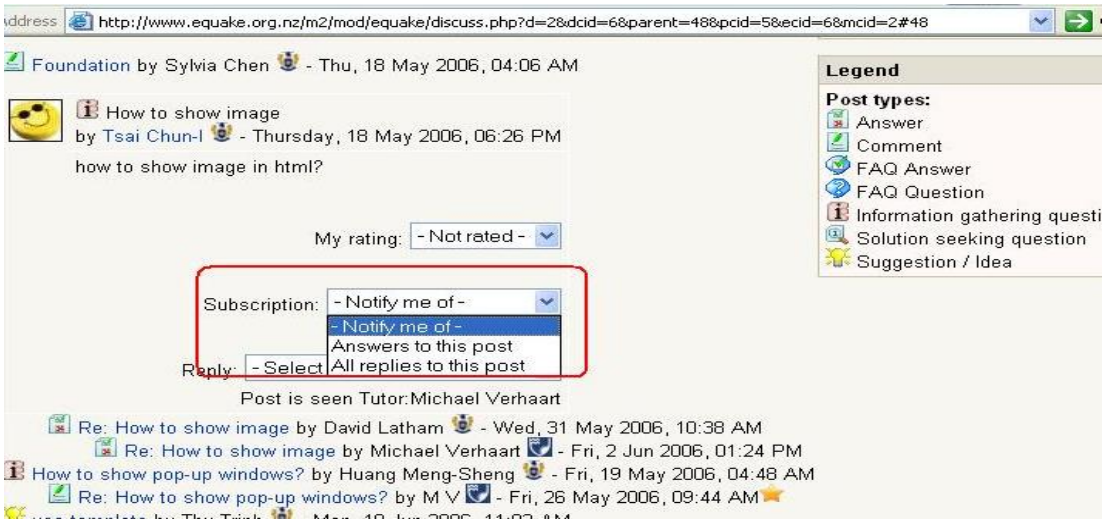


Figure 4.11: Subscription facilities

In addition to the facility provided by existing forums where students can subscribe to the whole topic to receive all replies posted in the discussion thread, students have the option to get notified of all replies to their questions and questions of their choice posted in the forum. This feature has email functionality with which students can subscribe to get notified of answers to the questions they select.

4.8 Rating quality answers

The rating feature is another improvement added to the forum interface. To allow students assess the helpfulness of answers, a dropdown box with a list of three options has been provided as shown in Figure 4.12.

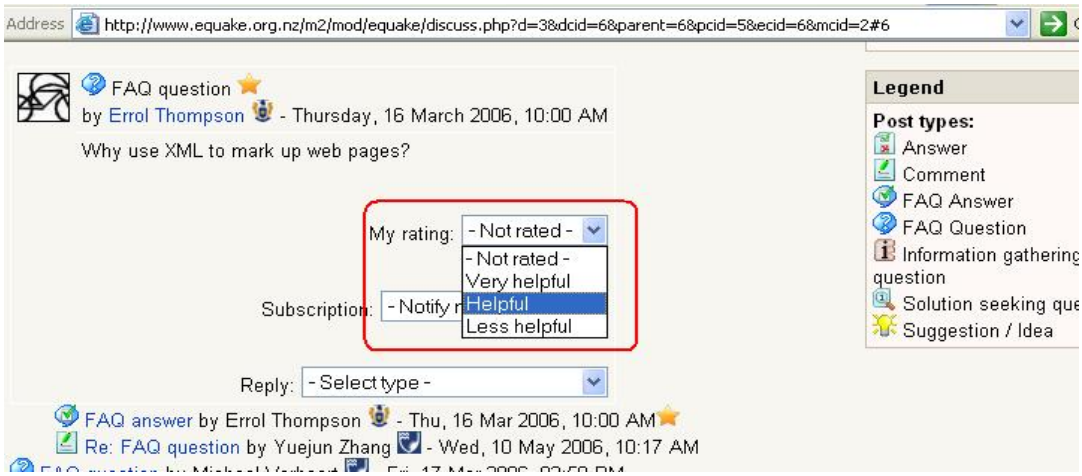


Figure 4.12: Rating function

icon suffixes the answers rated as *most helpful* as illustrated in Figure 4.13.

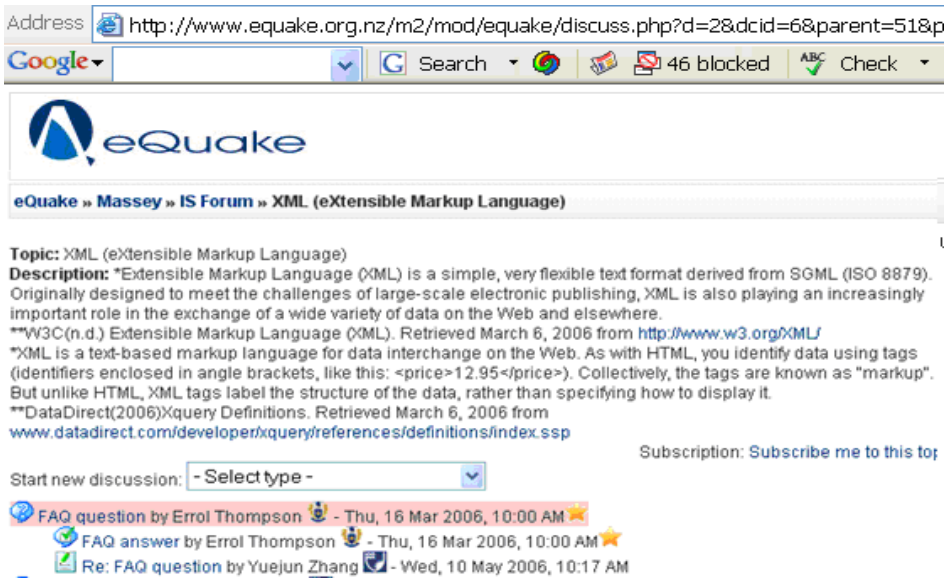


Figure 4.13: Star icon indicating the message as most helpful

The star icon associated with the message enables students to quickly determine the answers they want to read. It also gives educators an indication of students' understanding, expectations and the type of information that would satisfy them.

4.9 Finding existing answers to questions

Research literature on online learning environment has noted that responding to multiple posts in a timely manner as a major issue (Feng et al., 2006; Hew & Cheung, 2003). A desirable option in such situation would be to provide as Patel and Aghayere (2006) noted a knowledgebase of questions and answers. Providing a FAQ knowledgebase could be particularly useful for courses having consistent topics from one course offering to the next. Such an approach not only saves time of students looking for responses to their questions, but also has a potential to reduce duplication of questions and answers in the ODFs (Lytinen & Tomuro, 2002; Thaiupathump et al.,1998). However as more questions and answers get added to the FAQs, finding answers might become difficult. This is due to lack proper search support facility in the existing ODFs to enable users find answers quickly.

The Figure 4.14 demonstrates how the interface design facilitates students to quickly get existing answers to their questions. In eQuake, the task of inputting a question is the same as posting a message. For example, selecting a question label from the available options would open a window with a message box and a button called, *show possible answers*.

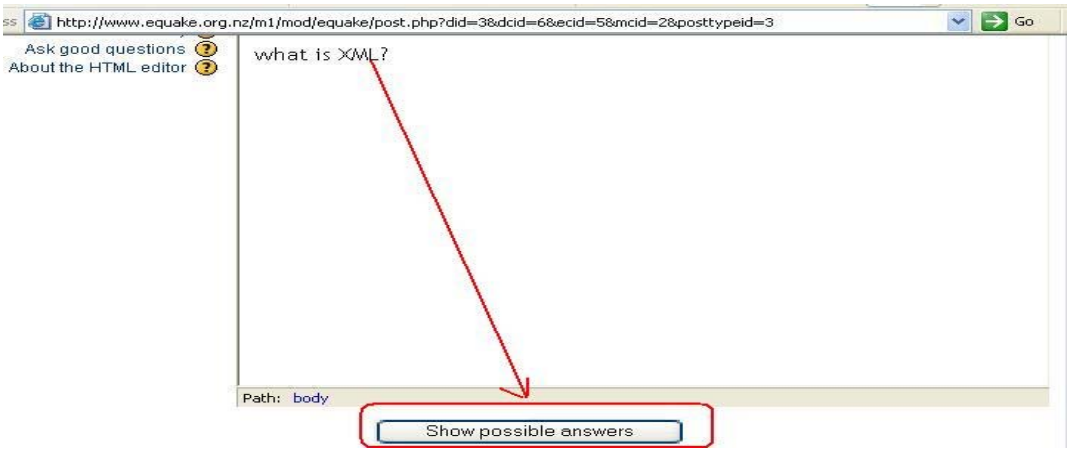


Figure 4.14: Display screen upon student selection the question type.

After keying the question, and clicking the *Show possible answers* button a new page would open up displaying the list of existing answers retrieved from the FAQ database, possible answers in other messages, as well as unanswered similar questions in the forum environment as shown in the Figure 4.15.

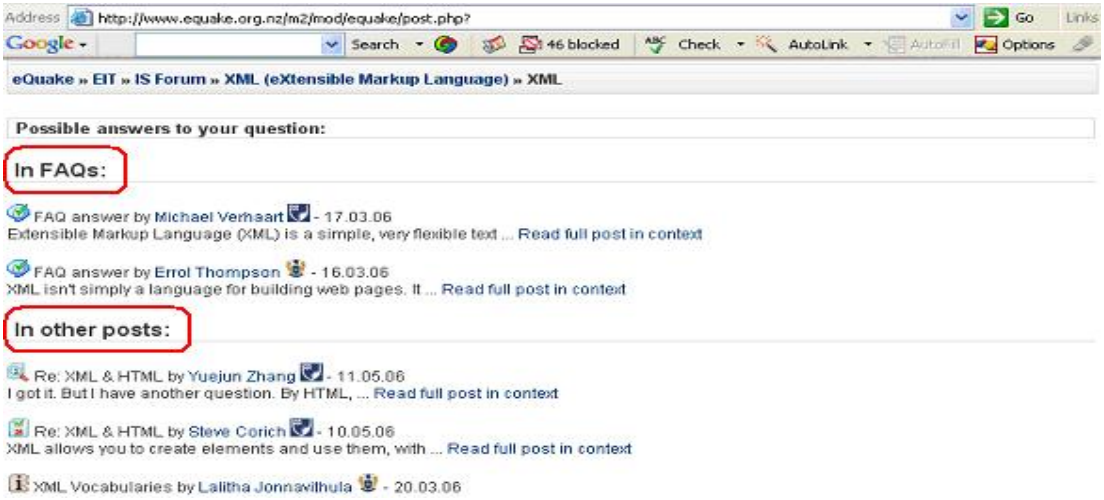


Figure 4.15: Screen displaying possible answers to questions

Additional advantage would be that students will not only quickly find the information they are searching for, but also get the opportunity to view multiple similar answers that can potentially assist them in enhancing their understanding. Since the answers are available instantly before posting the question in the forum it could reduce repeated questions.

Figure 4.16 shows the display of similar unanswered questions posted by students, and an option to either accept or re-phrase and re-post their question.

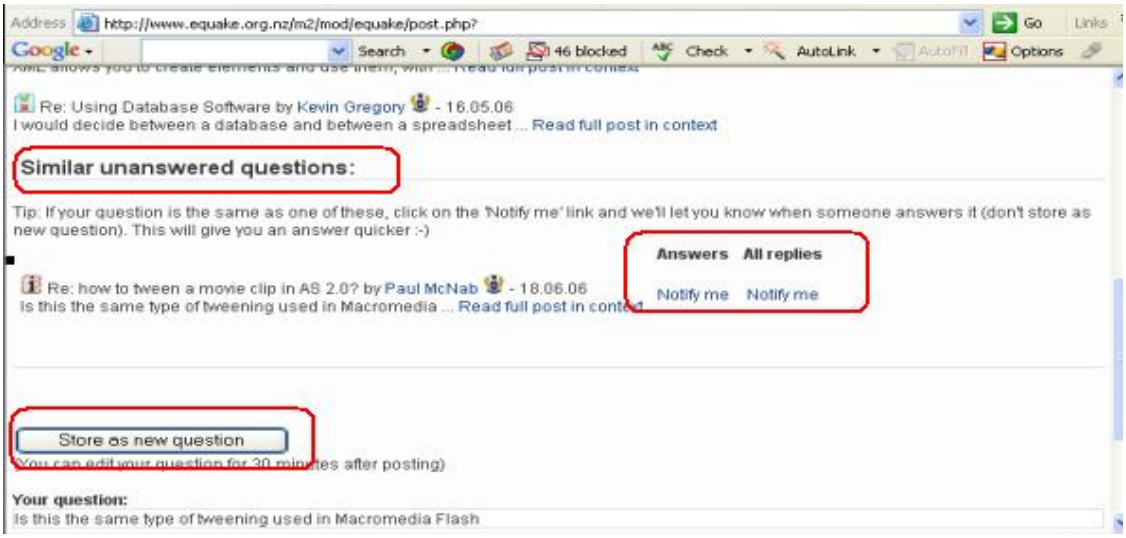


Figure 4.16: Option to edit, post questions and subscribe to receive answers.

If there are any unanswered questions on the results page, students can opt to choose and subscribe to receive notifications of answers or all replies. This is likely to cut down students asking repetitive questions (Ebner et al., 2006). Such facility could reduce waiting time for students to receive an answer and thereby allows them to concentrate on course content.

4.10 Summary

This chapter demonstrated enhancements to existing interface functionalities proposed in design and development in Chapter 3. The overall interface design objective was to improve forum's functionalities to enhance the ease of use and usefulness of forums' learning support. The foremost add-on can be seen in widening the interface to

accommodate students from multiple institutions to interact in a common forum environment. The other add-ons included providing customised interfaces for both educators and students.

From the educators perspective, the interface improvements would allow educators to: a) quickly acknowledge students' contributions in the forum, thus encourage continued interaction among students, b) add questions and answers to a FAQ knowledge base, thus provide a range of FAQs to potentially reduce students' waiting time for a response, and c) link questions in the forum to the existing matching answers in the FAQ knowledgebase and thus avoid repeating answers to similar questions.

Similarly, from the students perspective the interface improvements would allow students to: a) expose their thinking to multiple perspectives, thus maximise their learning experience, b) re-use questions and helpful answers posted in the forum and also FAQ, thus save waiting time for a response and refrain from posting similar questions, c) quickly obtain existing answers by keying in their question, and d) subscribe to obtain answers for the unanswered questions in the forum.

From the system's point of view, the message types to some degree address the issue of natural language processing, and assist the system in retrieving answers to students questions.

The next chapter describes the evaluation of improved functionalities of the forum in terms of their ease-of-use and potential usefulness in relation to learning from users' perspective.

Chapter 5: Evaluation

5.1 Introduction

This chapter describes the formal evaluation carried out to examine the improved interface functionalities implemented in eQuake to enhance learning support.

The overall evaluation purpose is described, and this is followed by a description of the participants' profile and the methodology used to evaluate the system. Finally, an analysis of the data is presented, which includes results and limitations of evaluation.

5.2 Purpose of evaluation

The purpose of the evaluation was to examine and obtain information relating to:

a) perceived ease-of-use of improved interface functionalities of the system to users,
b) perceived usefulness of improved interface functionalities of the system to enhance learning support,
c) predict intention to use the system at tertiary level courses in future, and
d) obtain suggestions for further improvements to increase system acceptability of the participating institutions.

5.3 Participants profile

About 200 users, spread out over the three institutions participated in the evaluation. The users included 116 students, educators and some interested research students from Massey University, 49 students and educators from Eastern Institute of Technology (EIT) and about 35 students and educators from the Auckland University of Technology (AUT). Student participants included first, second and third year students with a majority from first year Information Systems courses.

5.4 Methodology

An experimental research method was used to obtain the data. The survey instrument used was a questionnaire that contained 19 items with a 7-point self-report Likert scale

ranging from +3 to –3 with + 3 being *strongly agree*, and –3 being *strongly disagree* with zero being a neutral value.

Perceived Ease of Use (EOU) and *Perceived usefulness* (U) have been examined for the four improved interface functionalities listed below:

a) Posting messages.
b) Finding answers.
c) Rating answers.
d) Enhanced subscription facilities.

5.5 Survey instrument used

The design and development of the scale used in this study was based on the Technology Acceptance Model (TAM), a model originally proposed by Davis (1989) and later on tested and revised by Davis, Bagozzi and Waerhaw (1989).

The Technology Acceptance Model (TAM) is an adaptation of Theory of Reasoned Acceptance (TRA) formulated by Fishbein and Ajzen (1975). TAM is the most widely used model by researchers to predict and explain users' system acceptance and also their intentions to use information technologies in various contexts. TAM is one of the most widely used models by researchers to predict and explain users' system acceptance and also their intentions to use information technologies in various contexts. Researchers have confirmed this as a valuable tool in Information Technology domain (Chittibabu, Reithel, & Vikram, 2000; Koufaris, 2002; Onga, Laia, & Wang 2004).

5.5.1 Rationale for using Technology Acceptance Model (TAM)

Research identified TAM as a valid measurement scale for two important theoretical constructs (also called variables) namely *perceived usefulness* (U) and *perceived ease of use* (EOU). These two constructs have been hypothesized to be fundamental determinants of user acceptance.

Perceived usefulness (U) is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" and *perceived ease of use*

(EOU) refers to “the degree to which a person believes that using a particular system would be free of effort” (Davis, 1989, p. 320).

Figure 5.1 illustrates Davis, Bagozzi and Warshaw’s (1989) hypothesis of how a person's intention to use the system (BI) is jointly determined by the attitude towards using the system (A) and Perceived usefulness (U). It also shows how the system’s use (A) is jointly determined by Perceived usefulness (U) and Ease of use (EOU). The U and EOU are indirectly influenced by external variables. These external variables could be the tasks for which the system is used.

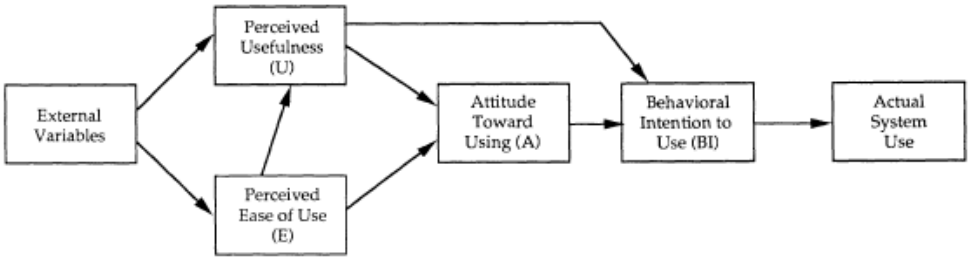


Figure 5.1: Technology Acceptance Model (TAM), adopted from Davis, Bagozzi and Warshaw (1989, p. 985)

TAM suggests that users have a positive attitude toward the technology if they perceive the technology *useful* (U) and *easy to use* (EOU). According to TAM, system’s usefulness is strongly linked to usage intentions, and intentions are significantly correlated with the future acceptance of the system. Therefore testing the perceived usefulness of the system in its early development stage allows predicting the future system’s use and to anticipate potential user acceptance problems.

5.5.2 Hypotheses

Based on TAM’s above-mentioned conclusions, the following hypotheses were made for this study.

Hypothesis 1: The improved interface functionalities of eQuake are perceived as useful and easy to use.

Hypothesis 2: Perceived usefulness (U) of the improved interface functionalities of eQuake is strongly correlated to behavioral intentions (BI) of use.

Hypothesis3: Perceived ease-of-use (EOU) of the improved interface functionalities of eQuake is correlated to behavioral intentions (BI) of use.

5.5.3 Procedure

To measure future use intentions or behavioural intention (BI) a community of students, and educators, including researchers who volunteered to evaluate the eQuake were provided with access to the system. The participants were asked to explore the various add-on functionalities of eQuake for a period of three weeks and then to self predict their future use of the system.

Two questionnaires, one for users (both students and educators) and the other exclusively for educators have been used. The first questionnaire (See Appendix A) was designed to collect data about the *perceived usefulness* (U) and *perceived ease of use* (EOU) of the improved functionalities to measure the acceptance of the system and their intention to use the system in future. The second questionnaire (See Appendix B) was designed to collect data to measure educators' intention to use the system in their courses. In both the questionnaires the users were asked to rate the importance of each item on the scale in terms of the ease-of-use and perceived usefulness.

5.6 Data Analysis

This section presents a summary of the users data tracked by the eQuake, and an analysis of data collected through the first questionnaire including the findings. Students, educators and other interested participants in the testing completed this questionnaire.

5.6.1 Analysis of the system tracked interactions

The following was a summary of the users data tracked by the eQuake. The data in Table 5.1 shows the number of registered users, the number of logins and the number of times the messages were viewed. On an average, over the three-week period, each participant used the system at least 3 or 4 times and viewed messages 11.5 times.

Table 5.1: Users data

Users	**Number**
Registered	200
Number of logins	681
Number of times messages are viewed	2306

In total 121 messages were posted. Of the 121 postings, 27 were answer type, 43 comments, 18 information gathering question, 9 were solutions seeking questions, 12 were suggestion/idea, 6 FAQ questions, and 6 FAQ answers. The participants' use of all type of communicative labels is shown in Chart 5.1.

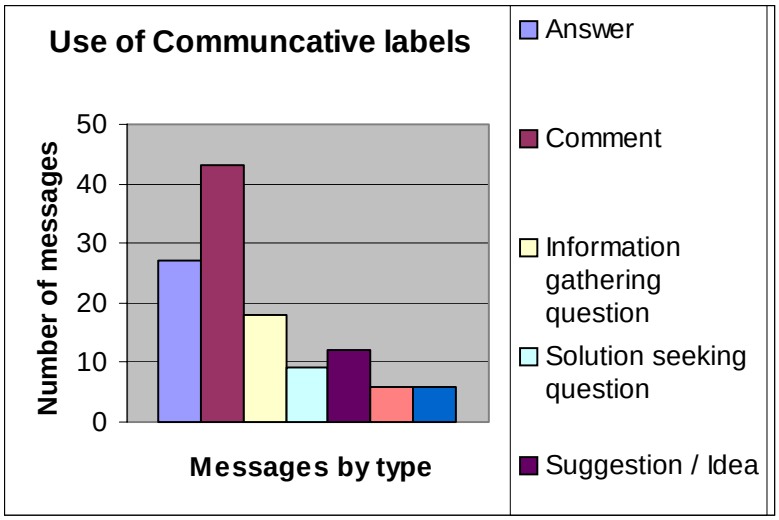


Chart 5.1: Participants postings by message type

Of the total 121 messages posted, 27 messages were identified as inter-institutional ones. The types of message exchanges between students and the number of responses using different communicative labels are shown in Table 5.2.

Table 5.2: Message types used in the inter-institutional interactions

Message type posed	Number of responses to messages	Response type
Information gathering question	6	Answers
Answer	5	Comments
Comment	4	Comments
Comment	3	Answers
Information gathering question	2	Comments
Answer	1	Answer
Answer	1	Information gathering question
FAQ answer	1	Comment
FAQ question	1	Comment
Solution seeking question	1	Answer
Suggestion/Idea	1	Answer
Suggestion/Idea	1	Suggestion

Of the sum total of 147 subscriptions, 21 of them showed users' preference for all replies to all postings in a topic, and 126 of them showed the preference for replies to individual postings in a topic. This is shown in Table 5.3.

Table 5.3: subscription features

Subscriptions	
Number of subscriptions to a topic	21
Number of subscriptions to a post	126
Sum	147

5.6.2 Analysis of the survey data

A total of 35 filled in questionnaires were received from the survey. The data offered an interesting overall scenario of the communication in the eQuake learning environment, showing a high level of user participation and interaction. Users explored all the features offered by the improved interface. The Mean and Standard Deviation for each item of all the variables is displayed in Table 5.4.

Table 5.4: Descriptive analyses of Items: Mean and Standard Variation

Variable	Item	Mean	Std. Deviation
Behavioural intention **(BI)**	Having examined/tested eQuake, I intend to use it in my degree program.	1.34	1.327
	In the future, if I have access to eQuake, I would use it.	1.83	1.200
Perceived Usefulness **(U)**	I find eQuake useful in my degree program.	1.20	1.132
	Using eQuake would improve my performance in my degree program.	1.46	.980
	Using eQuake would increase my productivity in my degree program.	1.3429	1.30481
	Using eQuake would enhance my effectiveness in my degree program.	1.54	1.379
Perceived Ease of use in relation to posting a message. **EOU (posting)**	In relation to posting a message in the forum: interacting with eQuake does not require a lot of mental effort from me.	1.43	1.399
	In relation to posting a message in the forum: I find eQuake easy to use.	1.5429	1.52128
	In relation to posting a message in the forum: I find easy to get eQuake to do what I want to do	1.5429	1.29121
Perceived Ease of Use in relation to finding an answer. **EOU (finding)**	In relation to finding an answer: interacting with eQuake does not require a lot of mental effort from me	1.2000	1.54919
	In relation to finding an answer: I find eQuake easy to use	1.4000	1.80196
	In relation to finding an answer: I find easy to get eQuake to do what I want to do	1.0571	1.57074
Perceived Ease of Use in relation to rating of answer. **EOU (rating)**	In relation to rating of answer: interacting with eQuake Does not require a lot of mental effort from me	1.7429	1.33599
	In relation to rating of answer: I find eQuake easy to use	1.7429	1.29121
	In relation to rating of answer: I find easy to get eQuake to do what I want to do	1.3143	1.47072
Perceived Ease of Use in relation to subscription features. **EOU (subscription)**	In relation to subscription features: interacting with eQuake Does not require a lot of mental effort from me	1.5429	1.48211
	In relation to subscription features: I find eQuake easy to use	1.6571	1.39205
	In relation to subscription features: I find easy to get eQuake to do what I want to do	1.6571	1.30481

The figures showed very high mean and standard deviation values for all variables with the exception of one of the items: *"finding an answer: I find easy to get eQuake to do*

what I want to do" relative to the finding answers features that showed a lower mean (1.0571), close to the "neutral" value with a fairly high standard deviation (1.57074).

A summary of the number of questions, mean and standard deviation for each category of questions is shown in table 5.5. All the variables had a very high mean and standard deviation value. The scale used for responses to the questions ranged from +3 to –3 with + 3 being *strongly agree*, and –3 being *strongly disagree* with zero being a neutral value.

Table 5.5: A summary of the mean with standard deviation for each determinant

Question category	No of questions	Mean	Std. Deviation
Ease of Use of the subscription feature	3	1.62	1.382
Ease of Use rating feature	3	1.60	1.370
Ease of Use of posting	3	1.50	1.395
Ease of Use of finding an answer	3	1.22	1.635
Perceived Usefulness	4	1.40	1.202
Intention of use	2	1.59	1.280

The high mean and standard deviation value for all the variables in the summary table suggested that the participants perceived the improved interface easy to use, and that they believe using eQuake would be free of effort (Davis, 1989).

Table 5.6 shows that all the four features had a moderate to strong coefficient of correlation from 0.5 to 0.7 for ease-of-use. Individual rankings were also analysed for the four features (posting, finding an answer, subscribing and rating). It was found that the *posting* and *finding an answer* ranked as one and two with significant relationship (at the 5% level) between the intention of use and the ease-of-use of posting (p-value below 0.01) and finding an answer (p-value below 0.05).

Table 5.6: Correlation Intention of Use and Perceived Ease-of-Use

			Average ease of use: posting	Average intention to use	Average ease of use: finding an answer	Average ease of use: rating	Average ease of use: subscription
Spearman's rho	Average ease of use: posting	Correlation Coefficient	1.000	.465(**)	.687(**)	.545(**)	.633(**)
	Average intention to use	Correlation Coefficient	.465(**)	1.000	.355(*)	.072	.169
	Average ease of use: finding an answer	Correlation Coefficient	.687(**)	.355(*)	1.000	.516(**)	.669(**)
	Average ease of use: rating	Correlation Coefficient	.545(**)	.072	.516(**)	1.000	.515(**)
	Average ease of use: subscription	Correlation Coefficient	.633(**)	.169	.669(**)	.515(**)	1.000

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Chart 5.2 illustrates eQuake's usage frequency based on the data collected through the questionnaire. Out of the total of 35 participants who completed the questionnaire, eight of them used the system 4 to 6 times per week; six used it 2 to 3 times per week; ten used it once a week, one used it more than once a day; three used it once a day; and three of them did not use at all.

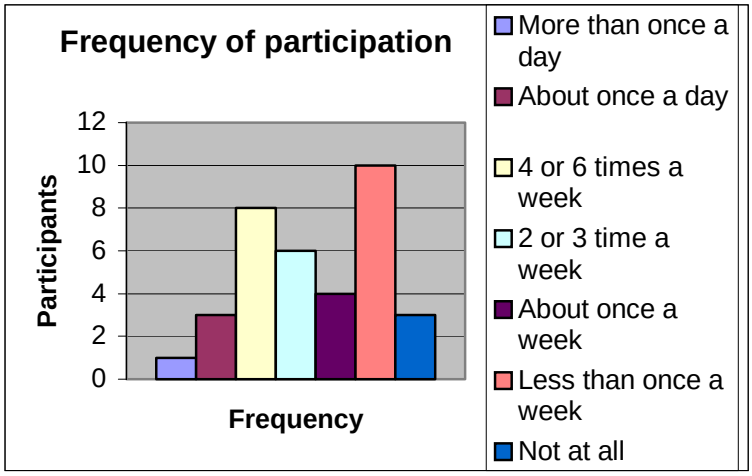


Chart 5.2: Participation frequency

5.7 Discussion on evaluation of the system

The results of this study provided significant insight into the system's usability. On an average each participant used the system at least 3 or 4 times and viewed messages 11.5 times. Compared to the number of registered users (200), the number of postings however were small (121). The high number of participants accessing the system could be attibuted to their familiarising with the system environment, exploring its functionaity and/or observing the activities.

Data in Table 5.2 suggested the occurrence of inter-institutional students' interactions using different message types. The number (22% or 27 out of 121 responses) and the types of responses suggested the students' intention to use the inter-institutional interaction feature.

Table 5.3 showed about 86% (126 out of 147) of students used the subscription feature to get answers for the particular questions they were interested, which suggested their intention to use the system in future.

The results in Table 5.4 showed a lower mean (1.0571), close to the "neutral" value and a relatively very high standard deviation (1.57074) for the finding answers feature. Although the result for this feature suggested the need for further improvement of this feature, it should be noted that at the time of evaluation, the FAQ database that provided

the answers to students' questions had limited questions and answers stored in it. So when the user posted the question for the possible answers to view, no results were displayed. Future work would include an evaluation of this feature to find out the difficulty after educators had added answers to FAQ database and students had used it to find the answers.

The summary data in Table 5.5 showed very high mean and standard deviation values for all the features. Although these results indicated the users intention to use the system, the moderate to strong correlation in Table 5.6 suggested some level of difficulty in use of all the features. The difficulty could be attributed to the short time given to the participants to familiarise themselves with the system and filling in the questionnaire.

Spearman's rho rankings of the features in Table 5.5 suggest that posting and finding an answer would be the key to encourage the future use of the system. It can be said that the more robust these features were in the system the better would the intention to use the system. Subscription and rating features ranked three and four with a weak relationship between the ease-of-use and intention to use suggesting that these features would not be significant for the future use of the system.

Overall, the evaluation of the first questionnaire supported all the three hypotheses: The improved functionalities have been perceived as useful and easy-to-use. The perceived usefulness (U) of the improved functionalities was strongly correlated to behavioral intentions (BI), and finally, the perceived ease of use (EOU) of the improved functionalities was also correlated to behavioral intentions (BI).

The next section describes the evaluation and results of the second questionnaire completed by educators.

5.8 Evaluation by educators

A separate questionnaire (see Appendix B) containing seven categories was distributed to educators in the three participating institutions as part of the formal evaluation process to find out the use of eQuake in their courses. The categories listed in the questionnaire included: (a) basic infrastructure; (b) query display; (c) student proxy agent; (d) query

monitoring agent; (e) tutor proxy agent and target selection agent; (f) learning community served; and (g) general usability of the system.

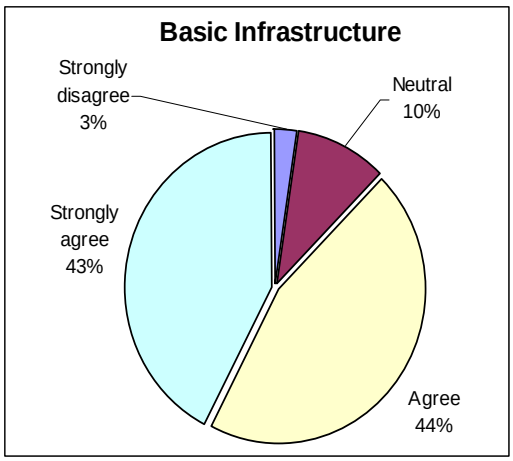
5.8.1 Instrument used in the survey

The instrument used was a five-point Likert scale ranging from 1 to 5, with one being strongly disagree, and five being strongly agree. Not applicable (NA) was used for an item that does not apply to five-point scale or not sure about the functionality of the system.

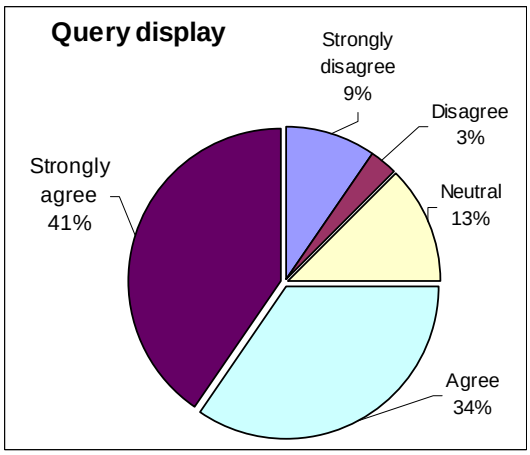
The next section discusses the survey results, and focuses on the aspects of the results that are directly related to the interface part of the system. A detailed discussion of the agents is beyond the scope of this study.

5.9 Results

Eight educators (potential users of the system) completed the questionnaire. The results are illustrated through the graphical representation in the form of pie charts as shown in Charts 5.3.



(a)



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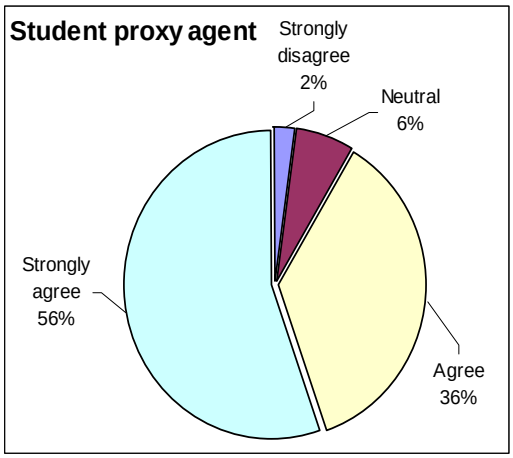

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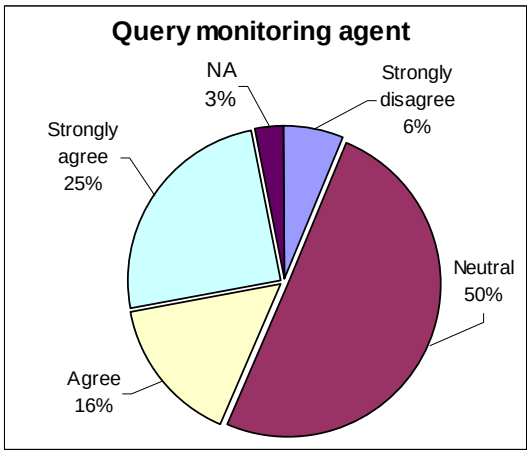

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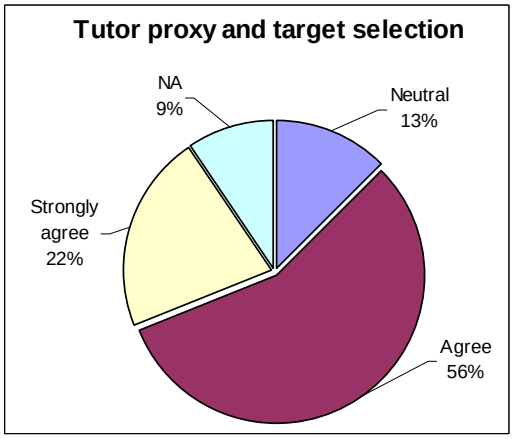

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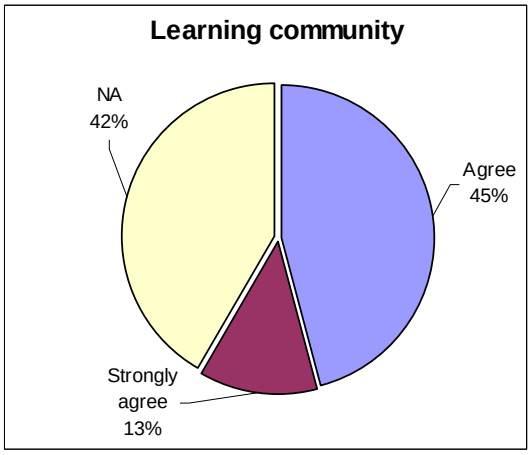

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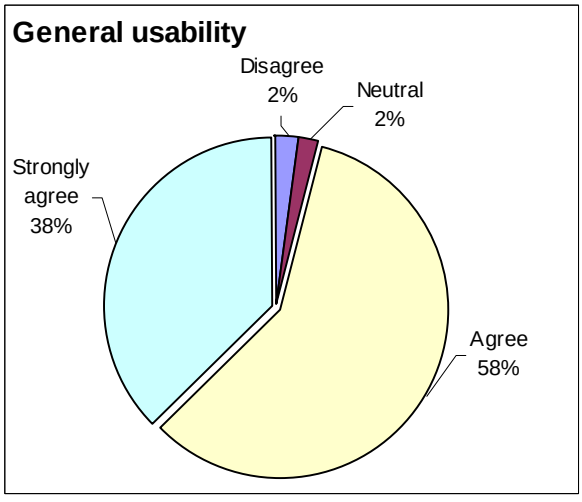

(g)

Chart 5.3: Average percentage of respondents for each of the seven main items

Satisfaction level of the participant educators for each of the five features listed in the *Basic infrastructure* section (a) was high (75% to 100%). This indicated that all these features were perceived as highly desirable and their intention to use the system in future.

The view query feature in *Query display* section (b) was found by the educators as highly beneficial with a satisfaction level of 100%. Educators found some difficulty in the ease-of-use and navigation for search and retrieve query. This suggests that there is a need to improve the navigation to make the interface user-friendlier.

In the student *proxy section* (c) 3 of the 6 features under this category were rated at 100% while the remaining three were rated at 75% to 87.5%. Educators found the post query, post comment and/or solutions features as highly desirable and beneficial. They also found the ease-of-use and navigation at 100% satisfaction level.

The features in the *query monitoring section* (d) received low satisfaction level indicating that the query monitoring process in relation to navigation should be improved. Comments from educators indicated the need for improvement in enhancing the facilities for posting question type messages. One of the suggestions included providing a link to where they are in the procedure for example: “Continue with submit process” buttons after viewing the existing answers and provide help to proceed further with the submission of question.

The satisfaction level of educators for *general usability* section (g) was 87.5 to 100% for all the 6 features in the category. This could mean that the add-on functionality has not increased complexity in the interface layout. The features were easy to identify and use which could mean that educators would be willing to promote to use of the system in their courses.

The following section describes limitations of the evaluation and finally concludes with a summary.

5.10 Limitations of evaluation

The evaluation was designed to obtain feedback on the usability of the enhanced features rather than testing the actual learning experience. The measure of success was essentially related to users' intention to use the system in future in relation to the enhanced functionality.

Although the system was continually evaluated during development, the users were allowed only three weeks to familiarise with and evaluate the fully functional system. The time period allocated thus was too short to draw any conclusive evidence.

Furthermore, self-report questions were administered to collect data. The main problem associated with the self-reported data is the accuracy of information provided (Hochstein, Basili, Zelkowitz, Hollingsworth, & Carver, 2005). For example, the participants might, consciously or not, have over-estimated their perceived usefulness and ease-of-use or conversely might not have explored the full features to examine their utility. No external variables that might have an indirect influence on the users' intention as illustrated in Figure 5.1 were considered while determining the accuracy of the respondents' answers.

Also, the questionnaire did not ascertain users' familiarity with other LMS platforms, which could have influenced their judgment, and therefore data accuracy cannot be assured. A *Not applicable* (NA) option was not provided in the questionnaire. This might have affected the results as participants were forced to choose from the options provided.

5.11 Summary

Overall, the results of evaluation showed a positive intention to use eQuake. The evaluation provides some interesting observations, and supports the hypotheses. Almost all participants in the survey perceived the enhanced interface functionalities of eQuake as useful and easy to use. This has been inferred from the two constructs or variables namely, *perceived ease of use* and *perceived usefulness*, identified by researchers as having significant impact on users' intention to use Information systems in general.

Survey respondents noted the overall functionalities of the eQuake system interface as good.

However, any conclusions drawn from this study must allow for its limitations. The findings can be taken as the first step of research towards understanding the usefulness and ease-of-use of the enhanced functions of the eQuake system in a collaborative learning environment. Actual usefulness may be different from perceived usefulness. To understand the real usefulness of the enhanced features, the system would need to be actively used for an entire course. Then the FAQ database would have answers stored to a whole range of questions added by the educators of multiple institutions. This task may provide convincing evidence of the utility of the features, and would allow an understanding of the problems on which further enhancements could be planned.

The next chapter summarises the study and considers directions for future research.

Chapter 6: Summary and future research

6.1 Introduction

This chapter presents a summary of the study conducted with a purpose to improve the interface functionalities of online discussion forums (ODFs) to effectively support learning. The chapter concludes with a discussion of the possible directions for future research.

6.2 Summary of the study

ODFs show much promise for fostering significant improvements in accessibility and opportunities for students to learn. They also promote a variety of interactions among users (students and educators) for knowledge sharing. One of the reasons for this supposition (as discussed in the review of related literature in Chapter 2) could be attributed to the distributed, asynchronous and text based nature of conversations that ODFs support. The review indicated ODFs as important resources in educational context. At the same time, the review also pointed to their limited interface support in facilitating users to take full advantage of the potential benefits resulting from their use. Based on the review results, several improvements to the ODF interface were identified, and the functional requirements were gathered. Discussions were held (face-to-face and online) among the project team members and other interested users on a continuous basis to decide about the features. These were then modelled and implemented in eQuake (electronic Question answer knowledge environment) using *Moodle*, an open source software platform. The rationale for the choice was its free availability as well as its flexibility in allowing the design modifications and add-ons. Finally an evaluation was conducted in a two-pronged manner with one questionnaire for students, educators and researchers, and the other exclusively for educators.

The next section provides a summary of the research questions raised and addressed in this study.

6.2.1 Research questions addressed in the study

Existing forum interfaces such as *Blackboard* and *WebCT* have been identified as lacking in features to support inter-institutional cooperation. Having such cooperation could potentially increase knowledge sharing between students and educators of different institutions.

The first research question: *Can the interfaces of online discussion forums be improved to increase knowledge sharing opportunities between users?* has been addressed by designing and implementing a common forum called eQuake where students and educators from different institutions could interact and communicate with each other. This forum was implemented independent of the LMS (Learning Management System) used by the participating institutions, and was designed to allow access to educators and students when they logged-in into their institution's LMS. Educators and students from three tertiary institutions who volunteered to participate in the evaluation were able to successfully access eQuake to interact and mutually exchange messages. This functionality demonstrated a clear improvement over existing forum interfaces.

Furthermore, existing ODFs use a threaded structure. In this kind of structure the messages of students get mixed with answers and information posted by the educators. Obtaining answers efficiently from the mixed messages can be difficult and students need to spend significant time and effort. The lack of a facility to distinguish messages by their type could have contributed to such a difficulty.

The second research question: *"Can the interfaces of online discussion forums be improved to assist users in easily finding existing answers to questions?"* has been addressed through the creation of an FAQ database where educators could add answers to the frequently asked students' questions. The add-on features allow students to view the existing answers (if available) before posting a question to the forum. In addition, students also get to view similar unanswered questions (if any). A subscription feature was developed whereby students could subscribe to the unanswered questions (if found) to get an email alert when educators post the answers. This was in contrast to

functionality in existing forums, where students have option to subscribe to the entire topic rather than to a particular posting in which the students were interested.

The third research question: *"Would students perceive the add-on interface functionalities to the forum, such as: (i) widened communication, (ii) obtaining existing answers, and (iii) notification facility useful and easy to use?"* has been examined by making the system with its enhanced functionalities available to potential students and other interested users of the participating institutions. Feedback on the perceived ease of use and usefulness of the functionalities was obtained by conducting a survey.

(i) Widened communication

The results showed that students in different institutions communicated with each other by posting messages. Some of these messages were answers to students' questions. They also posted useful information, and made comments to help students. This suggested that students found the communication useful and they intend to use such facility in future should it be available.

(ii) Obtain existing answers

The answer finding feature, which allowed students to view answers to their questions was perceived as useful by the participants. Although evaluation results showed a strong intention to use this feature it scored a lower mean and standard deviation, which was indicative of low perceived ease of use. The reason could be attributed to the fact that at the time of evaluation the FAQ database had no answers to retrieve satisfactory results to the participants. The real usefulness of the feature could be analysed when the FAQ database is populated with answers to common questions that could be retrieved by students. This in turn depends on the students' use of the forum and asking more number of questions.

(iii) Notification facility

The email alert notification feature to allow students get information about the answers posted by educators was found easy to use by the participants. This could be inferred

from the high percentage (about 85%) of subscription feature related postings. This result suggested that students have an intention to use the subscription feature in future.

The fourth research question: *"Would educators perceive the add-on interface support helpful and would they prefer to use the system in their courses?"* has been examined using a separate questionnaire. The results indicated that the educators found the features useful in supporting learning. They also indicated their intention to use the system in their future courses. The written comments suggested that this tool could be valuable resource for staff development.

6.2.2 Conclusion

The use of ODFs has become a more common feature of teaching and learning in recent times. It is hoped that the enhanced functionality of eQuake would help educators in creating a learning environment that would foster communication among large numbers of participants across institutions to strengthen learning.

The evaluation results in this study could be considered as a first step in finding the usefulness and ease-of-use of the enhanced forum interface functionalities. The forum's real usefulness could be understood when it is used in courses and a greater number of students actively interact with each other.

Finally, no one single forum interface suits the needs of all types of institutions and courses offered as each of them have different requirements. So, it is important to provide the forum interface with features that could be customised to support the learning needs of their students. Therefore, future research could include testing the relation between the use of forum features and the actual learning.

The next section discusses the future research to further enhance the forum interface effectiveness to support learning. The suggestions were based on the evaluation results in Chapter 5, and the recent research studies discussed in Chapter 2.

6.3 Future research

An important area for improvement could be seen in extending the FAQ usability. The FAQ database in this study was available to students of multiple institutions studying similar courses. The full utility of the information stored in the FAQ database can be achieved by making the information available to students in different courses and disciplines of the participating institutions. This could be implemented by providing search only access to the FAQ database to all the students of the participating institutions irrespective of the courses they are enrolled in. Tertiary educational institutions offer many courses in several disciplines, and it is possible that concepts and information in different courses overlap. Therefore, it would be beneficial to integrate the FAQ database of all the courses and make it available to all the students of participating institutions globally. For example, a student of information systems or business management or statistics could access an FAQ on report writing guidelines added by communications department educator. Such a facility would provide reliable information to students as educators add FAQs to the database similar to that of encyclopedia Britannica (http://www.britannica.com/).

Another improvement relates to further extending the FAQ database. This is inline with the research idea proposed by Jijkoun and De Rijke (2005). According to this idea the FAQ database could be configured to automatically collect and display ranked list of answers to students' questions from open-domain FAQ databases on the World Wide Web. The task as the researchers proposed involved three steps: (1) fetching FAQ pages from the web; (2) automatic extraction of question/answer (Q/A) pairs from the collected pages; and (3) answering users' questions by retrieving appropriate Q/A pairs.

The next improvement could be the creation of an improved search facility. This feature should provide the ability to view messages by date and time posted as well as by the institution. As students from several institutions share a common forum environment, it would be desirable to automatically separate course specific messages to facilitate viewing of forum messages.

Each course will have specific requirements, so a useful addition to the interface functionality to support discussion could include a feature that allows students to view a discussion based on the concepts. This could be achieved by providing students a list of pre-set concepts and allowing students to select and assign their message to a concept or concepts similar to the idea proposed in the experimental studies of Helic et al. (2004), and Ebner et al. (2005). Information retrieval from such a semantic model would make it easy to access a particular message by concept, and the resulting discussion would be clear for students.

Providing students a summary of discussion generated in the forum would be helpful to get an overview of the topic discussed. Two studies can be of particular use to improve the interface in the direction of developing such interface feature. Farrell, Fairweather and Snyder (2001) developed an algorithm that is capable of generating textual summaries of discussion groups, which was applied into a Web-based application called IDS (Interactive Discussion Summarizer). The algorithm was meant to combine sentences extracted from individual postings into variable-length summaries by utilising the hierarchical discourse context provided by discussion threads. Similarly, the study of Newman and Blitzer (2003) presented the use of clustering algorithm technique for processing multi-subtopic threads to form relatively short overviews or long summaries for each group.

To further enhance the performance of the system in retrieving relevant answers, further research could include refining the message types especially the question types by developing a catalogue of questions, and then categorise them under suitable concepts in the FAQ database. Only two question types have been used as a starting point in this current study. The study of Lytinen and Tomuro (2002) provides a useful resource to draw upon in this regard.

In this study interface features to retrieve answers and rate answers were implemented. Currently, the display of an answer in the FAQ database does not include the question for which the search is made. So the student has to remember the question while skimming through the answers. Allowing the system to display the student's question in

quotes at the top of the *show possible answers page* would solve this problem. Further improvement to this page would be to display answers in the order of their ratings.

Reflective argumentation and critical thinking are regarded as important to successful learning in tertiary education (Marra, Moore, & Klimczak, 2004). A useful extension to the forum interface to facilitate such type of discussion could be to assist students by providing negotiated guidance. This could take the form of providing specific types of communicative labels to organise, and pursue arguments with a goal to reach agreement or disagreement. The preliminary experimental study by Baker and Lund (1996) for solving physics problems could be a useful resource for designing such type of specific dialogue structuring support for students.

A further improvement could be by providing online tutorial movie clips for familiarising students with the forum. Including a help file in the system would also enable students to quickly find their way to use the forum features. A large number of new students join the tertiary education institutions every semester/year, and it would be important to allow them to familiarise with forum interfaces and functionality for effective use of this valuable tool for their learning. Providing a tutorial session to the new students or giving detailed read-me file (hard copy or in electronic form) with screenshots of the entire interface features, and how to use them would also be a useful supplement to students.

There is a need for several and varied empirical examples to strengthen support to the great potential this forum tool can offer to the student community in a technology mediated learning environment to support learning and how any additional features would impact on the usability of the system developed to maximise learning experience.

Finally with the increasing speed of the Internet and changing technologies, discussion forums could be made more interactive and include media elements other than text, for example, students could provide a voice recording of their questions. Educators could reply by recording the FAQ answers in the database, which students could download and hear even when they are not online. In addition, educators could add guest lectures or videos to provide additional resources.

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Appendix A: eQuake Evaluation Questionnaire for Users

eQuake Evaluation Form for Users

For each question listed below, cross the number on the scale that best fits your judgment. Thank you for your participation.

Having examined/tested eQuake, I intend to use it in my degree program.

Strongly agree	+3	+2	+1	0	- 1	-2	-3	Strongly disagree

In the future, if I have access to eQuake, I would use it.

Strongly agree	+3	+2	+1	0	- 1	-2	-3	Strongly disagree

I find eQuake useful in my degree program.

Strongly agree	+3	+2	+1	0	- 1	-2	-3	Strongly disagree

Using eQuake would:

a) Improve my performance in my degree program.

Strongly agree	+3	+2	+1	0	- 1	-2	-3	Strongly disagree

b) Increase my productivity[1] in my degree program.

Strongly agree	+3	+2	+1	0	- 1	-2	-3	Strongly disagree

c) Enhance my effectiveness[2] in my degree program.

Strongly agree	+3	+2	+1	0	- 1	-2	-3	Strongly disagree

In relation to <u>posting messages in the forum</u>:

a) Interacting with eQuake does not require a lot of mental effort from me.

Strongly agree	+3	+2	+1	0	- 1	-2	-3	Strongly disagree

[1] *Productivity*: the system enables you to save time, work, etc.

[2] *Effectiveness*: the system improves your capability of achieving the goal of getting your degree.

b) I find eQuake easy to use.

Strongly agree	+3	+2	+1	0	- 1	-2	-3	Strongly disagree

c) I find it easy to get eQuake to do what I want to do.

Strongly agree	+3	+2	+1	0	- 1	-2	-3	Strongly disagree

In relation to finding an answer to a posted question:

a) Interacting with eQuake does not require a lot of mental effort by me.

Strongly agree	+3	+2	+1	0	- 1	-2	-3	Strongly disagree

b) I find eQuake easy to use.

Strongly agree	+3	+2	+1	0	- 1	-2	-3	Strongly disagree

c) I find it easy to get eQuake to do what I want to do.

Strongly agree	+3	+2	+1	0	- 1	-2	-3	Strongly disagree

In relation to rating of answer features:

a) Interacting with eQuake does not require a lot of mental effort by me.

Strongly agree	+3	+2	+1	0	- 1	-2	-3	Strongly disagree

b) I find eQuake easy to use.

Strongly agree	+3	+2	+1	0	- 1	-2	-3	Strongly disagree

c) I find it easy to get eQuake to do what I want to do.

Strongly agree	+3	+2	+1	0	- 1	-2	-3	Strongly disagree

In relation to subscription features:

a) Interacting with eQuake does not require a lot of mental effort by me.

Strongly agree	+3	+2	+1	0	- 1	-2	-3	Strongly disagree

b) I find eQuake easy to use.

Strongly agree	+3	+2	+1	0	- 1	-2	-3	Strongly disagree

c) I find it easy to get eQuake to do what I want to do.

Strongly agree	+3	+2	+1	0	- 1	-2	-3	Strongly disagree

USAGE

Indicate how often you used eQuake.

frequently	more than once a day	about once a day	4 or 6 times a week	2 or 3 time a week	about once a week	less than once a week	not at all	infrequently

COMMENTS

Please feel free to add any comments relating to the use and features of eQuake that have not been addressed by this survey.

The evaluation of the system is being conducted by Mr Oyvind Smestad (o.smestad@massey.ac.nz). "This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s)named above are responsible for the ethical conduct of this research. If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher(s), please contact Professor Sylvia Rumball, Assistant to the Vice-Chancellor (Ethics & Equity), telephone 06 350 5249, e-mail humanethicspn@massey.ac.nz".

Appendix B: eQuake Evaluation Questionnaire for staff

eQuake Evaluation Form

Course: _____ Faculty/University: _____Date: _____

For each question listed below, circle the number on the Scale that best fits your judgment. Thank you for your participation.

1 = Strongly disagree

5 = Strongly agree

NA= Not applicable

Description of Item	Scale					
Basic infrastructure of the system						
1.1 The system provides an excellent student-student interaction. ----------	1	2	3	4	5	NA
1.2 The system provides an excellent student-teacher (or vice-versa) interaction. ----------	1	2	3	4	5	NA
1.3 The system provides an excellent environment for posting queries and solutions ------	1	2	3	4	5	NA
1.4 The system flags for significant and frequently repeated queries. ----------	1	2	3	4	5	NA
1.5 The system allows a teacher to intervene by creating FAQs. ----------	1	2	3	4	5	NA
Query display component						
2.1 The system allows users to view queries. ----------	1	2	3	4	5	NA
2.2 The system allows users to search queries. ----------	1	2	3	4	5	NA
2.3 The system allows users to retrieve queries. ----------	1	2	3	4	5	NA
2.4 Overall, the query display system is easy to use and navigate. ----------	1	2	3	4	5	NA

Student proxy agent						
3.1 The system allows students to post queries. ----------	1	2	3	4	5	NA
3.2 The system allows students to post comments and/or solutions. ----------	1	2	3	4	5	NA
3.3 The system allows students to rate the responses of others to their queries. ----------	1	2	3	4	5	NA
3.4 The system forwards teacher formatted answer of a topic to designated students. ------	1	2	3	4	5	NA
3.5 The system identifies students who rarely participate or exhibit lack of understanding of the already existing solutions.	1	2	3	4	5	NA
3.6 Overall, the student proxy agent is easy to use and navigate ----------	1	2	3	4	5	NA
Query monitoring agent						
4.1 The system detects queries pertaining to a question/topic that had been posted. --------	1	2	3	4	5	NA
4.2 The system flags for the frequently repeated queries on the same question/topic and send it with all the related postings to the teacher through the tutor proxy agent.	1	2	3	4	5	NA
4.3 The system is easy to configure and queries/postings can either be send to all the teachers (who are involved with the subject area) or only to the teacher whose students had asked majority of the questions on the topic.	1	2	3	4	5	NA
4.4 Overall, the query monitoring agent is easy to use and navigate. ----------	1	2	3	4	5	NA
Tutor proxy agent and target selection agent						
5.1 The tutor proxy agent is easy to use and navigate. ----------	1	2	3	4	5	NA
5.2 Tutor proxy agent is robust (performed well) ----------	1	2	3	4	5	NA
5.3 The target selection agent is easy to use and navigate --------	1	2	3	4	5	NA
5.4 The target selection agent is robust (performed well) ---------	1	2	3	4	5	NA

Learning community						
6.1 The system supports Massey University learning community very well. ----------	1	2	3	4	5	NA
6.2 The system supports EIT learning community very well ----------	1	2	3	4	5	NA
6.3 The system supports other learning community very well ----------	1	2	3	4	5	NA
General – usability testing						
7.1 On the first impression, the eQuake site looks very good (Not very cluttered) ----------	1	2	3	4	5	NA
7.2 Navigation features are easy to identify and use ----------	1	2	3	4	5	NA
7.3 Background colours do not hinder readability ----------	1	2	3	4	5	NA
7.4 Text style and font sizes are appropriate ----------	1	2	3	4	5	NA
7.5 All the links I clicked worked ----------	1	2	3	4	5	NA
7.6 All pages were loaded reasonably fast ----------	1	2	3	4	5	NA

1 = Strongly disagree

5 = Strongly agree
NA= Not applicable

Please put in the space provided any helpful suggestions for the improvement of eQuake that you wish to make.

Comments: