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# **Knowledge Management in Web Communication Technologies**

A thesis presented in partial fulfilment of the requirements for the degree of

## **Master of Information Science In Information Systems**

At Massey University, Palmerston North, New Zealand

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2005

## **Abstract**

In the tertiary educational area, the web communication technologies have been used for a long time for communication among students and teachers. The discussion forum system is one important type of web communication tools. This thesis suggests an advanced category of web-based discussion forum system to enhance the ability of knowledge management in the tertiary educational area. In this project, a prototype web-based discussion forum system is developed that not only contains the benefits of the traditional web communication tools, but also overcomes various shortcomings of current discussion system systems by using various technologies such as keyword search methodology, concept-based search methodology, interactive query expansion technology, and concept map methodology.

This project provides a solution which students can effectively and efficiently capture, retrieve, and share useful knowledge and relevant information in a web-based discussion forum.

## **Acknowledgements**

**I wish to thank my supervisor, Dr. Kinshuk, Associate Professor for his guidance, advice and inspiring wisdom throughout this project for his lots of valuable support and supervision from the beginning of the research project. He gave me such patient, effective support and encourages in such a year time.**

**In addition, I would like to thank my girl friend, Miss Yiwei Li, for her support and encouragement, without which this project would not have been completed. And thank all my friends who gave me such help and encourages during such a long time.**

**Your thought, help and kindness will encourage me to keep going!**

**Thanks You All!**

**Yours truly,  
Jingyu Yang**

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# Chapter 1 Introduction

## 1.1 Introduction

The aim of this thesis is to design and implement an advanced type of web-based discussion forum system, where students can communicate with each other and with teachers by using web communication technology. The system aims to overcome the limitations of the traditional discussion forum systems, and harnesses the power of knowledge management.

In the next sections of this chapter, the limitations of current discussion forum systems are analyzed. Then the objectives and methodology of this project are presented. Finally the outline of this thesis is introduced.

## 1.2 The Problems of the Traditional Discussion Forum Systems

As one of the web communication tools, a discussion forum (known also by various other names such as discussion group, discussion board, message board, and online forum) is an asynchronous communication module. It works much like a bulletin board, users post messages that can then be read and responded to by other users (Glossary Website, 2004). Although the web-based discussion forums are used in a range of undergraduate and graduate courses in many universities, some limitations exist in the traditional web-based discussion forum systems. These limitations are described below:

- **Too many messages in inappropriate topic folders** – In traditional discussion forum systems, students typically leave their message in inappropriate topic folders. This generally happens because while entering into a topic folder, many students are not concerned with the fact that different categories of messages should be left in different topic folders. In many cases students leave all of their messages and questions in the same topic folder for convenience, such as a query about “Java Programming” left in a “PHP

programming” topic folder. This approach makes it very difficult for other students and for teachers to find relevant information in appropriate topic folders, and forces teachers to spend more time and effort in managing the system.

- **Too many similar messages and queries in a topic folder** - Traditional discussion forum systems also suffer from duplicate messages and queries in topic folders. In particular when the number of messages is high in a particular folder, and if many of them are duplicate or not related to that particular topic, it becomes overwhelming for students to read all those messages. Students do not find enough time and patience to read all those messages to analyse if their own query has already been answered earlier. They just leave a message or query there, increasing again the duplication. It is possible that a similar query or message had already been posted by someone else in that same topic folder. It is more difficult for students to capture and retrieve relevant knowledge and useful information in such a scenario. Moreover, the teachers end up responding to duplicate queries more than once and spending more time and effort on managing the discussion forum.
- **Too many topic folders or not enough topic folders in the discussion forum** - In traditional discussion forum systems, if students are allowed to create their own topic folders, it is possible that many students will create either similar topic folders or separate (unnecessary) folders for most of their messages, contributing to an unmanageable situation. However, if students are not allowed to create topic folders, it is possible that students will not find any of the existing folders appropriate for their queries and therefore they will either hesitate to post or leave their messages in wrong topic folders.
- **Work overload for teachers to manage the discussion forum** - In traditional discussion forum systems, teachers typically end up managing too many unnecessary topic folders and duplicate messages. Sometimes they have to answer similar queries more than once because the student who asked at later stage would be expecting an answer.

### **1.3 The Objectives of the Project**

This project aims to find a new solution to overcome various drawbacks of the traditional discussion forum systems. A new type of web-based discussion forum system has been developed that aims to harness the benefits of knowledge management in the educational area. The objectives of this project are described as follows:

- To allow students to easily create their own topic folders and teachers to easily manage them.
- To prevent students from leaving a message in an inappropriate topic folder by the system identifying whether the message belongs to that particular topic folder or not.
- To allow students to easily find relevant information before they post a duplicate message.
- To allow students to easily retrieve and share relevant and useful information despite a large amount of messages in the discussion forum.
- To allow students to easily find the relevant information among different topic folders.
- To ensure teachers are not overloaded with the heavy burden of managing a messy discussion forum.

### **1.4 The Methodology of the Project**

In order to achieve above objectives, various methodologies and technologies are used:

- The discussion forum technology.
- The knowledge base methodology.
- The search engine technology.
- The keyword search methodology.
- The concept-based search methodology.
- The query expansion technology.
- The concept map methodology.

## **1.5 The Outline of the Project**

This thesis describes the rationale behind the development of the suggested web-based discussion forum system, the methodologies and the technologies used in the project, the outcomes and the way forward. The outline of the thesis is shown in Figure 1-1.

The thesis is largely divided into three sections:

- The first section presents the existing research in the field, which includes two chapters (chapters 1 and 2) – introduction and literature review.
- The second section discusses the system design and implementation, which includes chapters 3 and 4 – system architecture and technology, and system design and implementation.
- The third and final section is the project results, which includes chapters 5 and 6 – evaluation, discussion, conclusion and future work.

The next chapter will introduce the concept and theories of knowledge management, knowledge management systems, and the methodologies and technologies used for knowledge management.

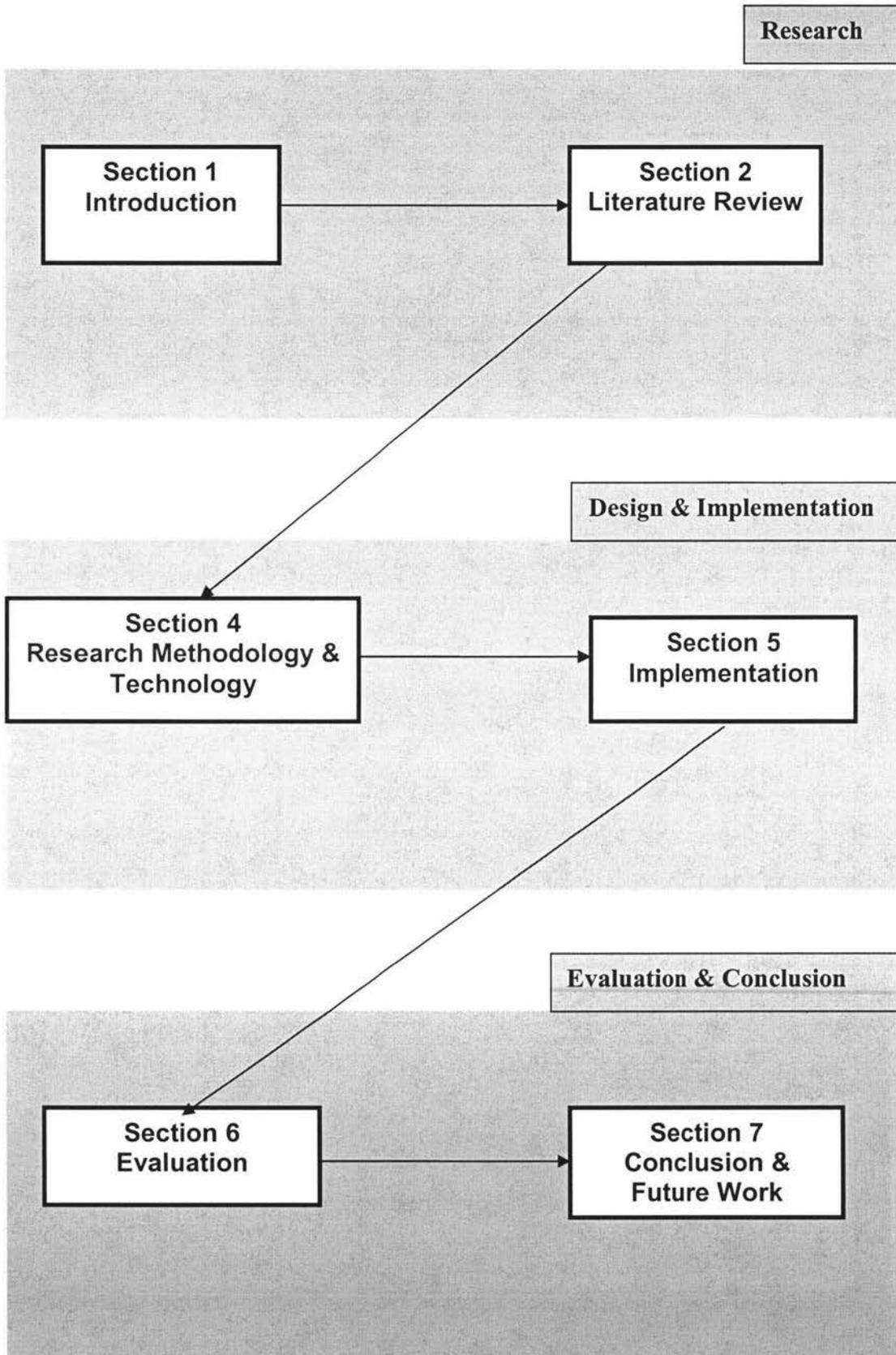


Figure 1-1: Outline of the thesis

## **Chapter 2 Literature Review**

This chapter first introduces an overview of knowledge management. This is followed by an overview of different types of knowledge management systems. Finally the chapter discusses some technologies which are used in this project. These technologies are used to design and develop a knowledge management system to solve some of the existing problems in traditional discussion forum systems.

It starts from the introduction of the Internet development in the world. In less than ten years since its emergence to the public, the World Wide Web (WWW) has become a prominent space for people to communicate, work, trade or spend leisure time. Increasingly the WWW is also being used for learning (Berenfeld, 1996; Sherry, 2000). Its growth-rate is impressive: from a few dozens of servers/sites in the beginning of the last decade to more than ten million servers today; from a limited and clearly defined population of users (mostly dealing with academic, research or institutional tasks) to a large and varied world community of users (an estimate of about 300 millions) across different countries, ages, occupations, interests, and purposes (Mioduser & Nachmias, 2002). With increased awareness of the potential of WWW for education, an increasing number of educational organizations are attempting to integrate web technology features within their educational and pedagogical infrastructure to support students' learning goals.

Therefore this thesis suggests utilizing the web communication technologies to enhance knowledge management in a learning environment, and overcome the limitation of current knowledge management systems.

The following sections of this chapter introduce knowledge management, knowledge management systems, and the technologies for knowledge management.

### **2.1 Overview of Knowledge Management**

#### **2.1.1 Introduction**

As people enter the first decade of the twenty-first century, knowledge management has become the latest strategy for increasing organizational competitiveness. It is the most innovative, creative, and important management concept to come along in the recent years (Motwani, et al., 2003). Sanchez (2001) suggested contemporary management thinking is being profoundly reshaped by two new convictions: (1) managing organizational knowledge effectively is essential to achieving competitive success; and (2) managing knowledge is now a central concern – and must become a basic skill – of the modern manager. Information, knowledge, and intellectual assets increasingly drive innovation, which give companies new opportunities to compete. Knowledge can be regarded as the only unique resource that grows when shared, transferred, and managed skilfully (Beerli, 2003). This literature review starts from the concept of knowledge.

### **2.1.2 What is knowledge?**

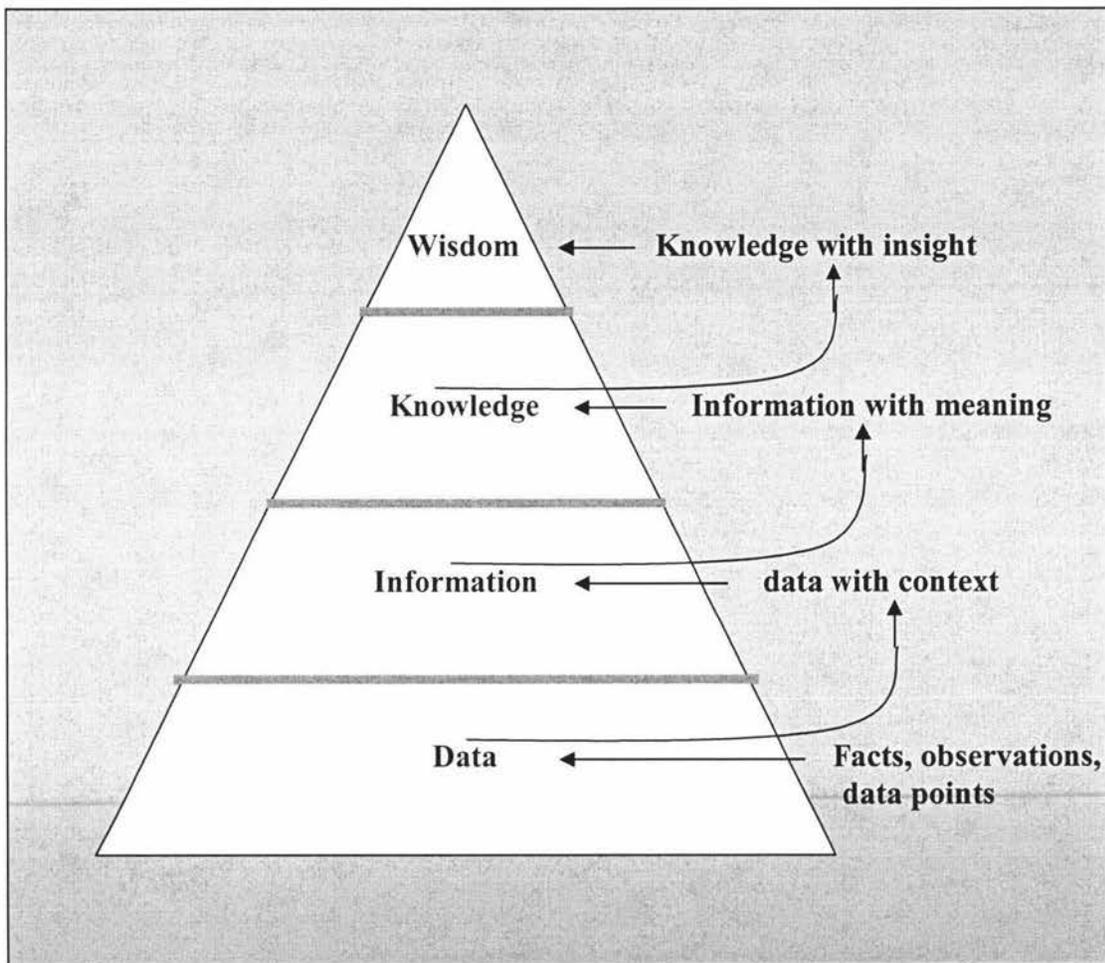
Knowledge is power. Whether one is in an educational institution, business, government or military having the right knowledge at the right time is necessary in making the right decisions. Knowledge is the lifeblood of the decision-making within an organization (Hussain, 1998).

Webster's dictionary defines knowledge as:

1. a (1): the fact or condition of knowing something with familiarity gained through experience or association; (2): acquaintance with or understanding of a science, art, or technique; b (1): the fact or condition of being aware of something; (2) the range of one's information or understanding (...); c: the circumstance or condition of apprehending truth or fact through reasoning: cognition; d: the fact or condition of having information or being learned (...);
2. a: the sum of what is known: the body of true, information, and principles acquired by mankind; b: archaic: a branch of learning.

Wiig (1996) also defined knowledge as “the insights, understandings, and practical know-how that people all possess – is the fundamental resource that allows people to function intelligently.” Knowledge is neither data nor information, though it is related

to both, and the differences between these terms are often a matter of degree (Davenport & Prusak, 2000). There are three definitions from Knight and Howes (2003) for data, information and knowledge: “data are symbols that have not yet been interpreted; information is data that has been assigned a meaning and knowledge is that which enables people to assign meaning to data and thereby generate information” (p. 12-14). Skyrme and Amidon (1997) made a clear distinction between data and information and between information and knowledge (See Figure 2-1).



**Figure 2-1: The knowledge hierarchy (reproduced and adapted from *Creating the Knowledge-Based Business*, Skyrme and Amidon, 1997)**

### **2.1.3 Tacit Knowledge & Explicit Knowledge**

There are two types of knowledge: tacit knowledge and explicit knowledge. As supported by Duffy (1999), Nonaka (1998), Tiwana (2000), and Zack (1999b), tacit knowledge is the form of knowledge that is subconsciously understood and applied. It

is difficult to articulate, developed from direct experience and action, and is usually shared through highly interactive conversation, storytelling and shared experience. Explicit knowledge, on the other hand, is easy to articulate, capture and distribute in different formats, since it is formal and systematic. For these reasons it can be easily communicated and shared, in product specifications or as a scientific formula or a computer program. Tacit knowledge is highly personal. It is hard to formalize and therefore difficult, if not impossible, to communicate. In addition to the concept and types of knowledge, it is also important to highlight why people need to manage knowledge (Nonaka, 1991).

#### **2.1.4 Why do people need to manage knowledge?**

Today's effective business must capture data from various internal and external production systems, databases, and resources and knowledge assets must be managed in order to ensure that enterprises drive value from their investment in knowledge assets (Liebowitz, 2001). Much of the trade press as well as the academic literature seem to assume that knowledge can and should be managed. Also as Stewart (1998) said the most important resource in organizations is knowledge which is increasingly recognized and knowledge is a key-differentiating factor in business today as well. On the other hand, the world is in an information age now and there are more and more new technologies emerging every day. Information overloading comes from overwhelming amounts of company-generated paperwork, printed sources, and electronically held material accessed via database and search engines. To solve such problems and improve productivity, innovation or knowledge reuse, knowledge management – as an active discipline for addressing these concerns –began to be defined and described by the mid-1990s (Knight and Howes, 2003). Therefore, the concept of knowledge management is very important in the research area.

#### **2.1.5 What is knowledge management?**

Different people have different answers for the concept of knowledge management. Even when people agree on the basics, particular emphasis varies according to experiences and priorities. Knowledge management is the explicit control and

management of knowledge within an organization aimed at achieving the company objective (Liebowitz & Wilcox, 1997). Duffy (1999) defined knowledge management as “the identification, growth and effective application of an organisation’s critical knowledge.” However, Takeuchi (1998) proposed a contradictory view on knowledge management which advocates less control over employees and involves everyone in the organisation to create and share knowledge, which in turn fuels the organisation’s innovative strategy. This different philosophy is shared by Sveiby (2000b) who argued that knowledge is not something that can be “managed” and that the term, “Knowledge Focused” is preferable. Sveiby (2000c) also stated that knowledge focussed managers do not manage knowledge, since this is impossible, but the environment in which knowledge is created. The thesis adopts the view of Duffy (1999), and includes some of Takeuchi’s (1998) and Sveiby’s (2000b) arguments, by proposing that knowledge management is the process of identifying, growing and effectively applying an organisation’s existing knowledge in order to achieve the organisation’s goals, while creating an organisational culture that permits further knowledge creation.

#### **2.1.6 Knowledge management objectives**

The objective of knowledge management can be formulated in terms of both the processes that are the part of knowledge management as well as in terms of the structure of knowledge. Liebowitz and Wilcox (1997) pointed out that the following objectives can be set in terms of the processes within the context of knowledge management: a) to ensure the effective and efficient development of new knowledge and improvement of existing knowledge with a view to the strategy of the organization and the individual objectives of the employees; b) to ensure a specific distribution of new knowledge to other departments and transfer of knowledge to new employees through knowledge transfer or relocation of knowledge bearers; c) to ensure an effective securing of knowledge that is also easily accessible to the whole organization, and d) to ensure the effective and to efficient combination of the best knowledge available within a company or network of companies.

#### **2.1.7 Review of knowledge management theories**

As mentioned in various theories, knowledge management is not just an explicit tangible “concept”, like Hi-Tech information, but information combined with experience, context, interpretation and reflection. Knowledge involves the full person, integrating the elements of both thinking and feeling. Knowledge management is related to information management. But as the concept was defined by Nyman (2002), information is the collection of data, and knowledge is the collection of information, so we cannot say information is knowledge.

Knowledge management is a very important phenomenon for any organization, company and academic institution, since knowledge management is the process of creating value from an organization’s intangible assets. For an organization, knowledge management can increase innovation within the firm. The importance of knowledge to the organizations and companies is self-evident. One may therefore expect that the control and management of knowledge and processes relating to knowledge will always be well organized. It aims to provide instruments to employees of professional organizations who are confronted with the need to optimise the control and management of their most crucial production factor. Knowledge management aims at preventing bottlenecks and cashing in on opportunities by determining from a strategic perspective where the requirements will be set for the knowledge household in the future.

Liebowitz & Wilcox (1997) tried to find the correct theories of knowledge management. They considered the core of knowledge management is the organization of process in which new knowledge is developed. In their theory, knowledge is distributed to those who need it and is made accessible for both future use and use by the whole organization. Therefore, in order to fulfil the goal of knowledge management, knowledge management systems have been designed and implemented for a long time. The following sections will introduce different types of knowledge management systems.

## **2.2 Knowledge Management Systems**

### **2.2.1 Introduction**

Alavi & Leidner (1999) pointed out many organizations are developing information systems designed specifically to facilitate the sharing and integration of knowledge. Such systems are referred to as Knowledge Management System (KMS). A Knowledge Management System(KMS) is an information system to promote ongoing business success through a formal, structured initiative to improve the creation, distribution, or use of knowledge in an organization (design and implementation of an integrated knowledge system) (Lau, Wongb, Huic & Pund, 2004).

Knowledge management systems can be categorized into knowledge retrieval systems which retrieve and capture knowledge; knowledge distribution systems which distribute and share knowledge, and knowledge-based (management) systems which share and integrate knowledge (Alavi & Leidner, 1999).

This section examines:

- Discussion forum systems as one type of knowledge management systems, which enable people to capture, share and retrieve knowledge;
- Search engines as one type of knowledge retrieval systems;
- Expert systems as one type of knowledge distribution systems;
- Knowledge-based (management) systems as one kind of knowledge sharing and integrating systems.

As mentioned above, the discussion forum system is one type of a knowledge management system. The next section will introduce concepts and examples of the discussion forum systems especially used in the area of education.

## **2.2.2 Discussion Forum Systems**

### **2.2.2.1 Introduction**

The widespread use of the World Wide Web in tertiary education has enabled the development of on-line learning environments. Many teachers use Web technology to broaden the learning experience of their students beyond what is possible in a traditional teaching environment. Courses may now be enhanced by the addition of

varied and interesting Web-based resources containing interactive elements that encourage student engagement in learning (Sheard, et al., 2001). The adoption of the Web technology in tertiary education has encouraged a shift in pedagogical thinking by educators and educational courseware designers (Lefoe, 1998). Meanwhile Web technologies provide an opportunity for students to learn and communicate with teachers on the Internet. Such online communication technology is already being used for many areas.

The Web communication technologies have been used in the area of education for a long time. Nowadays, it is a facility commonly provided as an integral component of typical Web-based learning environments. This enables synchronous or asynchronous communication between learners and teachers who are physically separated (Liaw & Huang, 2000). Synchronous communication, for example, chat sessions or conferencing, requires all participants to be present at the same time. Asynchronous communication, for example, discussion forums, does not require participants to be present at the same time and has the advantage of allowing the learner and instructor opportunities to analyse and reflect before they express their ideas. In this project the web-based discussion forum system is used as a tool to fulfil the goal of knowledge management.

#### **2.2.2.2 What is a discussion forum?**

As one type of a Web communication tool, a discussion forum (known also by various other names such as discussion group, discussion board, message board, and online forum) is an asynchronous communication module. It works much like a bulletin board where users post messages that can then be read and responded to by other users (Glossary Website, 2004). In learning environments, students and teachers communicate with each other using some sort of discussion forum. These forums are online posting areas in which participants could post their ideas and questions, while responding to the ideas and questions of others. These "asynchronous" bulletin board type discussions could be used for weekly topic discussions as well as for coordination of group activities (Zachry, 2000).

#### **2.2.2.3 Characteristics of the web-based discussion forum**

In the area of education, web-based discussion forums have many advantages in learning environments. Firstly as Liaw and Huang stated (2000), discussion forums do not require participants to be present at the same time and have the advantage of allowing the learner or instructor opportunities to analyse and reflect before they express their ideas and knowledge. In this way, discussion forums encourage deeper and more critical communication (Sheard, etc., 2003). Comparing the two forms of communication, synchronous and asynchronous, Hegngi (1998) found that synchronous discussion encouraged more participation, whereas asynchronous discussions generated more student-initiated discussion topics, a greater number of ideas and useful knowledge. Therefore, this on-line communication facility encourages engagement in the learning process and participation in collaborative learning (McKenzie & Murphy, 2000). It enables students to obtain help and information from instructors or other students, and contribute ideas to other students. Another purpose for which this facility may be used is to enable students to give feedback to staff, and in some cases this may be their main purpose (Jones, 2002).

#### **2.2.2.4 The use of the discussion forum**

In tertiary educational area, the web-based discussion forums are used in a range of undergraduate and graduate courses in many universities by the students to discuss course content or structure, or offer comments on any issues arising during the study semester. In addition, the facility is seen as "a place to encourage further learning", particularly as many questions not asked in lectures or tutorials could be asked in the forum (Sheard, et al., 2003). Users can ask queries and browse the forum to obtain, share and retrieve knowledge. In many case, anonymity of postings is provided to encourage students to use it freely without revealing their identity (Lowder & Hagan, 1999). The impetus for this development came partly from a workshop titled "Computer-supported cooperative work" (Brugge & Houghton, 1996) which led some staff to consider ways to introduce student interaction in the computer-supported course environment and turn it into a cooperative learning environment.

A particular type of collaboration systems, called on-line discussion databases, facilitates formulation and sharing of metaphors, and analogies facilitate capturing tacit knowledge. In this type of discussion forum, features such as access control

enable discussions to be restricted to team members and this has been proven to encourage frankness and engender feelings of trust amongst the members (Bradner, Kellogg & Erickson, 1999).

Not only in the area of education, but also in other areas, newsgroups and similar forums offer similar opportunities but they generally differ in that they are open to all unlike the specific team discussions. Many people have been found to offer advice and guidance in newsgroups by a mixture of motivations such as altruism, recognition and acknowledgements though newsgroups face the potential threat of flaming, personal abuse and irrelevant postings. The archive of the forum serves as a useful repository of knowledge and the number of questions a person has answered and the speed of response could be utilised as a means to index the person as an expert in the domain (Marwick, 2001).

This project is concerned with how some technologies enhance knowledge management in the discussion forums system. The next section will introduce examples of discussion forum systems which are used in academic organizations.

#### **2.2.2.5 Discus**

The 'Web-based Multimedia Systems' at Massey University (New Zealand) for postgraduate students incorporates "Discuss" discussion forum in the course website. This website's (Figure 2-2) contents include Course News, Information and the Discussion forum. The forum is for the communication between teachers and students. It is available through the campus local area network and the Internet. All discussion topics and replies can be posted from any computer connected through the Internet.

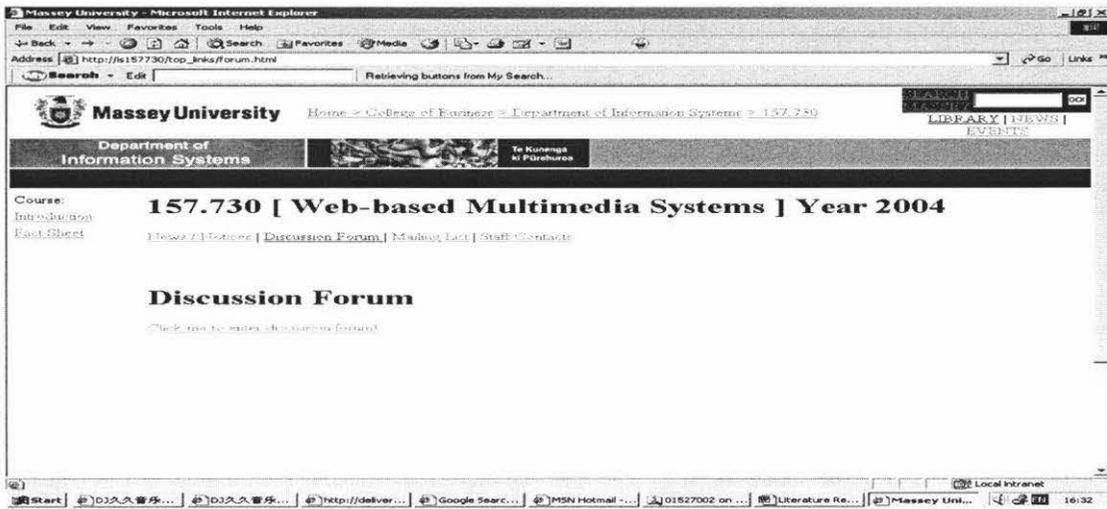


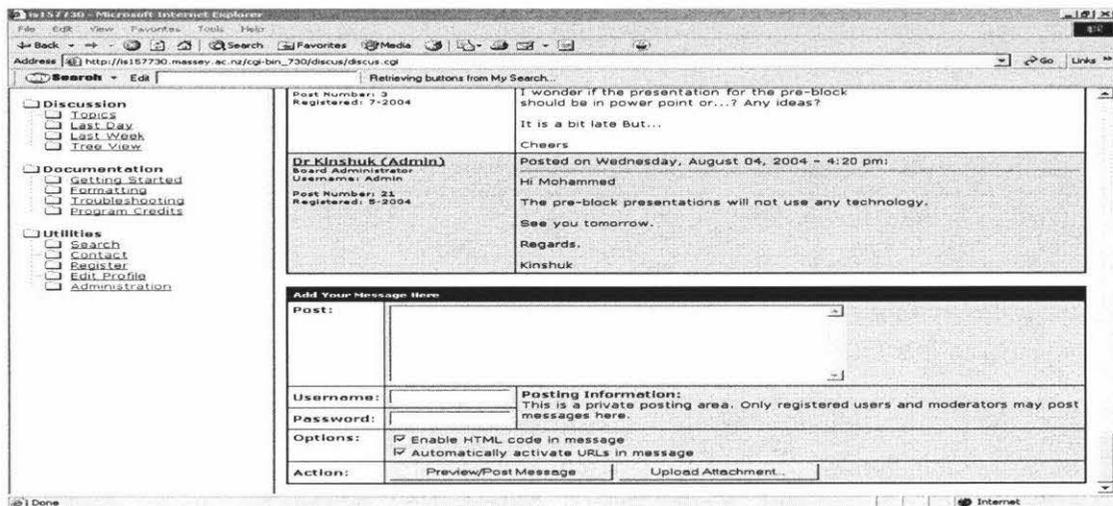
Figure 2-2: A website Used for a Course (<http://is157730.massey.ac.nz>)

After students register, they become authorized users in the discussion forum system. The discussion forum has five topic folders (Figure 2-3) for students to post their messages, such as Introduction, Discussion on Specific Topic, Projects, Discussion on Assignment and Other Issues.



Figure 2-3: Different Topic Folders in the Discussion Forum

In each topic folder (Figure 2-4), students can post their messages and instructors also respond to students' queries or post some important information related to the course.



**Figure 2-4: Discussing Area of the Discussion Forum**

### 2.2.2.6 CRPP's web portal

Another type of discussion forum system, which is called web portal, was developed by CRPP (Centre for Research in Practice & Pedagogy, National Institute of Education, Singapore). It has a number of discussion forums tailored to different contexts for use in the CRPP's web portal. Protecting the confidentiality of knowledge contents residing in the knowledge portal is of the prime concern, and therefore different users have different access rights to log into the online discussion forum. A general forum is designed for the public who do not have login rights to post and discuss issues of relevance and importance. All members who are assigned rights of log-in into the portal are able to access project specific discussion forums. The discussion forums have database-driven search engines which have a limitation with the search to information hosted in the discussion forum only. The ability of the search is pegged to the access rights of the individual participating in the forum (Muthukumar & Hedberg, 2004). The CRPP's web portal is developed for the public and all members to have a different right to post, discuss and search relevant information. It has a better solution rather than the traditional discussion forums. However there still exist many problems in all types of discussion forum systems currently. Next section will list all problems and limitations of the traditional discussion forum systems.

### 2.2.2.7 Problems with available discussion forum systems

Although web-based discussion forums are used in a range of undergraduate and graduate courses in many universities, the enthusiastic adoption of these facilities by students has impacted upon staff workloads, and recently staff have raised concerns about the time and effort required to manage them. Furthermore, it has been difficult to determine the pedagogical value of these facilities and the level of educational support they provide to the teaching and learning community (Sheard, et al., 2003).

Usually a web-based discussion forum is set up to have different folders for different topics, such as introduction, assignments, tutorials, and so on. In practice, the efficiency and effectiveness of the system suffers when students post their messages into inappropriate folders. Sometimes when students enter a topic folder, they leave all questions in a same topic folder for convenience, or sometimes students do not know where their messages should be left in. Therefore, too many messages and queries are left in inappropriate places. It makes it very difficult for other students to understand the context of the queries and the purpose of such messages. Teachers also end up putting too much time in the management of the forum and in distinguishing whether there are some messages left in an inappropriate place and moving them to right folders.

Furthermore, forums save the information posted by people to be viewed at any time and this creates a discussion environment (Callan, 2004). In many cases, people post too many unnecessary messages, similar messages, or even the duplicate messages in the system. For instance, while discussing the assignment topic folder for a particular course, many students simultaneously post queries regarding due date near the submission deadline, and the teacher and other students end up responding to these similar queries more than once. Besides wasting computing resources, this phenomenon wastes the time and energy of teachers and students.

As the number of messages in any topic folder increases, it becomes difficult for students to browse through and the end up wasting too much time navigating through the forum rather than getting appropriate and timely knowledge. Facing overwhelming amounts of messages in a discussion forum, students find it difficult to spare enough time and patience to browse all of them carefully to distinguish which

ones are useful. Pointing such situations, the discussion forums do not fulfil the goal for users to easily capture and retrieve knowledge effectively and efficiently.

In a conclusion, discussion forum systems have been used widely in education as popular Web communication tools. They have proved to be useful tool for people to easily capture, share and retrieve knowledge. Meanwhile more and more limitations of the discussion forum have been found and those problems have been a big obstacle for people to fulfil the goal of capturing and sharing their knowledge. As the result, in order to overcome all of the available problems and enhance knowledge management, this thesis proposes an advanced category of discussion forum system.

Before discussing discussion forums in detail, the following sections will introduce another type of knowledge management systems – information retrieval systems.

### **2.2.3 Information retrieval systems**

Information Retrieval (IR) is a computer science discipline that deals with the representation, storage and organization of unstructured data in general and textual documents in particular. The main goal of this discipline is to assist in information discovery tasks such as searching and browsing (IBM.com, 2004), which suggests that such search engines, metadata search engines and domain search engines can be considered as information capturing and retrieving tools to fulfil the goal of knowledge management. This section will review general purpose search engines as one type of knowledge management retrieving system. It starts from the concept of the search engine.

#### **2.2.3.1 What is a search engine?**

A search engine is a tool that explores its own database of text for web pages that contain specific words, phrases and/or numbers that match the specific terms one has requested. When found, "click-able" links to these pages are presented in a list ranked by relevancy. Search engines operate by sending programs, called "spiders" or "robots" that constantly "crawl" the web, looking at web pages, following the links they found and add any new pages found to its master database or index. It is the

master database that is searched when one makes a request. Simply put, a search engine is a program on the Internet that enables people to find information.

### **2.2.3.2 Types of search engines**

Search services can generally be categorized into two types: directories and search engines (Williams, 2004). A directory uses human editors to manually place web sites or web pages into specific categories. A directory is commonly called a “human-based” search engine. A search engine, on the other hand, uses special software robots, called spiders or crawlers, to retrieve information from web pages. This type of search service is called a “spider-based” or “crawler-based” search engine (King, 2003).

### **2.2.3.3 How does a search engine work?**

As Sonnenreich and Macinta (1998) stated, search engines perform three basic tasks: search engine spiders find and fetch web pages using a process called crawling or spidering, and build lists of words and phrases found on each web page; search engines keep an index (or database) of the words and phrases found on each web page the spiders are able to crawl. The part of the search engine that places the web pages into the database is called an indexer; and search engines then enable end users to search for keywords and keywords phrases found in their indices. Search engines try to match the words typed in a search query with the web page that is most likely to have the information for which end users are searching. This part of the search engine is called the query processor.

As Talim, et al. (2001) suggested, the search engine systems consists of four main components: a database that contains web pages, a user interface that deals with queries, an indexing engine that updates the database, and robots that traverse the web servers and bring web pages to the indexing engine. If users want to know how search engines work, the usual starting points are lists of heavily used servers from major Internet service providers (ISPs), such as America Online, and the most frequently visited web sites, such as Yahoo!, the Opening Directory LookSmart, and other major directories. Search engine spiders will begin crawling these popular sites, indexing the words on every single page of the sites and following every link found within those

sites. This is one of major reasons why it is important for web sites to be listed in the major directories.

Because search engine spiders continually crawl the web, their indices constantly receiving new and updated data. A typical search engines regularly update their indices about every four to six weeks. The search engine index contains full-text indices of web pages. Thus, when people perform a search query on a search engine, they are actually searching this full-text index of retrieved web pages, not the web itself.

#### **2.2.3.4 The use of search engines**

Search engines and directories are two main ways which Internet users discover web sites. According to King (2003), various sources have reported the percentages of Internet users in the range of 42% and 86% are using search engines to find useful websites. Search engines and directories average over 300 million searches per day. Therefore, regardless of the differences among reported percentage, millions of searchers are performed every day. The amount of information available on Web is vast and growing at a staggering rate. More and more people choose to use search engine to find websites and useful information on the Internet. Even search engines can be considered as the prime way to search information on the Internet for ordinary people.

#### **2.2.3.5 Review of Available Search Engine Systems**

World Wide Web is a vast source of information which is growing at exponential speed. Indeed more than 7 million pages are added to the Web each day (study of Cyveillance in Washington, 1999). Search engines are used by people to search useful information from overwhelming amounts of information on the Internet. There are two different services of search engine, directories, such as Yahoo!, ISEDB and MSN, and spiders, such Google, AltaVista, Excite and HotBot.

Table 2-1 summarizes some general purpose search engines including Directories and Spider types.

**Table 2-1: Summary of General Purpose Search Engines**

	<b>Introduction</b>	<b>Requirement</b>	<b>Website</b>	<b>Type</b>
<b>1. Yahoo!</b>	A combination search engine and search index to information on the World Wide Web.	Users should know which area they want to go.	www.yahoo.com	Directory
<b>2. ISEDB</b>	Users can choose different categories according to search engines list.	Users should know which area they want to go.	http://www.isedb.com/	Directory
<b>3. MSN</b>	It provides an online information resource such as careers, games, health, etc.	Users should know which area they want to go.	www.msn.com	Directory
<b>4. Google</b>	Currently the most important spidering search engine by far, Google is dominating the search engine market	Users just input keywords as search query	www.google.com	spider
<b>5. AltaVista</b>	A popular search engine with the largest database on the web, indexing more than 140 million pages.	Users just input keywords as search query	http://www.altavista.com/	spider
<b>6. Hotbot</b>	Offers a search powered by a choice of Google, Lycos (Alltheweb), Hotbot (Inktomi) or AskJeeves (Teoma).	Users just input keywords as search query	http://www.hotbot.com/	spider
<b>7. Excite</b>	Excite is the leading personalization Web portal, featuring world-class search, content and functionality.	Users just input keywords as search query	http://www.excite.com/	spider

#### **2.2.4 Knowledge distribution systems – Expert Systems**

Knowledge management practice launch should begin with a systemic knowledge audit, which maps communication and information flows onto specific content repositories and validation processes. In addition to technology, costs will also be incurred in providing for and training content roles like content editor, knowledge

steward and subject matter expert (Madanmohan, 2004). Therefore as one type of knowledge distribution systems, expert systems provide a natural way to capture expert knowledge, making the experience of a few available to all users and preserving corporate knowledge (Hayes-Roth, Waterman, & Lenat, 1983). Both tacit and explicit knowledge are converted by expert systems to all users which is a key process in knowledge management. And it is considered as an ideal ways to distribute knowledge in a firm. There are two procedures which are involved in the implementation of expert systems: systematic and well-established procedures. They are used for representing the knowledge of experts, a process referred to as knowledge engineering. However, how to deal with eliciting and documenting tacit knowledge has become the big obstacle for knowledge management efforts. Meanwhile data warehouses, a mainstay of knowledge management, are a valuable source of information that may not always be used effectively in expert systems (Lamont, 2004).

In conclusion, the expert system is a class of computer program that can advise, analyze, categories, communicate, consult, design, diagnose, explain, explore, forecast, form concepts, identify, interpret, justify, learn, manage, monitor, plan, present, retrieve, schedule, test or tutor. They address problems normally thought to require human specialist for their solution.

### **2.2.5 Knowledge-based (Management) systems**

Knowledge-based theory suggests that knowledge is the organizational asset that enables sustainable competitive advantage in hypercompetitive environments. Many organizations are developing information systems designed specifically to facilitate the sharing and integration of knowledge. Such systems are referred to as Knowledge-based (management) Systems which is one subset of Knowledge Management System (KMS) (Alavi & Leidner,, 1999). Following Waterman's (1986) conclusion, a knowledge-based system (KB system) is a computer program in which knowledge from a narrowly defined application domain is separately encoded and processed by a distinct general problem solving method. Knowledge-based systems are the tools of intelligence that define how organizations are structured, how they respond and react to opportunities, and how vertical and horizontal communications encourage productive completion for resources while creating highly efficient orders of parallel

processing (concurrent synchronized management) within the organization (Liebowitz, & Wilcox, 1997). From another point the knowledge-based (management) systems (KBMS) differ from the traditional database management systems (DBMS) in that they provide not only the traditional database management services, but also a set of knowledge base management services (Su, Lam, Javier, Yu, & Yang, 1995).

There are many knowledge-based (management) systems currently available, such as

- Multimedia Databases System (MMDB);
  - KB\_SQL (Access and retrieve data systems);
  - PROSIM (Automated process modelling and analysis with simulation model generation);
- Multimedia Databases System (MMDB): Database systems are used to manage persistent data. (Bekke, 2002).
- KB\_SQL is a high-performance, SQL (Structured Query Language)/ODBC (Open DataBase Connectivity) and reporting environment for M Technology (MUMPS) databases (The MUMPS User's Group is known as the M Technology Association.). Answering the need for robust access to organizational data, KB\_SQL supports a flexible range of reporting and application (KBSI, 2003).
- PROSIM is a knowledge-based system for modelling processes, analyzing those using simulation and project management tools, and designing improved processes (Perakath, Dursun & Madhav, 1998).

## **2.3 Technologies for knowledge management**

### **2.3.1 Introduction**

In order to fulfil the goal of knowledge management, there are many technologies that can be used. This section will review some of these technologies. As Luan and Serban (2002) concluded, the technologies supporting knowledge management have been grouped in one or more of the following categories:

□ Business intelligence

Whether businesses or higher education, the main interests of organization about competitors are systematic gathering, accessing and capturing of intelligence, and knowledge (Wallach, 2000).

□ Knowledge base

Knowledge base refers to databases and repositories of data, information, and knowledge. The primary purpose of knowledge base applications is to create such repositories in a structured fashion that can facilitate searching and circulate knowledge throughout the organization (Luan & Serban, 2002). In this project, there is a knowledge base developed that is used to store information of the discussion forum.

□ Collaboration

The ability to collaborate, such as collaboration among employees within an organization and collaboration between different organizations even collaboration between different computer systems without human interaction is one of the core tenets of knowledge management.

□ Content and document management

The ability to manage documents and content over the Web has been recognized as key to a sound knowledge management infrastructure Wallach (2001).

□ Portals

The enterprise information portal –simply in the concept but previously elusive in practice – “is suddenly front and centre on the IT agenda. Bringing together in one embodiment the notions of business intelligence, documents classification, text analysis, group collaboration, executive information, and the company intranet” (Roberts-Witt, 1999).

□ Data mining

Data mining is one of the knowledge management techniques that have direct applicability to the work of institutional researchers.

#### □ Workflow

Workflow applications cover a wide array of operational processes from routine ones such as form routing to complex, integrated organizational activities such as data-gathering, scenario testing, and trends assessment.

#### □ Search

The amount of data and information available in organizations has increased exponentially, and consequently one of the major challenges is to find the appropriate information and obtain it in a format that is user friendly and easy to share. In recent years, search methods have already been used everywhere in the world and sophisticated search applications have been developed that can create taxonomies based on pattern recognition and can access information stored across multiple servers and in various repositories and formats, such as web-based search engines. In this project, search technology is the major approach used in a discussion forum system to fulfil the goal of knowledge management.

#### □ E-learning

Many organizations have come to recognize that ongoing training for their workforce is the only way to maintain competitiveness in changing environments. Knowledge workers must be able to adapt and acquire new skills as technologies and domains evolve. However, organizations are also sensitive to issues related to time and costs involved in training employees. E-learning has emerged as a viable solution that deals with the need for continuous, on-demand training that is less expensive than the traditional in-classroom format, which requires employees to be away from the organizations days at a time (Luan & Serban, 2002).

The technologies supporting knowledge management are introduced above. The next section will review the details of technologies which have used in this project.

### **2.3.2 Technologies used in this project**

#### **2.3.2.1 Introduction**

There are various technologies that can be currently used for knowledge management. In this project, search methodologies, query expansion technologies, and concept map methodology have been used in a discussion forum system. This section will review these technologies in details.

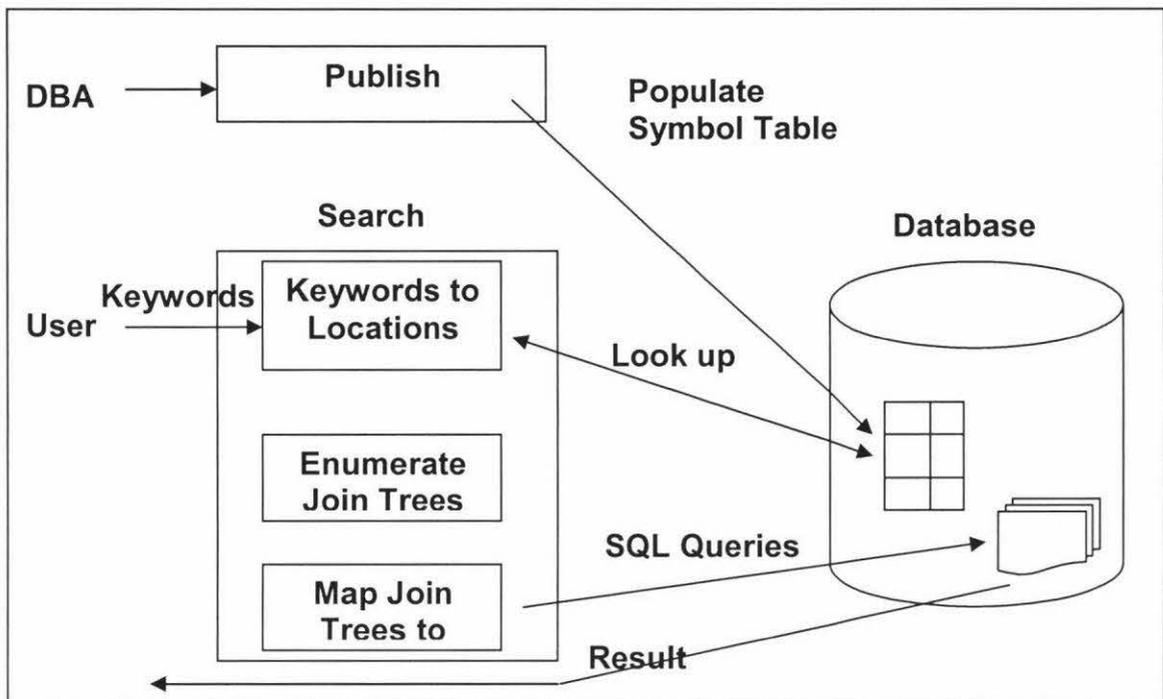
### **2.3.2.2 Search methodologies**

This section will review three kinds of search methods a) keyword search, b) concept-based search, and c) natural language processing. In this project, only keyword search and concept-based search have been used. Natural language processing is discussed as potential technology for future work.

#### **a) Keyword Search**

As Hassana, et al. (2004) concluded, adapting a keyword search to structured databases has already attracted the attention of several researchers, e.g., DBXplorer (Agrawal, Chaudhuri & Das, 2002), DataSpot (Dar, et al., 1998), DISCOVER (Hristidis & Papakonstantinou, 2002) and BBQ (Munroe & Papakonstantinou, 2002). The rest of this section describes an example of a system to explain how the keyword search method works. However, existing approaches mainly concentrate on searching a single database. They also have one thing in common; almost all of them use a graph to implement the basic database representation. The main limitation of this work is that all keywords must be contained in the same tuple.

For instance, Agrawal, Chaudhuri & Das (2002) presented DBXplorer, a system that enables a keyword search over SQL databases. Given a set of query keywords, their system returns all rows (either from single tables or by joining tables connected by foreign-key joins) so that each row contains all keywords. Figure 2-5 shows the architecture of the DBXplorer system.



**Figure 2-5: DBXplorer Architecture (Agrawal, Chaudhuri & Das, 2002)**

The system has two core components – publish and search. The publish component is a preprocessing step that prepares the database for a keyword search by building a symbol table that helps map a keyword to a database structure (tables, columns and/or rows). They build a compact symbol table that leverages the physical design of the database to enable a fast lookup.

Figure 2-5 shows the various steps of the search component. Given a set of query keywords, the system first uses the symbol table to determine the location within the database where the keywords occur. Next, the system uses this location information to enumerate join trees. A join tree is a sub-graph of the database schema graph where the tables together contain all the query keywords and the leaf table matches at least one of the user specified keywords. The join trees are mapped to SQL queries that are executed against the database to retrieve results. Thus, a keyword search is mapped to one or more SQL queries. Finally, the system also allows navigation capabilities through the database as a part of the search experience (Agrawal, Chaudhuri & Das, 2002).

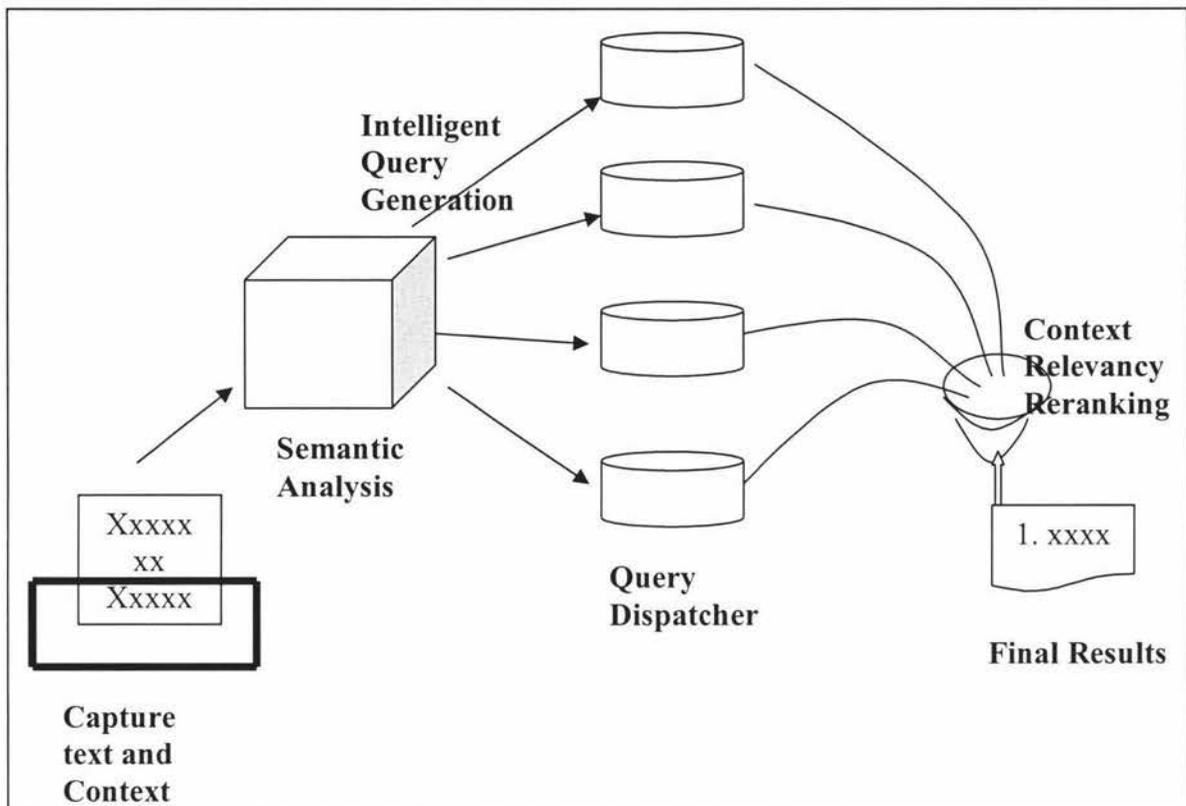
When a user wants to gather knowledge, the DBXplorer system and other systems that use a keyword search method can provide useful information in response to a

query. Despite many approaches by using keyword searching, some problems exist with the keyword search method such as information overloading and too much irrelevant information (Lager, 1996). Also, effective keyword searching takes a certain amount of experience and skills, so results will vary widely depending on the expertise of the searcher (Frase-Blunt, 2003). Hence there is another search method called concept-based search that can be used for information retrieval. .

### **b) Concept-based search**

Concept-based information retrieval is currently receiving widespread attention. Within legal domains the necessity of the transition from syntax based methods to semantic ones has been apparent for many years. The benefits of concept based searching for legal data have been advocated by many artificial intelligence (AI) researchers (Osborn & Sterling, 1999). Using the idea of concept-based search, for instance, a search engine can expand upon the keyword that a user may input. In this manner, users do not have to know the exact words to use to retrieve relevant document. And, instead of reinstating the search based on “confidence” or “weighting” the search engine automatically includes the like terms (Lager, 1996). Finkelstein, et al. (2002) developed a system called IntelliZap that performs a context search from documents on users’ computers. When viewing a document, the user marks a word or phrase (referred to as text) to be submitted to the IntelliZap service. The client application automatically captures the context surrounding the marked text, and submits both the text and the context to server-based processing algorithms. The IntelliZap system has four main components (Figure 2-6):

1. Context capturing (performed by client-side software).
2. Extracting keywords from the captured text and context.
3. High-level classification of the query to a small set of predefined domains.
4. Reranking the results obtained from different search engines.



**Figure 2-6: IntelliZap system: information and processing flow (from left to right) (Finkelstein, et al., 2002)**

This approach caters for the growing need of users to search directly for items of interest they encounter in the documents they view. Using the context surrounding the marked queries, the system enables even inexperienced web searchers to obtain satisfactory results. This is done by automatically generating augmented queries and selecting pertinent search engine sites to which the queries are targeted. The experimental results they have presented testify to the significant potential of the approach (Finkelstein et al., 2002). However, as Frase-Blunt (2002) said, “There is no technology out there that can get relevant searching results better than a human being.” There do exist some problems which are not solved properly with concept-based searching such as how to get more accurate and relevant searching results, and how to deal with the augmented queries in a disambiguated manner to include new terms. The natural language processing is another search method which can be used to solve some problems of the concept-based search method. The next section is a simple introduction to the natural language processing.

### **c) Natural Language Processing (NLP)**

Natural language processing is the act and science of greeting computers to understand natural language. It is a part of artificial intelligence discipline. Computers process language by exact match or by using keywords. NLP involves using a set of concepts to sort out the interrelationships of words (Lager, 1996). Details of NLP are beyond the scope of this project. NLP is identified as a potential future direction to improve the quality of search results in this system.

According to the identified problems with search methods, there is another technology called query expansion which can help users obtain more accurate search results in this system.

#### **2.3.2.3 Query Expansion**

Query expansion is a powerful assistant for search method technology. It can help to find additional search terms (Qiu, 1992). Once a search has been completed, it often needs to be enhanced or changed. For instance, a library patron who comes to the desk asks one question, but usually there is some other additional information needed. The purpose of the librarian is to elicit that actual request. The quest of the information scientist is to discover how the computer can assist in evoking that query and its modifications. Newer search engines provide the user with more control over the query, by adding some means to resubmit the search with any changes (Lager, 1996).

“In free-text retrieval systems, queries can often be improved by adding extra terms that appear in relevant documents but which were not included in the original query. This is called query expansion (Magennis & Rijsbergen, 1997).” Query expansion techniques aim to improve a user’s search by adding new query terms to an existing query. A standard method of performing query expansion is to use relevant information from the user – those documents a user has assessed as containing relevant information. The content of these relevant documents can be used to form a set of possible expansion terms, ranked by some measure that describes how useful the terms might be in attracting more relevant documents (Robertson, 1990). All or some of these expansion terms can be added to the query either by the user –

interactive query expansion (IQE) – or by the retrieval system – automatic query expansion (AQE) (Ruthven, 2003).

### **Automatic Query Expansion (AQE)**

The automatic query expansion or modification based on term co-occurrence data has been studied for nearly three decades. Qiu and Frei (1993) classified the various methods proposed in previous literatures into the following four groups:

- 1) *Simple use of co-occurrence data.*
- 2) *Use of document classification.*
- 3) *Use of syntactic context.*
- 4) *Use of relevance information.*

In addition to automatic query expansion, there is another query expansion technology called semi-automatic query expansion. In contrast to the fully automated methods, the user is involved in the selection of additional search terms during the semi-automatic expansion process. In other words, a list of candidate terms is computed by means of one of the methods mentioned above and presented to the user who makes the final decision (Qiu & Frei 1993). The next section will introduce another type of query expansion technology – Interactive Query Expansion.

### **Interactive Query Expansion (IQE)**

In query expansion, terms from a source such as relevance feedback are added to the query. This often improves retrieval effectiveness but results are variable across queries. In interactive query expansion (IQE), the automatically-derived terms are instead offered as suggestions to the searcher, who decides which to add (Magennis and Rijsbergen, 1997). There have been promising results in the use of IQE techniques in which the suggested terms come from lexical resources such as thesauri; these results have prompted a flurry of work in the area (see e.g. Chen, 1996 & Schatz, 1996), especially within the context of the Digital Libraries Initiative (Sebastiani,2001).

Comparing AQE with IQE, one argument in favor of AQE is that the system has access to more statistical information on the relative utility of expansion terms and can make a better selection of which terms to add to the user's query. The main

argument in favor of IQE is that interactive query expansion gives more control to the user. Since it is the user who decides the criteria for relevance in a search, the user should be able to make better decisions on which terms are likely to be useful (Koenemann & Belkin, 1996). A number of comparative user studies of automatic versus interactive query expansion have also come up with inconclusive findings regarding the relative merits of AQE versus IQE. For example, Koenemann and Belkin (1996) demonstrated that IQE can outperform AQE for specific tasks, whereas Beaulieu (1997) showed AQE as giving higher retrieval effectiveness in an operational environment. One reason for this discrepancy in findings is that the design of the interface, search tasks and experimental methodology can affect the uptake and effectiveness of query expansion techniques.

According to previous literature (Ruthven, 2003), one of the main claims for IQE is that searchers can be more adept than the system in identifying good expansion terms. This may be particularly true for certain types of search, e.g. Beaulieu (1996) showed that searchers preferred IQE when dealing with complex query statements. Subjects may also be better at targeting specific aspects of the search, i.e. focusing on parts of their information need.

In this project, IQE will be used with search methodologies to help users obtain more accurate information that they are looking for. The proposed system is supposed to be used in an educational area, and the users will be college students and teachers. Students do have experiences with their course, so they can be the final decision maker to expand their query in the proposed system. Details of IQE used in the proposed system will be introduced in the next chapter.

Concept maps are another methodology which will be used with the search methodology in this project. The next section will review the concept maps methodology.

#### **2.3.2.4 Concept Map Methodology**

Concept maps have been used for a long time in the world. The use of concept maps as a teaching strategy was first developed by J.D. Novak of Cornell University in the

early 1980's. As Novak (1991) defined, "concept maps are tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes of some type, and meaningful relationships between concepts or propositions, indicated by a connecting line between two concepts. Propositions are two or more concept labels linked by words which provide information on relationships or describing connections between concepts."

According to Lanzing (1997) concept mapping can be done for several purposes:

- To generate ideas (brain storming, etc.);
- To design a complex structure (long texts, hypermedia, large web sites, etc);
- To communicate complex ideas;
- To aid learning by explicitly integrating new and old knowledge;
- To assess understanding or diagnose misunderstanding.

One big advantage of using concept maps is that they provide a visual image of the concepts under study in a tangible form which can be focused on very easily. Students can easily understand the inter-relationships of concepts. Using concept maps can reinforce students' understanding and learning. This enables visualization of key concepts and summarizes their relationship. Therefore, concepts maps can help students understand a segment of a text, a laboratory activity, or a particular problem or question that one is trying to understand (Novak, 1991).

In this project, the concept map will be used in search functionality in the discussion forum system. They are aimed to help students understand the relationship between different topics. Each topic is one big concept such as "Java Programming" and "PHP Programming". For each topic, there is a keyword base which includes all of keywords (sub-concepts) about this topic (concept). Therefore, when students search a keyword by using search functionality in the proposed system, there is a keyword map available for students to understand the relationship between different topics. The details of the keyword map method used in this project will be discussed in the next chapter.

## **2.4 Summary**

This project proposes a new type of discussion forum system which is different from the traditional discussion forum system in terms of fulfilling the goal of knowledge management. The difference is that the new system is developed with various technologies to overcome the drawbacks of the traditional discussion forum system and add some new functions so that it can improve its effectiveness and efficiency for knowledge management.

In this project, the search methodology, the concept map methodology and the query expansion technology are used in the proposed discussion forum system to help users capture, retrieve, and share knowledge and useful information in the proposed discussion forum system. The system uses keyword search, concept-based search, interactive query expansion technology, and keyword map methodology. These technologies are used to overcome various drawbacks of the traditional discussion forum systems such as too many duplicate messages in the discussion forum, too many messages left in inappropriate places, and difficulties encountered in capturing useful and relevant information from the overwhelming amount of messages in the discussion forum. Moreover, new search functionality is developed in this proposed discussion forum system to help users obtain accurate search information faster. In the next chapter, the framework of the proposed system is introduced.

## Chapter 3 Prototype Methodology

### 3.1 Introduction

In this chapter, we describe the analysis and design of the prototype system in this project. Then various technologies are discussed that are used to develop the system. We apply the use case approach to gather the dynamic functional requirements of the system. A *use case* is a description of a complete course of events initiated by an actor and the interaction between the actor and the system (Jacobson, *et al.*, 1992). The *use case* approach requires creating *use case* diagrams, and creating a *use case* description for each use case-actor relationship identified in the use case diagrams. Based on the analysis of the system, we apply the activity diagram to design the system and the entity-relationship diagram to design the system database.

As discussed in the previous two chapters, the traditional discussion forum systems have some drawbacks, such as

- too many messages in an inappropriate place;
- too many duplicate messages; and
- difficulties in finding useful information.

While implementing the basic functionalities of a traditional discussion forum system, this thesis is aimed to solve these problems. Therefore the following functionalities are expected in the proposed prototype system:

- Users should be able to create a new topic folder rather than just leaving their messages in inappropriate places if they do not consider that their messages belong to any existing topic folders.
- The system should be able to automatically identify whether a message belongs to a particular topic folder or not in which the user is trying to post such a message.
- The system should automatically check the content of a message, and show all previously posted relevant messages to the user when the user attempts to post

a message. After viewing the previously posted messages, the user can decide whether they still want to post their message or not.

- The system should be able to provide a search functionality to help users in finding useful and relevant information in fast manner rather than trying to find information from overwhelming amounts of posted messages.

For any discussion forum systems used in the area of education, including the proposed system, there are three types of users: students, teachers and system administrators. In terms of use case approach, the users are called “actors” and what the actor does is called “*use cases*”. We will firstly describe the functionalities of each actor in our system and then give the details for each use case.

### **3.2 System Analysis**

There are three actors in the proposed system: students, teachers and system administrators. The responsibilities of teachers include creating topic folders at the beginning stage, responding to students’ queries, and managing users’ accounts and the discussion forum. Students can register themselves to become authorised users by themselves, create a new topic folder, and post their messages. The responsibility of the system administrators includes managing teachers’ accounts.

The system should include following functionalities so that students are able to

- register to be authorized users;
- log in
- create a new topic folder;
- post messages;
- search information; and
- log off.

The system should include following functionalities so that teachers are able to

- log in
- manage students’ accounts;
- manage existing topic folders;

- manage existing messages;
- create a new topic folder;
- confirm new topic folders;
- confirm new messages;
- change password; and
- log off.

The system should include following functionalities so that administrators are able to

- create teachers' account; and
- manage teachers' accounts.

### 3.3 The Use Case Diagram

The use cases diagram in Figure 3-1 gives an overall view of all functionalities in the proposed system. The details of each use case are described below.

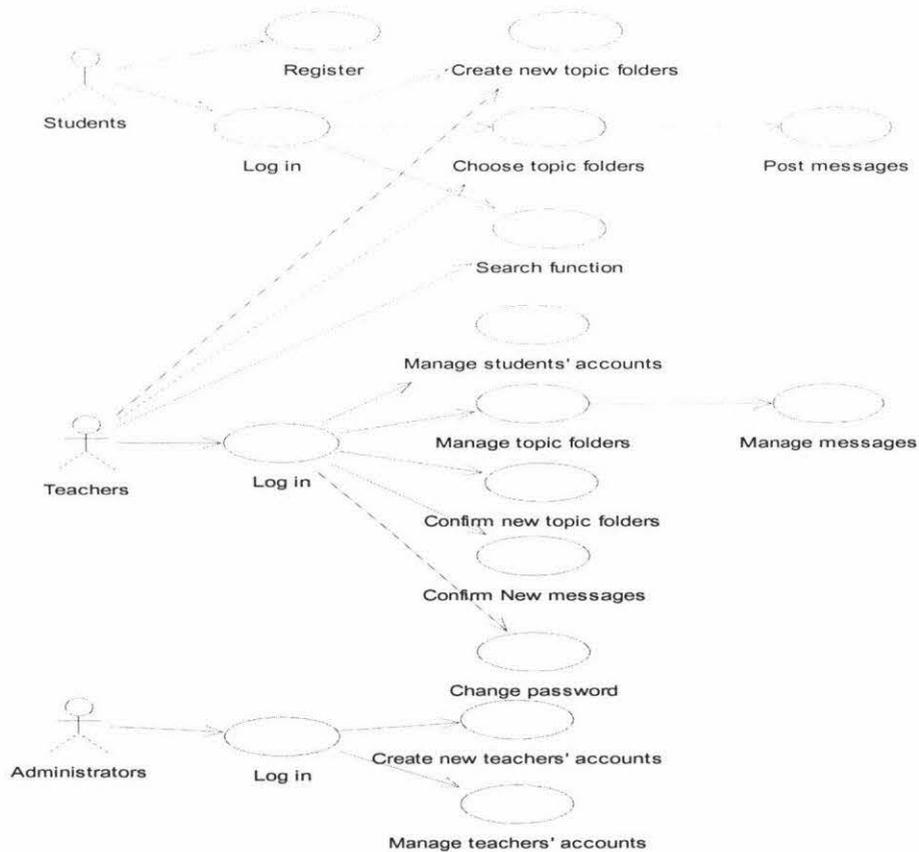


Figure 3-1: The User Case Diagram

***Use case: Log in***

Actors: Student, teacher or administrator

Goal: User authentication

Description: The user should provide the user name and password. The system will check whether there is such a user registered in the system. If not, the system will give user a warning message. The user name should be unique in the system. The system should check the uniqueness when users are registering.

***Use case: Register***

Actor: Student

Goal: User registration

Description: The user can register to become an authorized user in the system. Users need to input unique username and password. If the system checks that there is no such this username already in the system database, users will become the authorized user and then they can log into the system.

***Use case: Create a new topic folder***

Actors: Student, teacher or administrator

Goal: Create a new topic folder in the discussion forum

Description: Users can select the function of new topic folder creation if they consider that their messages do not belong to any existing topic folder. Then the system will provide a blank form for the details of the new topic folder. After inputting some necessary information, such as the topic title, the first message title, and content, and so on, and submitting the form, the information will be stored into the database. However if the user's type is "Student", they need to wait for the teacher's confirmation, and then their new topic folder will be available for all users. If the user type is "Teacher", the new topic folder will be available for all users immediately.

***Use case: Choose a topic folder***

Actors: Student, teacher or administrator

Goal: The user chooses a topic folder to post messages

Description: After logging into the system, users can choose an available topic folder and enter the topic folder to view previously posted messages, and post their own messages.

***Use case: Post messages***

Actors: Student, teacher or administrator

Goal: Add messages into the discussion forum

Description: After choosing a particular topic folder, users can read all currently available messages of the particular topic folder, and leave their own messages in that topic folder.

***Use case: Search function***

Actors: Student, teacher or administrator

Goal: Search messages in the discussion forum

Description: Users can use search function to find previously posted useful messages by searching a keyword.

***Use case: Manage Students' account***

Actor: Teacher

Goal: Manage students' accounts.

Description: After logging into the system, teachers can manage students' accounts, for example, deleting a student' account.

***Use case: Manage topic folders***

Actor: Teacher

Goal: Manage topic folders

Description: After logging into in the system, teachers can manage all existing topic folders, for example, deleting an existing topic folder.

***Use case: Manage messages***

Actor: Teacher

Goal: Manage previously posted messages in each topic folder

Description: After logging into the system, teachers can manage previously left messages in each topic folder, for example, deleting an existing message in a topic folder.

***Use case: Confirm new topic folders***

Actor: Teacher

Goal: Confirm new topic folders which are created by students

Description: After logging into the system, teachers can confirm or delete new topic folders which are created by student. After teachers' conformation, topic folders will be available for students.

***Use case: Confirm new messages***

Actor: Teacher

Goal: Confirm new messages posted by students

Description: After logging into the system, teachers can confirm or delete new messages which are posted by students that do not belong to the particular topic folders in which students want to post them. After teachers' confirmation, those new messages in those topic folders will be available for all users.

***Use case: Change password***

Actor: Teacher

Goal: Change password

Description: After logging into the system, teachers can change the old password to new password.

***Use case: Create a new teacher's account***

Actor: Administrator

Goal: Create new teachers' accounts

Description: After logging into the system, the system administrator can create a new teacher's accounts.

***Use case: Manage a new teacher's account***

Actor: Administrator

Goal: Manage teachers' account

Description: After logging into the system, system administrators can manage teachers' accounts, for example deleting an existing teacher's account.

**3.4 Three-tier system architecture**

The proposed system in this project is implemented with a *three-tier, client-server* architecture. The *client* side contains the presentation logic, including simple control and user input validation. This application is also known as a thin *client*. The middle tier is also known as the application server, which provides the business process logic and the data access. The data server provides the business data. The Figure 3-2 shows the three tier architecture of the system.

There are various advantages of the three-tier architecture (Hirschfeld, 1996):

- It is easier to modify or replace any tier without affecting the other tiers.
- Separating the application and database functionality means better load balancing.
- Adequate security policies can be enforced within the server tiers without hindering the clients.

### **3.4.1 Client tier**

The client tier is the user interface running on a web browser on the student or teacher computer. The browser is responsible for handling the presentation of discussion forum. Most of the interfaces use HTML frames that are generated by PHP engine in the middle tier. For the maintenance of the discussion forum, after teachers and the system administrators log into the system, they can administer and manage the system. Students can log into the system and leave messages on the web pages.

### **3.4.2 Middle tier**

The middle tier that resides on the server side provides the web service and data storage service. It is responsible for receiving client requests, retrieving information from database if needed, processing the data contained in the requests, and generating a client response. The middle tier requires the database to store the necessary data. The web server receives the requests from the client html form and passes them to the PHP engine. The PHP engine interprets these requests, invokes functions in the server side web pages and sends the responses to the web server. The web server then produces presentations back to the client.

### 3.4.3 Data management tier

The Database Management System (DBMS) stores the data required by the middle tier. It also resides on the server side and is composed of a back-end database server – MySQL (one application software of DBMS). By using a database connection, the PHP application components can access the database by using the SQL call-level interface.

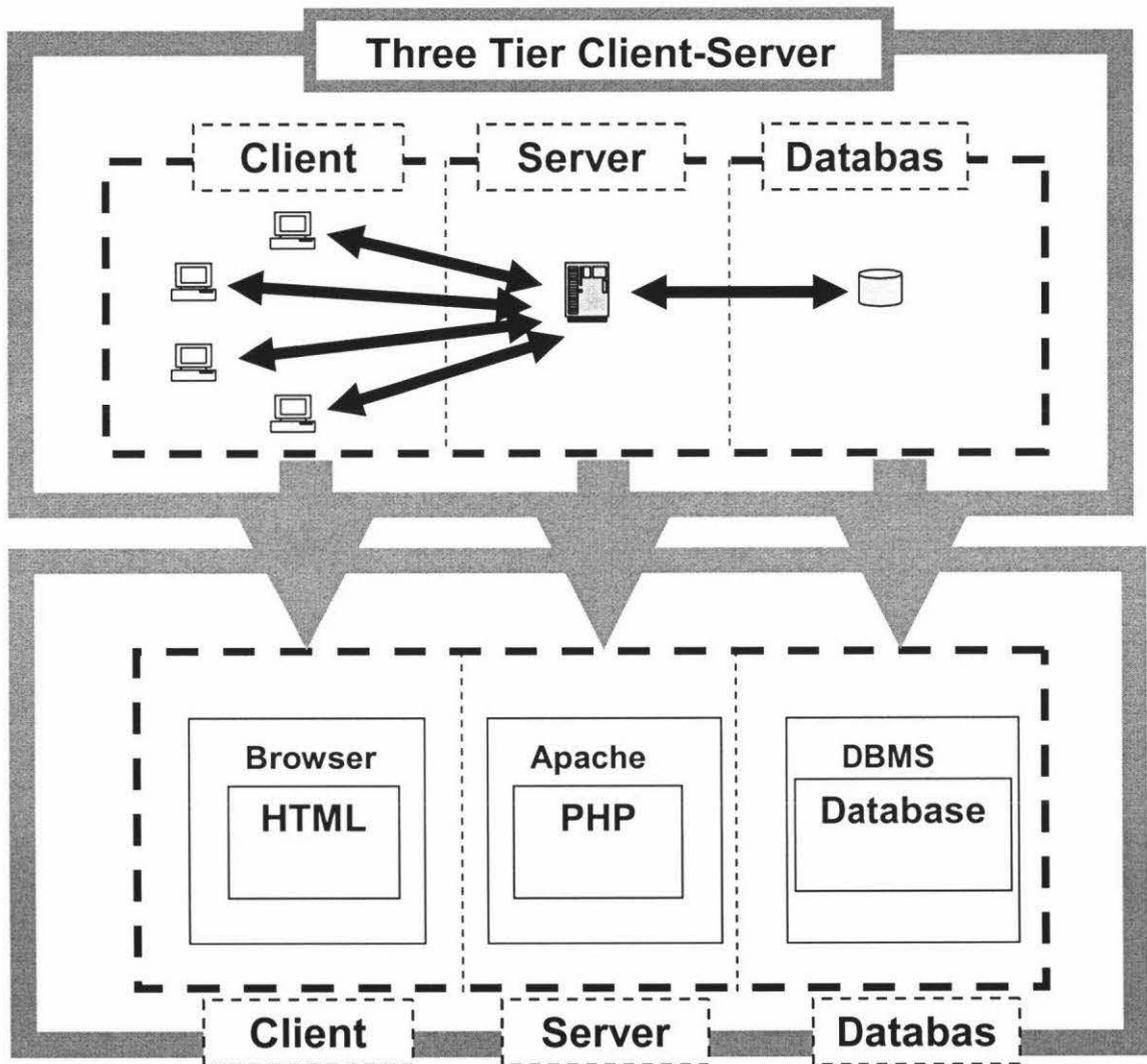


Figure 3-2 Three Tier Client – Server Diagram

### 3.5 The design of the overall system

Based on the system described above, this section presents the proposed system design methodology. The high-level design is first described, followed by the detailed

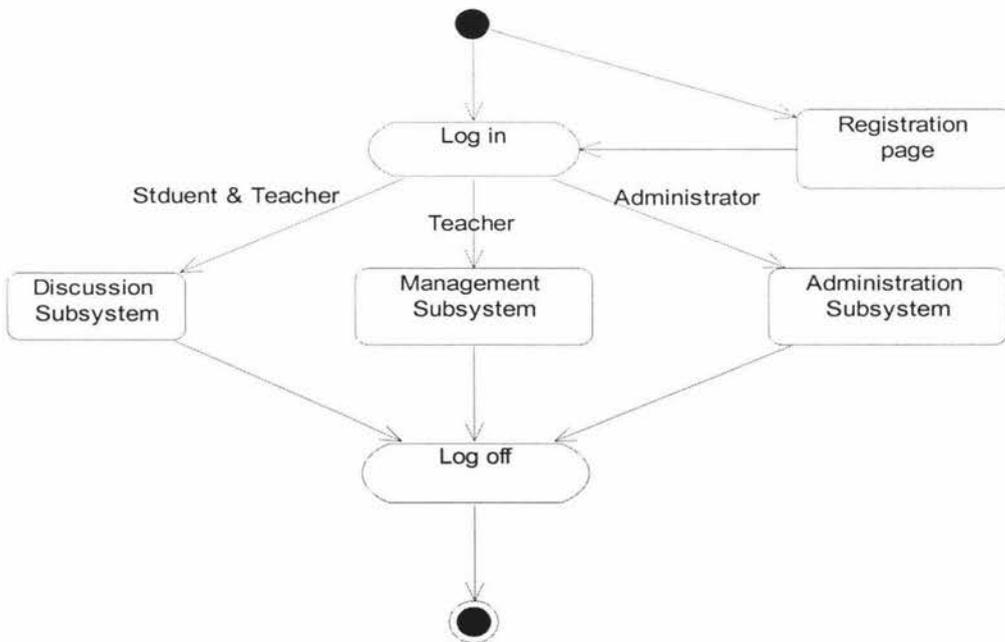
design. According to the functionality, the whole system is divided into three subsystems: discussion subsystem, management subsystem, and administration subsystem. The design of each subsystem is described in details.

Bennett et al. (1999) pointed out that there are two levels of the system design:

- Architecture Design
- Detailed Design

### 3.5.1 Architecture of the System

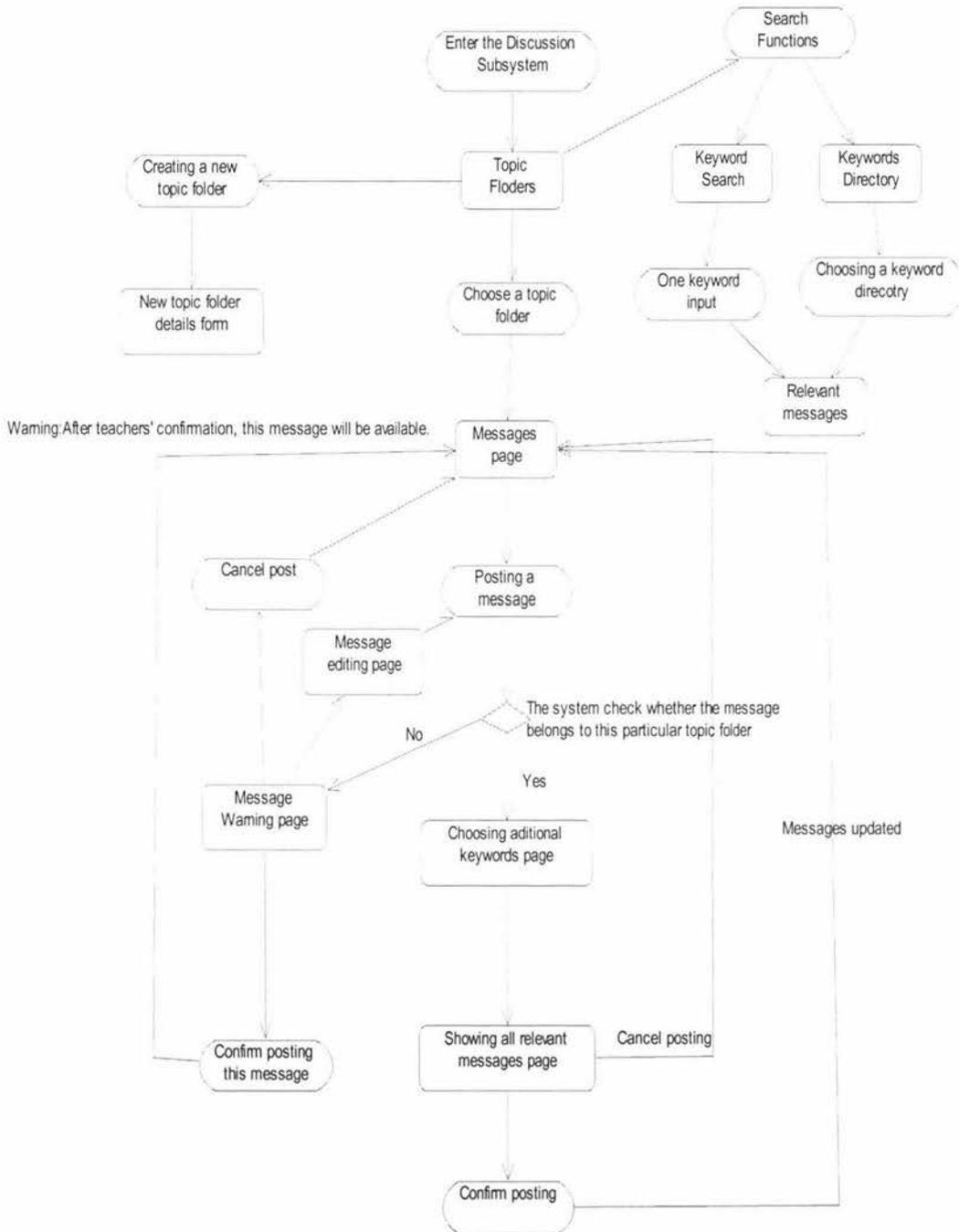
The system includes three subsystems: discussion subsystem, management subsystem, and administration subsystem. The activity diagram used for designing the workflow process of the overall system is shown in Figure 3-3. After logging into the system, students, teachers and the system administrators can enter into the discussion subsystem. Only teachers can enter into the management subsystem. Only the system administrators can enter into the administration subsystem.



**Figure 3-3: The activity diagram for the overall system**

#### 3.5.1.1 Discussion Subsystem

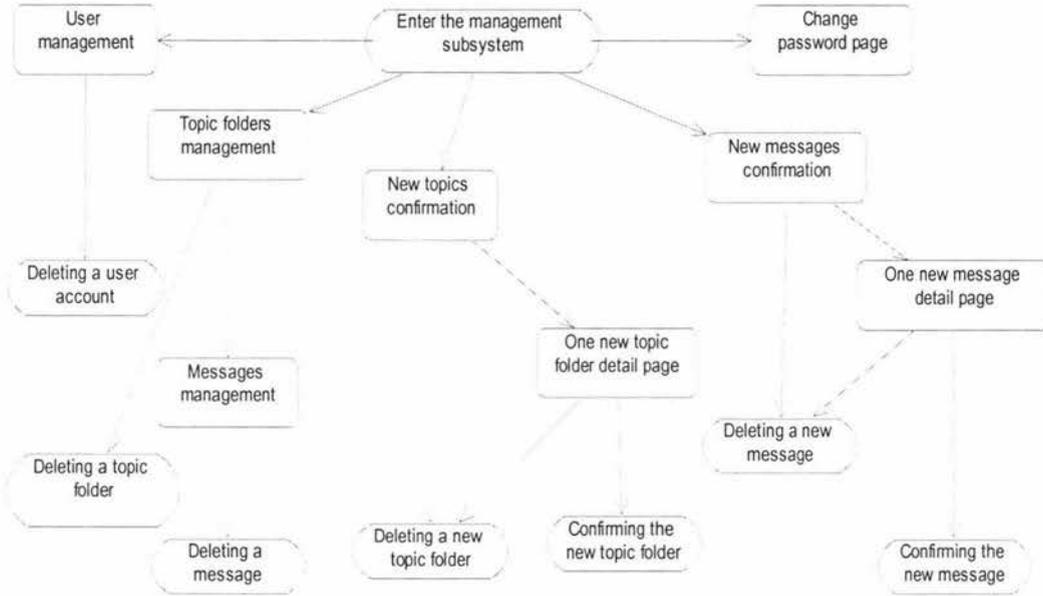
After logging into the system, students, teachers and the system administrators can enter the discussion subsystem to choose topic folders and leave messages. For the discussion subsystem, Figure 3-4 displays the part of the overall system activity diagram that describes the architecture of the discussion subsystem.



**Figure 3-4: The architecture of the Discussion Subsystem**

### 3.5.1.2 Management Subsystem

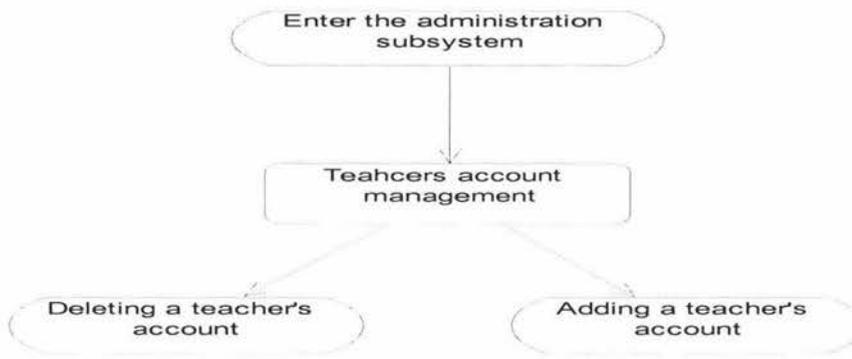
After logging into the system, only teachers can enter into the management subsystem. This subsystem is for teachers to manage students' accounts and the discussion forum. Figure 3-5 displays the part of the overall system's activity diagram that describes the architecture of the management subsystem.



**Figure 3-5: The architecture of the management subsystem**

### 3.5.1.3 Administration Subsystem

After logging into the system, only the system administrators can enter into the administration subsystem. This subsystem is for the system administrators to manage teachers' accounts. Figure 3-6 displays the part of the overall system's activity diagram that describes the architecture of the administration subsystem.



**Figure 3-6: The architecture of the administration subsystem**

### 3.5.2 Details Design of the Overall System

#### 3.5.2.1 Introduction

Based on the architecture the overall system above, this section presents the detailed system design and database design. According to the functionalities of the proposed system, the overall system is divided into three subsystems:

- Discussion subsystem,
- Management subsystem, and
- Administration subsystem.

And in this system, there are three kinds of databases:

- User information database,
- Knowledge & information database, and
- Keyword database.

The detailed design for each subsystem and each kind of database is described in the next following sections.

#### 3.5.2.2 Design of log in and log off functionality

The login interface (Figure 3-7) is used to identify whether the user is a registered user. There is a link on the login page for new users to register to become authorized users. After registration, the user should enter username and password to log into the

system. If there is something wrong with login, a warning message will be displayed in the login interface to inform the user about failed login. If the user ID and password is confirmed, the system automatically identifies the users' types according to the username and takes them to the option page. For students, there is one option - discussion subsystem - to choose. For teachers, there are two options to choose: one is the discussion subsystem and another is the management subsystem. For administrators, there are two options: administration subsystem and discussion subsystem, to choose. If the users would like to log off, they may just click the log off link in any interface and the system will immediately go to the initial login interface.

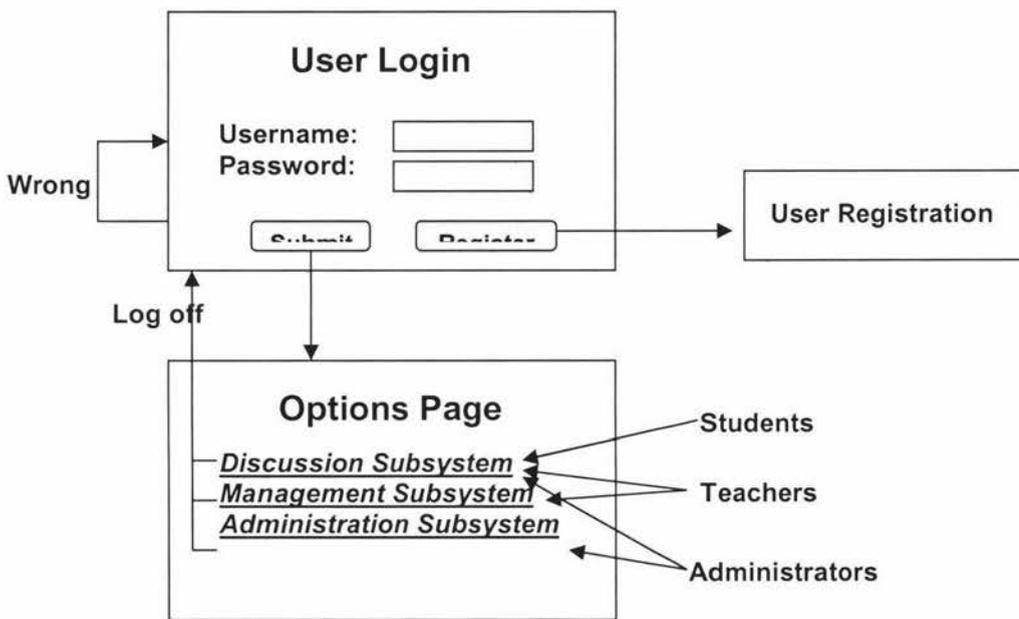


Figure 3-7: Interface for log in and log off functionality

### 3.5.2.3 User Information Database Design

The user information database is used to store all users' information. It includes one entity – *user* (Table 3-1). For the attribute of Role, it includes three categories:

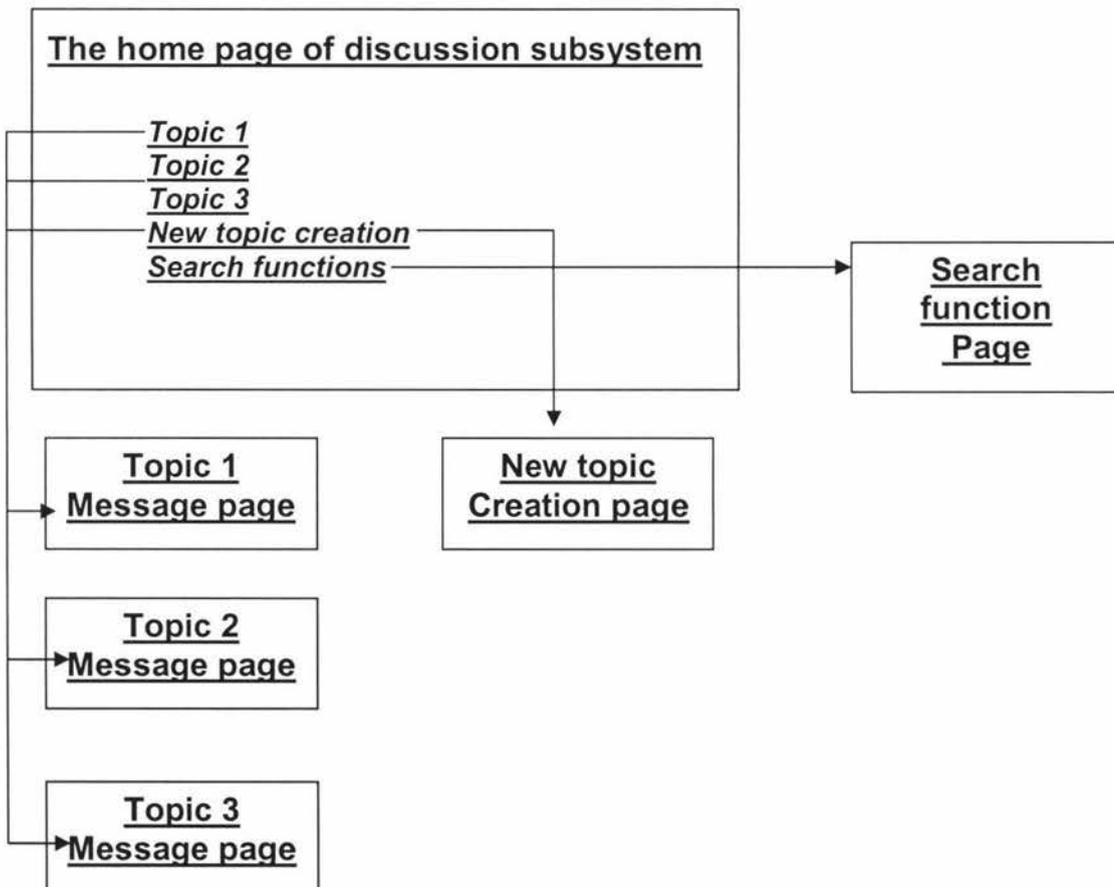
- Student: students can enter only into discussion subsystem.
- Teacher: teachers can enter into discussion subsystem and management subsystem.
- Administrator. Administrators can enter into discussion subsystem and administration subsystem.

**Table 3-1 Entities and Attributes of User Information Database**

Entity	Attributes	Data Type	Constraint	Null Value
System_user	Username	Int (20)	Primary key	No
	Password	Int(8)		No
	Role	Varchar(8)		No

**3.5.2.3 Discussion Subsystem Design**

After logging into the system, all users can enter into the discussion subsystem. There is a home page of the discussion subsystem (Figure 3-8) allows users to go to various topic folders, the new topic folder creation page or the search function page.



**Figure 3-8: Interface design for the home page of the discussion subsystem**

In each topic message page (Figure 3-9), users can view all previous posted messages about that particular topic and they can post their own new message by using the “adding a new message” facility. In the “adding a new message” facility, users need

to input the “title” and “content” of their new message. Moreover, users need to pick up some important words from the content of their new message as the keywords and input these keywords into the “keywords” field. After users submit their new message, the system automatically checks the keywords of the new message to decide on whether this new message belongs to this particular topic folder or not.

### Topic Message Page

**Previously posted messages**

1.....

2.....

3.....

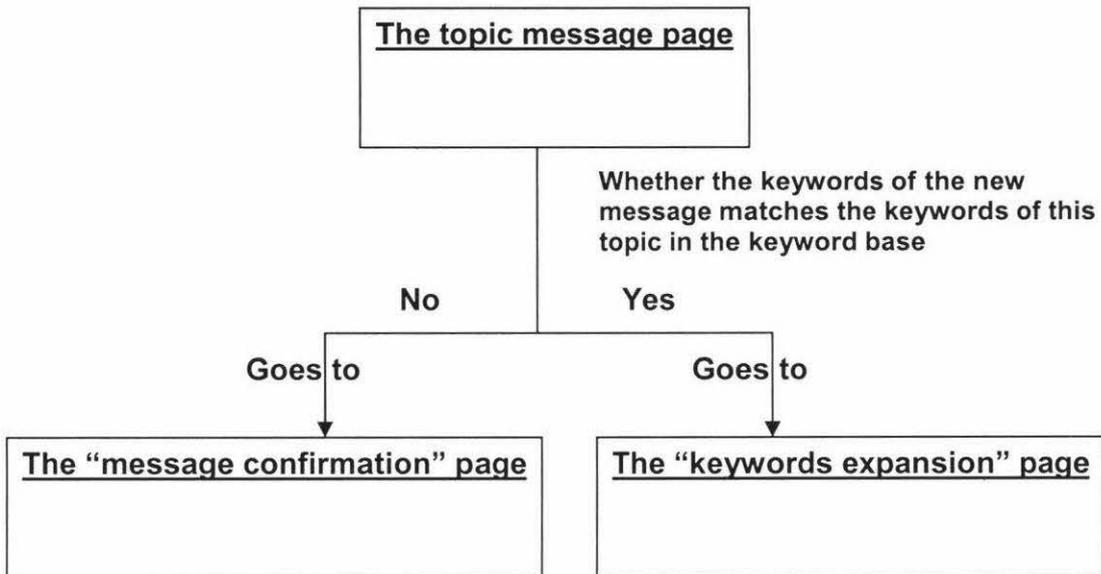
**Adding new message facility**

Title.....

Content.....

Keywords.....

**Figure 3-9: Interface design for the topic message page of the discussion subsystem**



**Figure 3-10: The system process checks the keywords of the new message**

**The system process checks the keywords of the new message**

One of the databases in the proposed system is the keyword base. In the keyword base, a large number of keywords exist for each topic. Once the users submit their new message, if one of the keywords of the new message which users input matches the keyword base for that particular topic, the new message is considered to belong to that particular folder. Then the users are forwarded to the “Keywords Expansion” page (Figure 3-11). Otherwise, if the system considers that the message does not belong to that particular topic folder, the system takes the users to the “Message Confirmation” page (Figure 3-12).

The whole process is shown in Figure 3.10.

**“Keywords Expansion” Page**

Keyword 1    Keyword 2    Keyword 3

**New message details:**

**Title: XXXXXXXXX**

**Content: XXXXXXXXX**

**Keywords: XXXXXXXXXXXXXXXX**

Figure 3-11: The interface design for the “keywords expansion” page

**“Message Confirmation” Page**

**New message details:**

**Title: XXXXXXXXX**

**Content: XXXXXXXXX**

**Keywords: XXXXXXXXXXXXXXXX**

Figure 3-12: The interface design for the “message confirmation” page

***“Keywords Expansion” Functionality***

In the “keywords expansion” page (Figure 3-11), the concept search methodology and the interactive query expansion technology are used to help users to view more words related to their new message. The users can then add these additional words in the keywords list of their new message. These additional words are those words from the content of the new message that users did not initially identify in the keywords list. At this stage, users can view what the additional words are and have a choice to add some or all of the suggested additional words to the keywords list. Then they can confirm the posting of their new message. Then the system proceeds to the “Relevant Messages” page (Figure 3-13).

**Concept-based Search Methodology and Interactive Query Expansion**

The users of the discussion subsystem will be students and teachers and they do have enough experiences with discussion forum systems. Therefore, they have a clear understanding of what they want to post and what they want to know in the discussion forum. For this reason, users can be considered to have the ability to make a final decision on which words may be the keywords of their new message. Therefore, the interactive query expansion technology will be adopted in this system rather than the automatically query expansion technology. Each topic folder has a keyword base which includes a large number of keywords about that particular topic. According to the concept-based search methodology, each topic can be considered as a sub-concept, so each sub-concept has a topic keyword base. When a user posts a new message in a particular topic folder, the system will use the concept search method to search each word of the new message in this particular topic keyword base. If the system finds some words of the new message which users did not input as the keywords but they do exist in particular topic keyword base, the system will show all of these additional words for users to select. This is the concept-based search method and the interactive query expansion technology used in this discussion subsystem. Once users have added additional words as the keywords of their new message, they can submit their new message.

#### *“Relevant Messages” Functionality*



**Figure 3-13: The interface design for the “message confirmation” page**

Once users have added some additional relevant words as the additional keywords of the new message and have confirmed the new message, the web page goes to the “relevant messages” page (Figure 3-14). In the “relevant messages” page, the keyword search method is used for users to view the previously posted relevant messages that are relevant to the new message. For this purpose, the system searches all previously posted messages which are stored in the knowledge and information database by each keyword of the message. Then the system shows all of the previously posted relevant messages to users in the “relevant messages” page. The relevant messages should have at least one same keyword with the new message. Whiling viewing all of these relevant messages, users have two choices:

- *To confirm posting the new message:* After users click the “Confirm” button, the new message is added into the particular topic folder and stored into the knowledge and information database. It is then available immediately to all users. Then the web page goes back to the particular topic message page which is already updated by addition of the new message.
- *To cancel posting the new message:* If users do not want to post their new message after they have viewed previously posted messages, they can click the “Cancel” button, and then the web page will go back to the particular topic message page.

### ***“Message Confirmation” Functionality***

In the “message confirmation” page (Figure 3-12), the system gives users a notice that their new message may not belong to this particular topic folder and that they have three choices:

- *To confirm posting the new message:* If users still want to post their new message which the system considers as not belonging to this particular topic folder, they can click the “Confirm” button. The system will then pop up a notice window to tell users that they have to wait for teachers’ confirmation before their new message could be available to all users. All details of the new messages will be stored in the database waiting for teachers’ confirmation. The system will then take the user back to this particular topic message page.

- *To cancel posting the new message:* If users want to cancel posting the message, they can click the “Cancel” button and the web page will go back to this particular topic message page.
- *To edit the new message:* If users want to edit their message, they can click the “Edit” button and the system will go to the message editing page. Users can edit their message including the title, content and keywords fields here and then post the message again. Then this message will go through the process of the system which checks the keywords of the new messages again.

### ***“New Topic Creation” Functionality***

If users are not satisfied with all existing topics, they can go to the “new topic creation” page (Figure 3-14) to create a new topic by themselves. After they have entered the “new topic creation” functionality, they need to input the “title” of the new topic folder and the details of the first new message in this new topic folder, including “title”, “content” and “keywords”. The difference of this functionality between the proposed system and other traditional discussion forum systems is that in this system, users need to wait for teachers’ confirmation for their new topic available for all users. Therefore, after users submit all details of the new topic folder and the first new message, the system will pop up a notice indicating users have to wait for teachers’ confirmation and then their new topic folder and the first new message will be available to all users. This method is adopted to prevent creation of any unnecessary or duplicate topic folders in the discussion forum.

## The “New Topic Creation” Page

***New topic details:***

**Topic title: xxxxx**

**Message title: xxxxxx**

**Message content: xxxxxxxxxxxx**

**Message keywords: xxx xxx xxx**

**Submit**

**Cancel**

**Figure 3-14: The interface design for the “new topic creation” page**

### **3.5.2.4 Knowledge and information database design**

A knowledge and information database is used to store all information about the discussion between students and teachers. It is based on following assumptions:

- Each discussion forum may have many topic folders;
- Each topic folder may have many messages;
- Each message may have many keywords;
- Each user may post many messages;
- Each user may create many new topic folders but each new folder will require confirmation by teachers;
- Each new topic folder has at least one new message (required at the time of new topic folder creation); and
- Each user in the discussion subsystem may have two roles: teacher or student.

Based on above requirements, the knowledge and information database is designed by the entity-relationship model (Figure 3-15). The entities and their attributes of knowledge and information database are defined in Table 3-2.

**Entity: User**

Each user has a unique username which is the primary key. There are two attributes of the role,

- Teachers; and
- Students.

#### **Entity: Message**

Each message has an ID number as the primary key, and the topic ID number and user name are the foreign keys. Therefore, one particular topic folder may have one or more messages but one particular message must belong to just one particular topic folder and one user.

#### **Entity: Wrong Message**

Each wrong message has a wrong message ID as the primary keys and foreign keys and the wrong message type is the primary key as well. The message which the system considers as not belonging to a particular topic folder is stored in this entity.

#### **Entity: Topic**

Each topic has a unique topic ID number as the primary key. It includes following attributes: title and author of the topic folder and the date and time of the creation of the topic folder.

#### **Entity: New Topic**

If users create a new topic folder, all information of the new topic folder is stored in this entity. The topic ID is the primary key and foreign key, and the new topic type is the primary key.

#### **Entity: New Message**

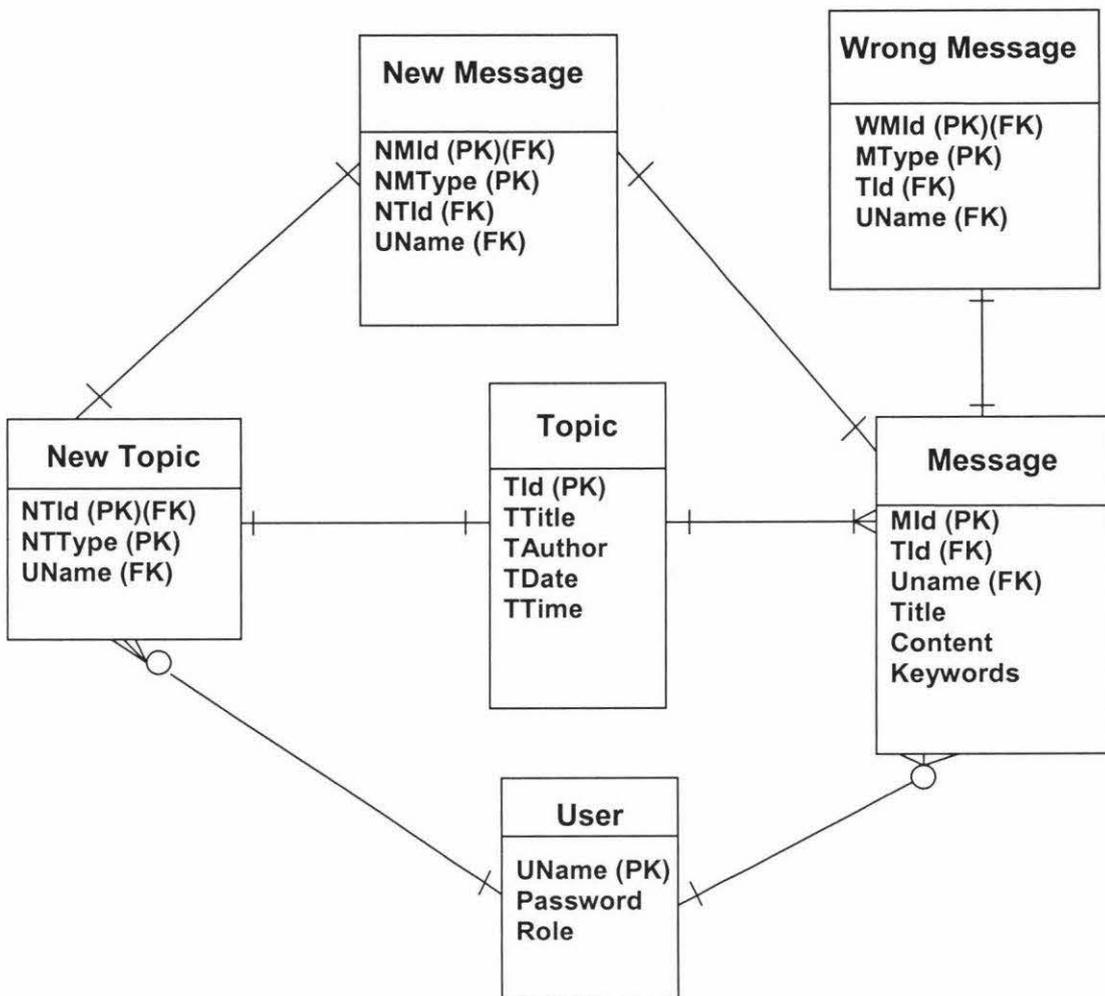
If users create a new topic, they also need to submit the details of first message details in this new topic folder. All information of this new message is stored in this entity. The message ID number is the primary key and foreign key, and the new message type is the primary key.

**Table 3-2 Entities and Attributes of knowledge & Information Database**

Entity	Attributes	Data Type	Constraint	Null Value
User	UName	Varchar (20)	Primary Key	No
	Password	Int (8)		No
	Role	Varchar (8)		No
Message	MId	Int (8)	Primary Key	No
	TId	Int (4)	Foreign Key	No
	UName	Varchar (20)	Foreign Key	No
	Title	Varchar (200)		No
	Content	Text		No
	Keywords	Varchar (200)		No
Wrong Message	WMId	Int (8)	PK*, FK**	No
	TID	Int (4)	Foreign Key	No
	MType	Varchar (8)	Primary Key	No
	UName	Varchar (20)	Foreign Key	No
Topic	TId	Int (4)	Primary key	No
	TTitle	Varchar (200)		No
	TAuthor	Varchar (20)		No
	TDate	Date		No
	TTime	Time		No
New Topic	TID	Int (4)	PK, FK	No
	NTType	Varchar (8)	Primary Key	No
	UName	Varchar (20)	Foreign Key	No
New Message	NMID	Int (8)	PK, FK	No
	NTID	Int (4)	Foreign Key	No
	NMType	Varchar (8)	Primary Key	No
	UName	Varchar (20)	Foreign Key	No

\* PK: Primary Key;

\*\* FK: Foreign Key.



**Figure 3-15: The Entity-Relationship Diagram for Knowledge & Information Database Design**

### 3.5.2.5 The keyword database design

The keyword database is used to store all keywords of each topic in the discussion forum system. It is based on the following assumptions:

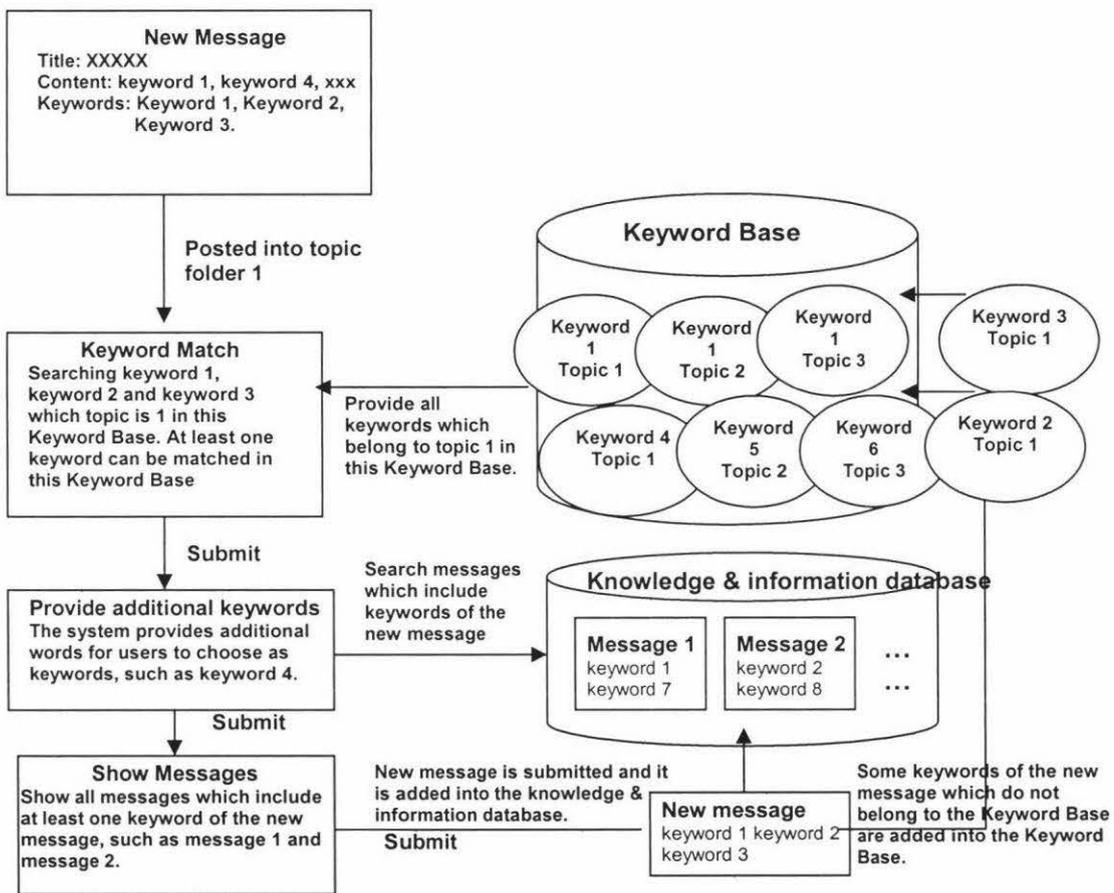
- Each topic folder has many keywords;
- Each keyword may belong to more than one topic folder; and
- The keyword base is automatically growing larger by keywords of newly posted messages.

Based on the above requirements, the keyword base is designed. The process of the keywords searching in the keyword base and knowledge and information database is

shown in Figure 3-16. The entities and their attributes of keyword database are defined in Table 3-3.

**Table 3-3 Entities and Attributes of Keyword Database**

Entity	Attributes	Data Type	Constraint	Null Value
Keywords	KId	Int (8)	Primary key	No
	Content	Varchar (100)		No
	TID	Int(4)		No



**Figure 3-16: The process of the keywords searched in the keyword base and knowledge database**

### 3.5.2.6 Search functionality design

The search methodology is used for users to retrieve useful information within a faster time in the system. If users want to capture useful knowledge or information that is already in the discussion forum, they do not need to try to read all posted messages or leave a query in the discussion forum. They can just use the search function to obtain all useful knowledge or information by the fastest method. There are two types of search functions developed in this proposed system: Keyword Search and Keyword Directory.

### **The Keyword Search Function**

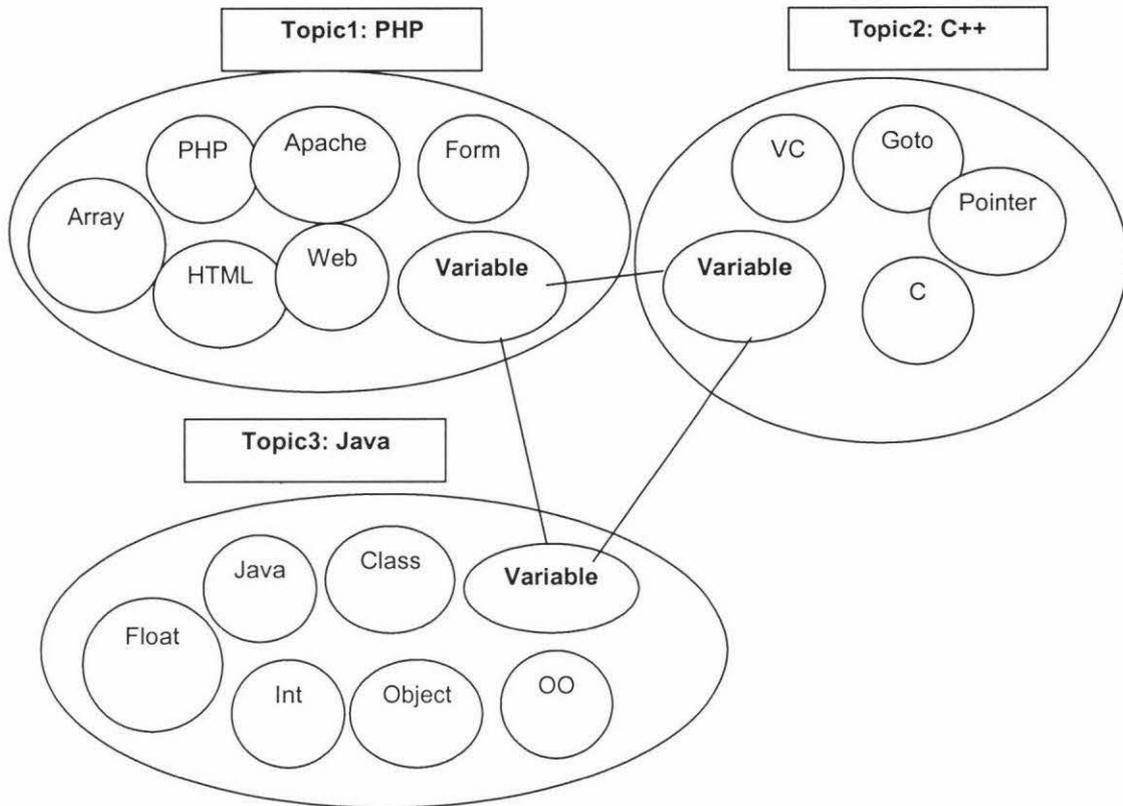
There is a keyword search engine for users to find useful messages that exist in this discussion forum. The keyword search method is used in this search engine. After users submit a word to search, the system will show all previously posted relevant messages where the keywords of all these shown messages include the searched word. Meanwhile there is a keyword map available to help users understand the relationship between different topic folders.

### **The Keyword Map**

The concept map method will be used in the keyword map functionality of the proposed discussion forum system. When users search a word by the keyword search function, they will obtain all relevant messages and a keyword map if the searched word does exist in the discussion forum as one of the keywords of some messages. Because each topic has a keyword base which includes a large number of keywords, if the searched word belongs to one or more of the topic keyword bases, the keyword map will show all these topic keyword bases and all keywords in these keyword bases. The searched word that may occur in different topic keyword bases will be connected in a relationship among these different topic keyword bases. Figure 3-17 shows an example where the searched word is “Variable” and there are three topic keyword bases that include the keyword “Variable”, so the keyword map shows these three topic keyword bases and all keywords where the common word “Variable” is connected in the relationship among these three different topic keyword bases.

The keyword map shows the relationship among different topics. Therefore, the searched common keyword will be the relationship to connect different topic folders. Users can view some relevant keywords which are in the same topic keyword base as

the searched word in the keyword map, and they may use these relevant keywords to search more relevant useful messages of this discussion forum.



**Figure 3-17: The example diagram of the keyword map**

### 3.5.2.3 Management subsystem design

Management subsystem is one of the subsystems of the proposed discussion forum system. Only teachers can enter the management subsystem to manage student accounts and the discussion forum. After entering the management subsystem, there are four options for users (See Figure 3-18).

## **The Homepage of The Management Subsystem**

### **Select Options**

***Enter the User Administration***

***Enter the Topic Administration***

***Enter the New Topics Confirmation***

***Enter the New Messages Confirmation***

**Figure 3-18: The homepage of the management subsystem**

#### ***“User Administration” Functionality***

After teachers enter the “user administration” page, there is a table that shows all information about student accounts. Teachers can view and manage all student accounts, for example, deleting an exiting student’s account.

#### ***“Topic Administration” Functionality***

After teachers enter into the “topic administration” page, they can view all information about existing topic folders in the discussion forum and manage them, for example, deleting an existing topic folder. Meanwhile teachers can enter each topic folder to view all existing messages in this particular topic folder and manage them, for example, deleting an existing message.

#### ***“New Topic Confirmation” Functionality***

If students create some new topic folders, the details of the new topic folders and the first new messages are shown in the “new topic confirmation” page. Teachers can confirm these new topic folders and first new messages or delete them here. If teachers confirm the new topic folder and the first new message, they become available to all users in the discussion forum.

#### ***“New Messages Confirmation” Functionality***

When a student posts a new message into a particular topic folder and the system identifies that message as not belong to that particular topic folder, that new messages

is shown in the “new message confirmation” page. Teachers can confirm such messages so that they become available to all users in the discussion forum or delete them here.

### **3.5.2.5 Administration Subsystem Design**

The administration subsystem is for the system administrator to manage teacher accounts. All information of teachers’ accounts is shown in this subsystem and the system administrator can create a new teacher’s account, or delete an existing teacher’s account here.

## **3.6 Techniques Specification**

Based on a defined knowledge management model and the architecture of the web-based discussion forum system, the prototype system is developed to prove how various web communication technologies are used in conjunction with a traditional discussion forum system to enhance the knowledge capturing, knowledge sharing and knowledge retrieving.

There are many types of techniques which can be used to implement this prototype system, such as SAP, JSP and Oracle for server side, and JavaScript, Java Applet and so on for client side. In the end, PHP was chosen for server side and MySQL for database development, because PHP is a widely used general-purpose scripting language that is especially suited for dynamic web pages and can be embedded directly in the web pages. Additionally, the PHP environment software is free for everybody. MySQL is a popular free SQL server. Both of them can be easily found and obtained from their official web site. They run in a server environment.

### **3.6.1 PHP Characteristics**

There are many programming languages available which can be used at the server side, but PHP is one of the easiest tools for users to build the dynamic web pages. PHP can fulfil most of the major all functional requirements of the server side.

### **3.6.1.1 What is PHP?**

Conception of PHP: Hypertext Preprocessor, an open source, server-side, HTML embedded scripting language used to create dynamic Web pages. In an HTML document, PHP script (similar syntax to that of Perl or C) is enclosed within special PHP tags. A dynamic Web page is a page that interacts with the user, so that each user visiting the page sees customized information. PHP is freely available and used primarily on Linux (UNIX) Web servers, and as an alternative to Microsoft's Active Server Pages (ASP) technology (<http://www.php.net/>)

### **3.6.1.2 Why Chose PHP in This Project?**

It is simply a matter of “the right tool for the right job”. The existing tools and language were not ideal for the specific task of embedding code in markup. It becomes more ideal to develop a server-side scripting language for developing dynamic Web-based sites and applications (eSysDesign, 2002).

PHP was created with these particular needs in mind. Moreover, PHP code was developed for embedment within HTML. In doing so, it was hoped that benefits such as quicker response time, improved security, and transparency to the end user would be achieved. PHP is an established server-side scripting language for creating dynamic web pages. As a language that has been designed expressly for the web, it brings many features that commercial entities are looking for: exceptionally short learning curve, quick development time, and very high performance. According to the project content and the functions of PHP, at the mean time, the main application of the prototype is using web technology, so the PHP is most suitable for implementing the web-based discussion forum system rather than other methodologies.

### **3.6.2 MySql Characteristics**

Modern web sites seem to be relying on more and more database support. Databases can store all information and data for the web site or the system. Therefore the database is an important part of any information systems. The proposed web-based discussion forum system needs to choose a suitable database as well. The Structured

Query Language (SQL) is a very popular database language, and its standardization makes it quite easy to store, update and access data. A very popular SQL server is called MySQL which is free for every one including organizations and individuals.

### **3.6.2.1 What is MySQL?**

MySQL is a SQL database management system. It is a relational database management system, which means it stores data in separate tables rather than putting all the data in one big area. This adds flexibility as well as speed. The SQL part of MySQL stands for "Structured Query Language," which is the most common language used to access databases. The MySQL database server is the most popular open source database in the world. It is extremely fast and easy to customize, due to its architecture. Extensive reuse of code within the software, along with a minimalist approach to producing features with lots of functionality, gives MySQL unmatched speed, compactness, stability, and ease of deployment (<http://www.mysql.com/>).

### **3.6.2.2 Why chose MySQL along with PHP in this project?**

MySQL is an open source relational database management system that uses Structured Query Language (SQL). Therefore, users can obtain it for free. It is the most important reason why users choose it as database tool rather than expensive commercial software packages, such as Oracle database software. MySQL is a database server, which is ideal for both small and large applications alike. And it also compiles on a number of different platforms and has multithreading abilities, which makes for great performance. PHP is a server-side scripting language. It means server processes the script and sends HTML web pages back to the browser. The data is stored in the local database. PHP and MySQL are working together in the system. Therefore, based on all those features, in the project, PHP and MySQL are proved to be the most popular combination at this time and the main project developing techniques.

## **3.7 Summary**

This chapter has described the system analysis and design of the proposed system, there are three actors including students, teachers and administrators. The key role of students is to view all messages and post their messages in the discussion forum. On the other hand, the key role of teachers is to manage the discussion forum and respond to various students' queries. The proposed system includes three subsystems: discussion subsystem, management subsystem, and administration subsystem. Each subsystem is designed and implemented using three-tier, client-server architecture. In order to fulfil the goal of knowledge management, keyword search methodology, concept-based search methodology, and interactive query expansion technology are used as major approaches in this project. The keyword base and concept map methodology have been used with the traditional discussion forum technology to implement the prototype system so that students can easily to capture, share and retrieve knowledge and relevant information. Moreover, the system makes it very easy for teachers to manage the discussion forum. At the end of this chapter, the PHP programming language and the MySQL database management system are discussed, which have been used to implement the prototype system. The next chapter will present the details of the prototype system.

## Chapter 4 Prototype System

### 4.1 Introduction

This chapter introduces the structure of the prototype web-based discussion forum system developed in this project. The functions of the prototype system are then described.

### 4.2 System Structure

Figure 4-1 shows the structure of hardware nodes structure of the prototype system. On the server side, there is one server called “System Server”, where the web server and the database server are installed. The system server is used by all system users and therefore is therefore accessible from the Internet.

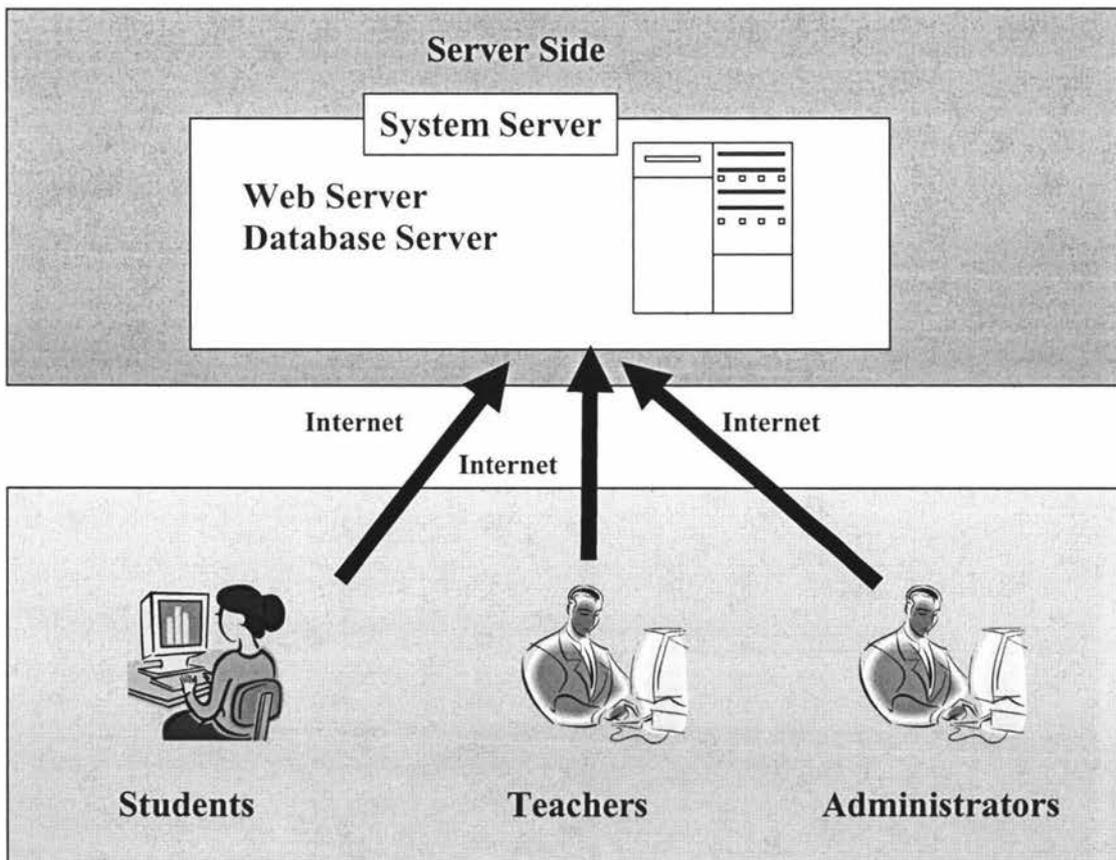


Figure 4-1: Hardware nodes of the prototype system

The functions of the prototype system are introduced in the following sections.

### 4.3 User Login/Logout

In order to use the prototype system, every user should first log into the system. On the login interface (Figure 4-2) the user should enter the username and password. If the login fails, a system warning message appears, asking the user to try again. Otherwise, users will go to the option page. According to the different types of user roles, different options are shown. Students can view only one subsystem option on the option page: the discussion subsystem (see Figure 4-3). Teachers can view two subsystem options on the option page: the discussion subsystem and the management subsystem (see Figure 4-4). Administrators can view two subsystem options on the option page: The discussion subsystem and the administration subsystem (see Figure 4-5).

There is a 'logout' link in all web pages. The user may log out at any time by clicking that link. Then that session will be terminated and the login interface will be displayed.

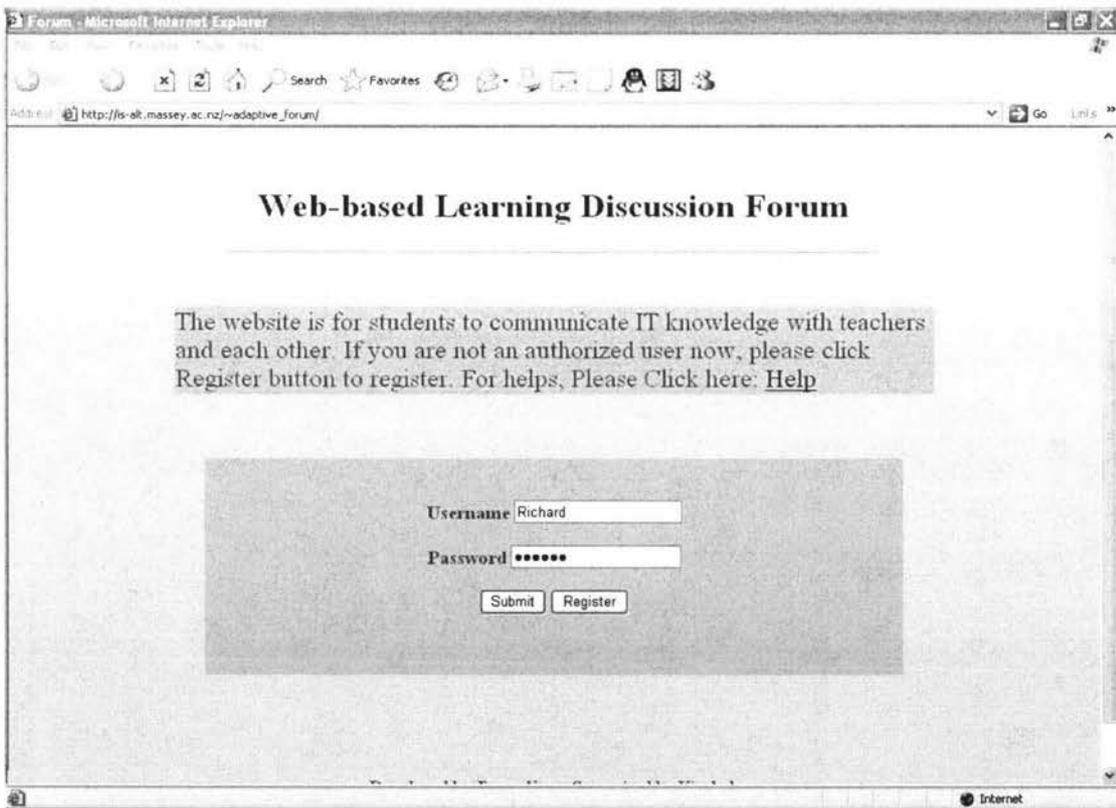


Figure 4-2: Interface for Login Page

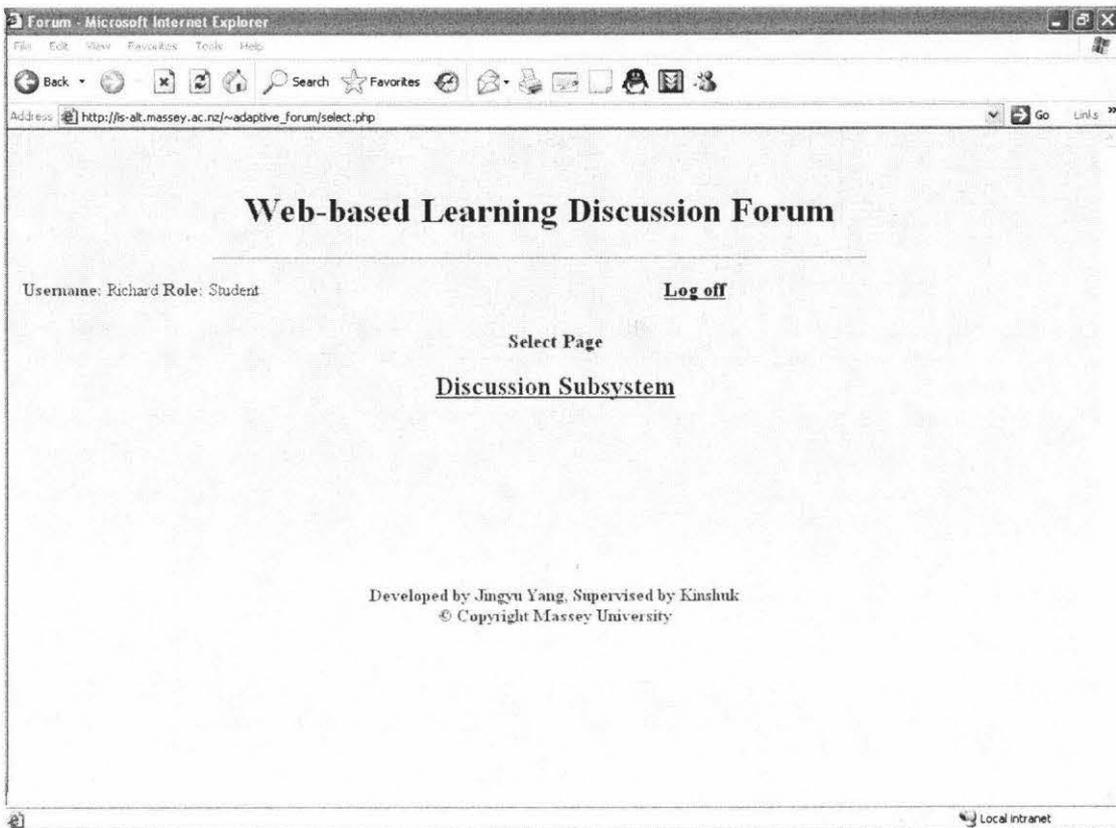


Figure 4-3: The Option Page for Students

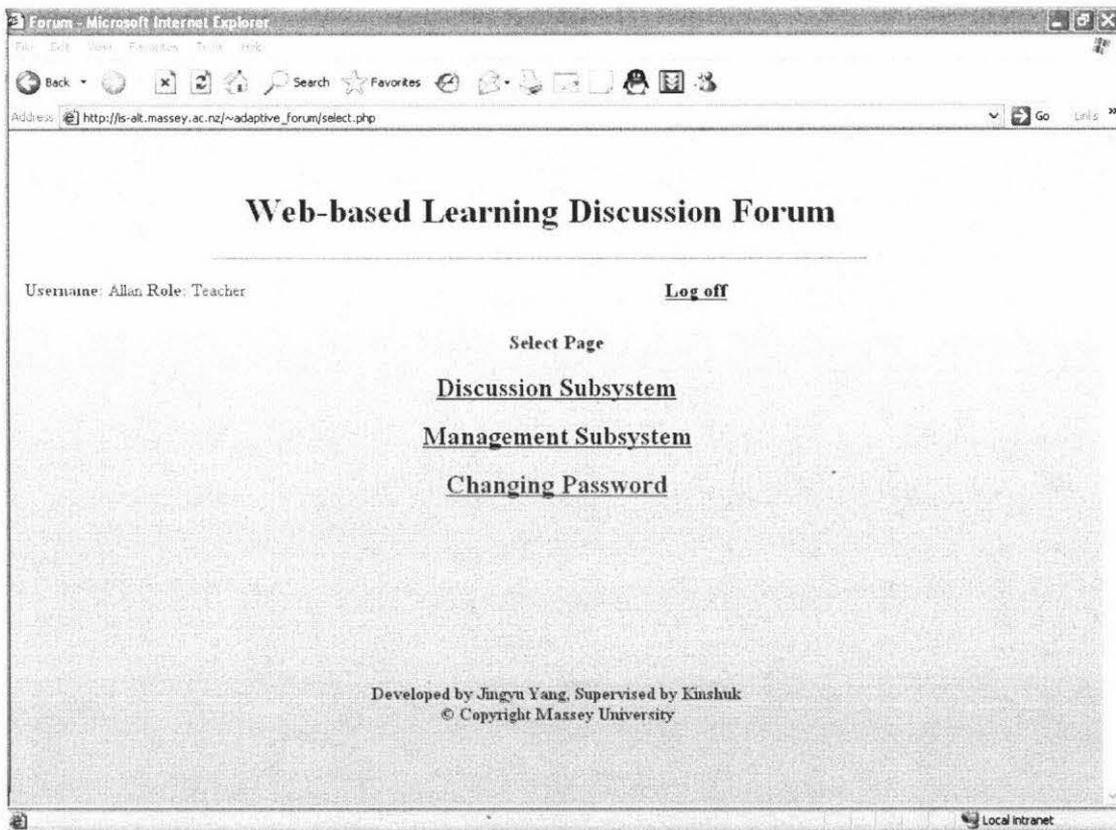


Figure 4-4: The Option Page for Teachers

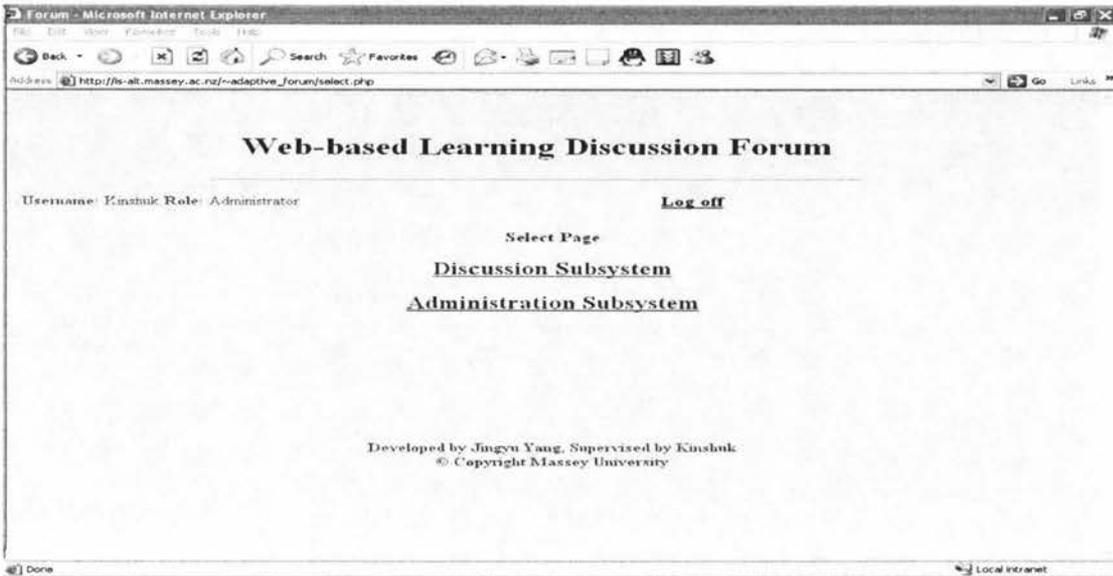


Figure 4-5: The Option Page for Administrators

## 4.4 The Discussion Subsystem

### 4.4.1 Introduction

The discussion subsystem is for users to view all topic folders and all messages in these topic folders. Moreover, users can add their own new messages into the topic folders. There are two other functionalities in the discussion subsystem: new topic folder creation and the search function. The following section introduces all functionalities of the discussion forum.

### 4.4.2 The *Topic* Section

When users enter the discussion subsystem, they see a topic page which shows all topic folders (Figure 4-6). From the topic page, users can enter a topic folder to view all messages in that topic folder; they can use two search functions: Keywords Search and Keywords Directory; or they can create a new topic folder by clicking a *new topic creation* page link.

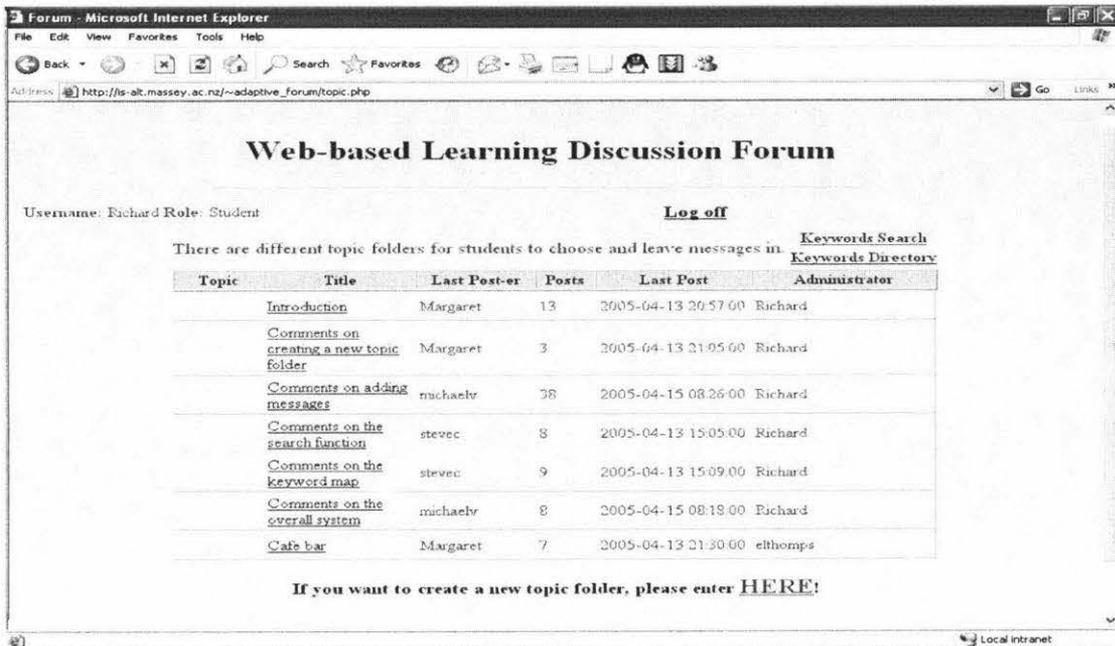


Figure 4-6: The Topic Page of the Discussion Subsystem

#### 4.4.2.1 The Topic Message Section

After users enter a topic folder, they go to the topic message page which shows all previously posted messages in that topic folder (Figure 4-7). Users can view all previously posted messages in that particular topic folder. Moreover, users can post a new message into that topic folder by 'Add a New Message' facility (see Figure 4-8).

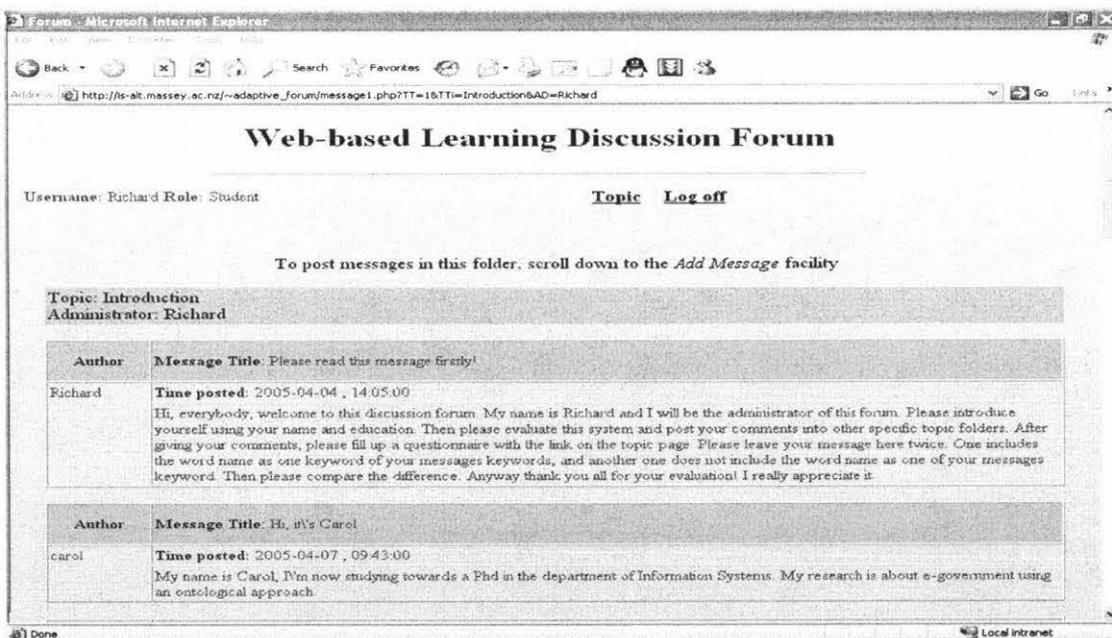
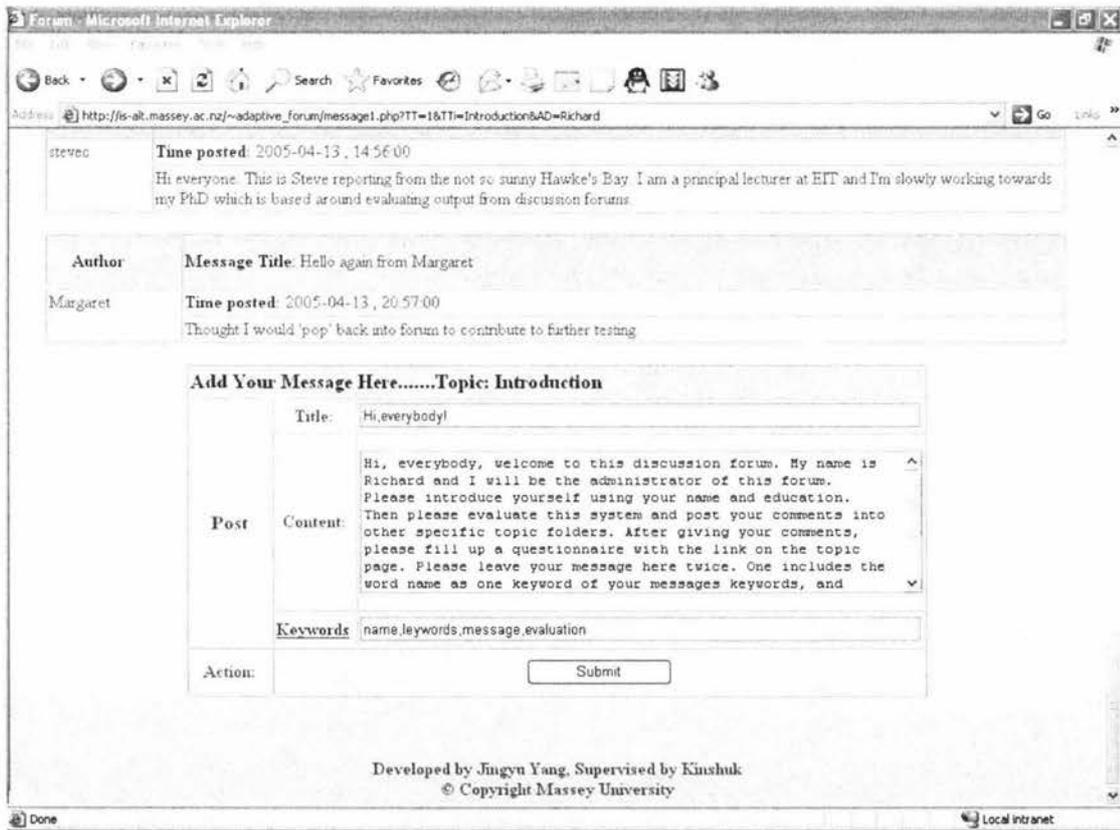


Figure 4-7: The Topic Message Page

On the topic message page, users can scroll down to the ‘Add a New Message’ facility (see Figure 4-8). If users want to post a new message, they need to fill up ‘title’, ‘content’, and ‘keywords’ fields in the facility for their new message. For ‘keywords’ field, users need to select some important words from the content of their new message to be the keywords of the new message. After they fill up all fields in the ‘Add a new Message’ facility, users can submit the new message. After users submit the new message, the system will then automatically identify whether the new message belongs to that particular topic folder or not by checking the keywords of the new message. If it does, the web page will go the *Keywords Expansion* page. If it does not, the web page will go to *Message Confirmation* page.



**Figure 4-8: The ‘Adding a New Message’ Facility on the *Topic Message* Page**

#### 4.4.2.2 The *Keywords Expansion* Section

When the system identifies that the new message belongs to that particular topic folder, the web page will go to *Keywords Expansion* page (Figure 4-9). On the *Keywords Expansion* page, the system will provide some additional words which are

related to the new message for users to view. Users can then add these additional words to be the additional keywords of the new message. These additional words are those that appear in the new messages but were not selected by users as the keywords of the new message. Users can then confirm their new message. The web page will then go to *Relevant Messages* page.

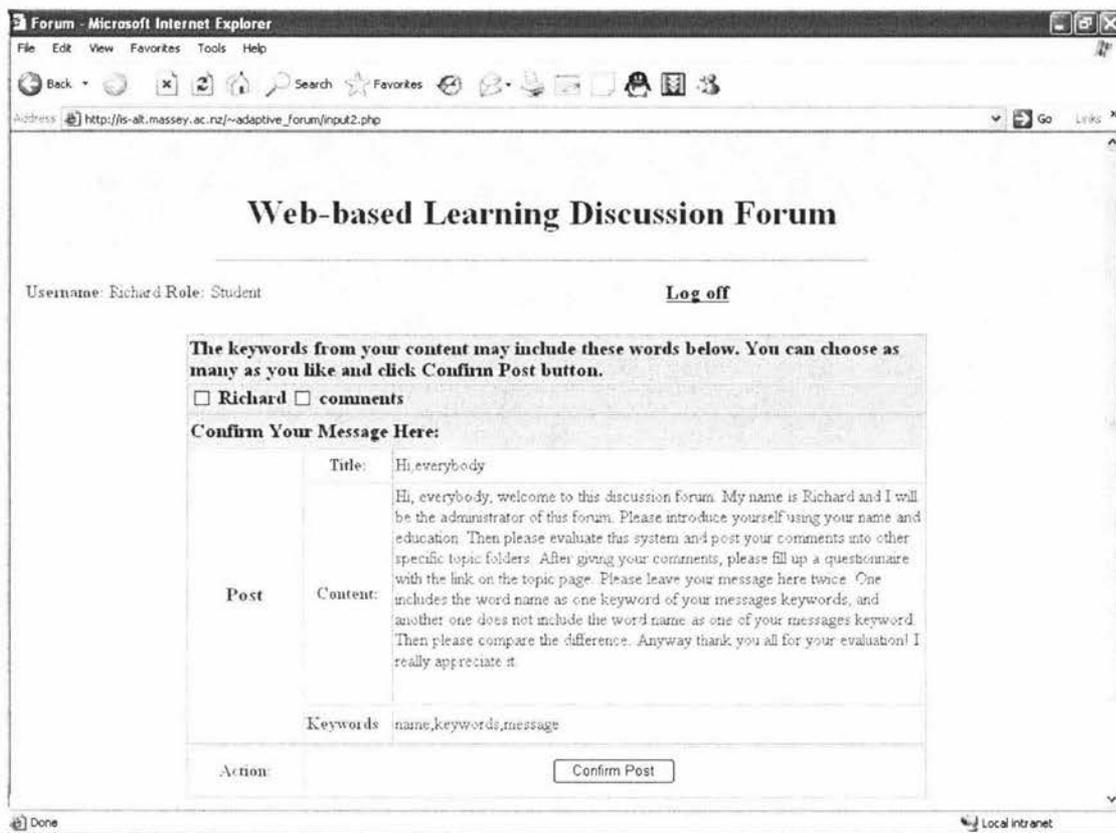
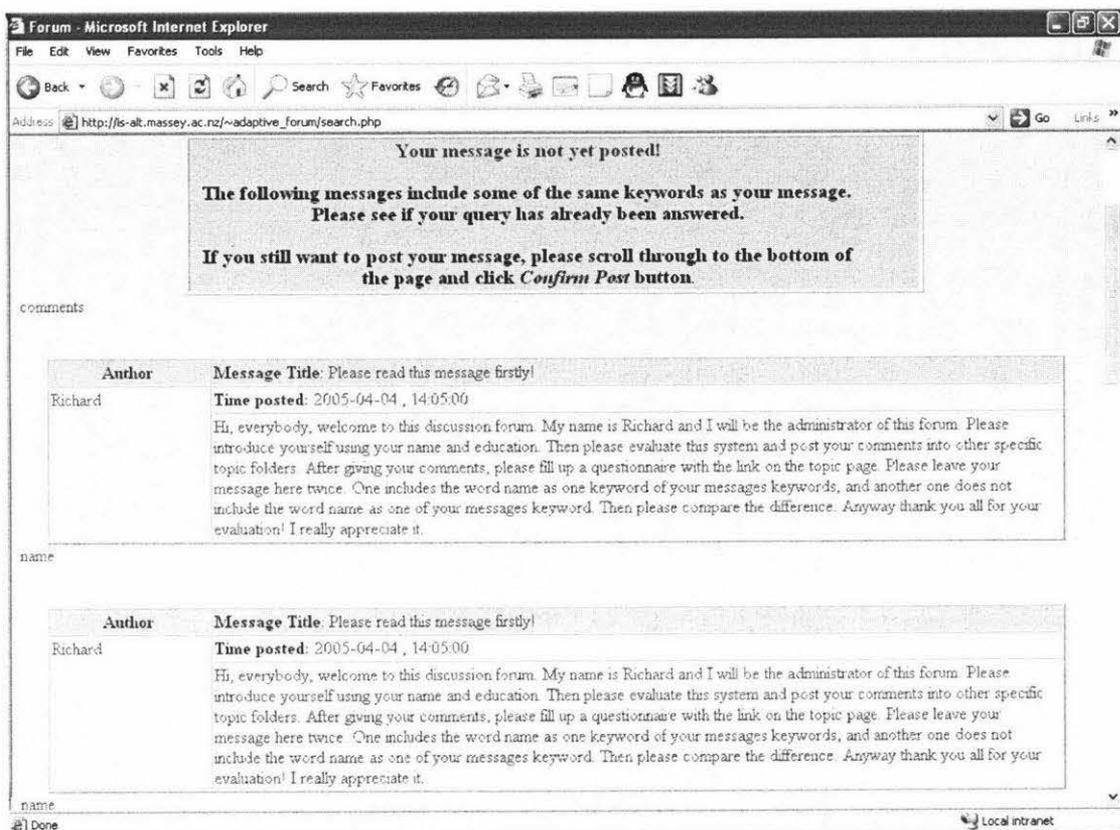


Figure 4-9: The *Keywords Expansion* Page

#### 4.4.2.3 The “*Relevant Messages*” Section

After confirming the new message, users are taken to the *relevant messages* page (Figure 4-10). In the *relevant messages* page, users can view all previously posted relevant messages that are relevant to the new message. The system searches all messages which are stored in the knowledge and information database by each keyword of the new message. The system then shows all those relevant messages to users in the *relevant messages* page. The relevant messages should have at least one common keyword with the new message.



**Figure 4-10: The Relevant Messages Page**

When users view all previously posted relevant messages, they have two choices: they can confirm the posting of new message or they can cancel it (see Figure 4-11). If the posting of new message is confirmed, the details of this new message are stored in the knowledge and information database and the messages becomes available in that particular topic folder (see Figure 4-12). Furthermore, if the keywords of the new message include some words which were not stored in that particular keyword base, the keyword base is updated with addition of those keywords. If users cancel the posting of new message, the web page goes back to that particular topic message.

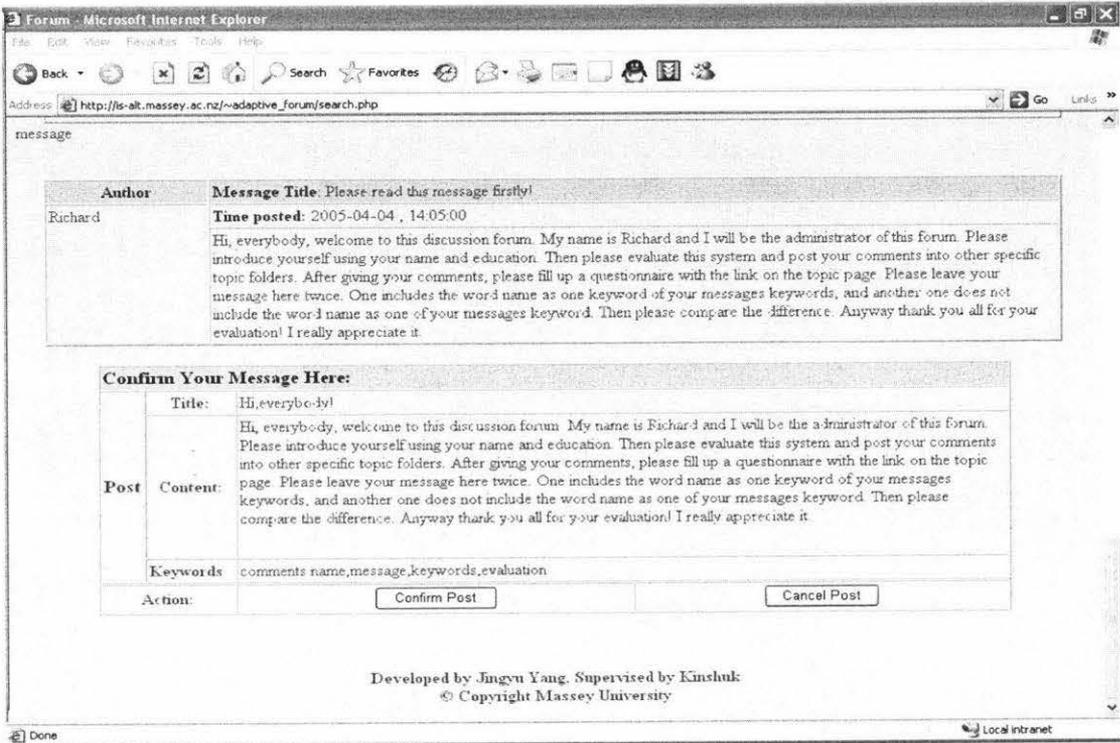


Figure 4-11: Two Choices for Users on the *Relevant Messages* Page

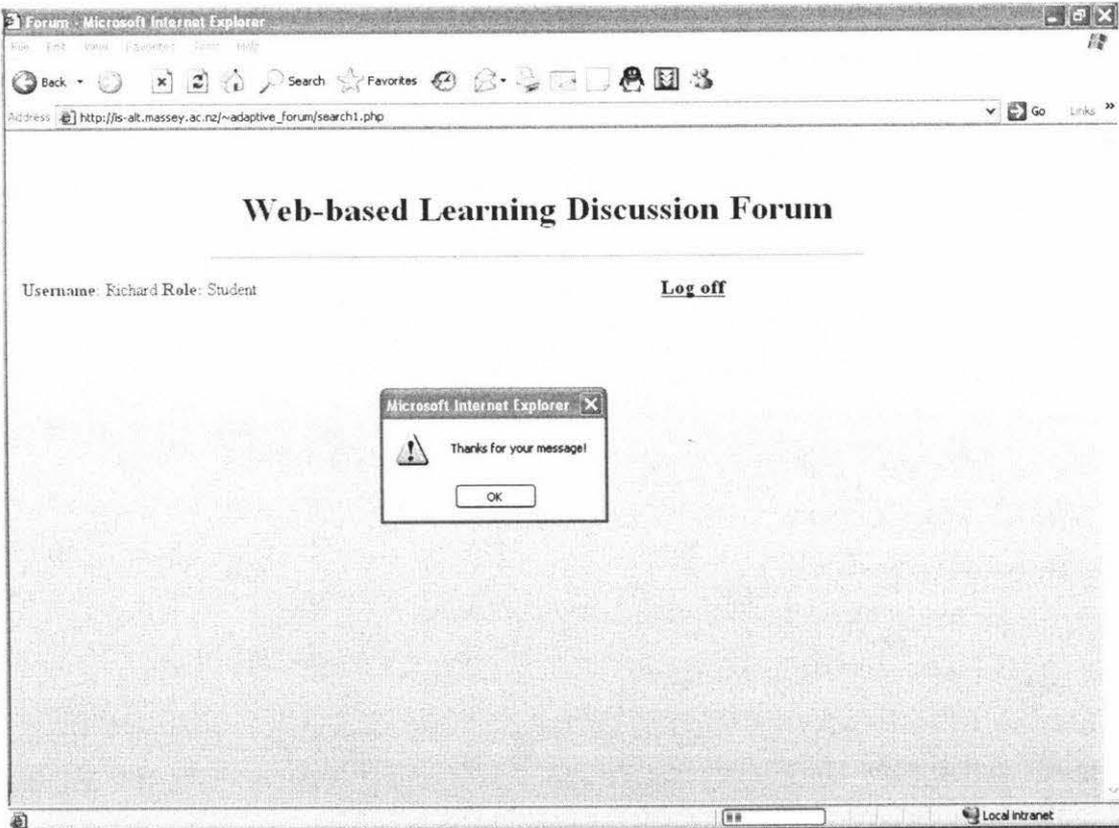


Figure 4-12: A system message after users confirm posting the New Message

#### 4.4.2.4 The Message Confirmation Page

If the system identifies that the new message does not belong to that particular folder, users are taken to the *Message Confirmation* page (Figure 4-13). This happens if the system does not find a match between the keywords of the new message and the keywords of the topic folder where users are trying to post that message. On the *Message Confirmation* page, users are asked to verify that they really want to post that message in that particular topic folder. They are given three options: they can confirm the posting of their new message, they can cancel the posting, or they can edit their new message.

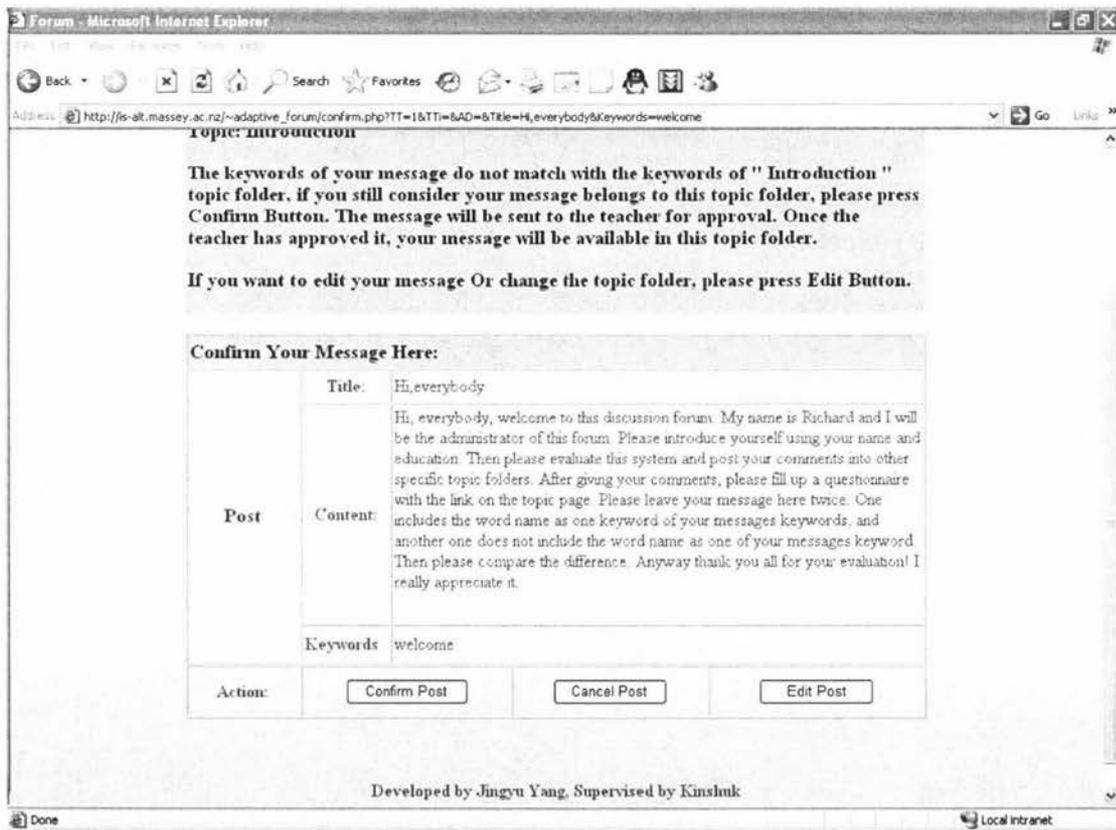


Figure 4-13: The “Message Confirmation” Page

If users still want to post their new message, they can confirm the posting and the system will pop up a message to notify users that their message has been sent to the teacher for confirmation and it will be available for all users in that topic folder as soon as teacher has confirmed it (see Figure 4-14) The web page then returns to that particular topic message page. If users choose to cancel the post, the web page will go

back to that particular topic message page. If users choose to edit their new message, they will go to the *Message Editing* page (Figure 4-15). On the *Message Editing* page, users can edit all details of the new message and they also select another topic folder from the topic folder list menu. Here, users have two options: they can post their message again or cancel the post. If users post their message, the system identifies the new message again. If it belongs to the topic folder where users want to post it, the web page will go to the *Keywords Expansion* page. Otherwise the web page will go to the *Message Confirmation* page again.

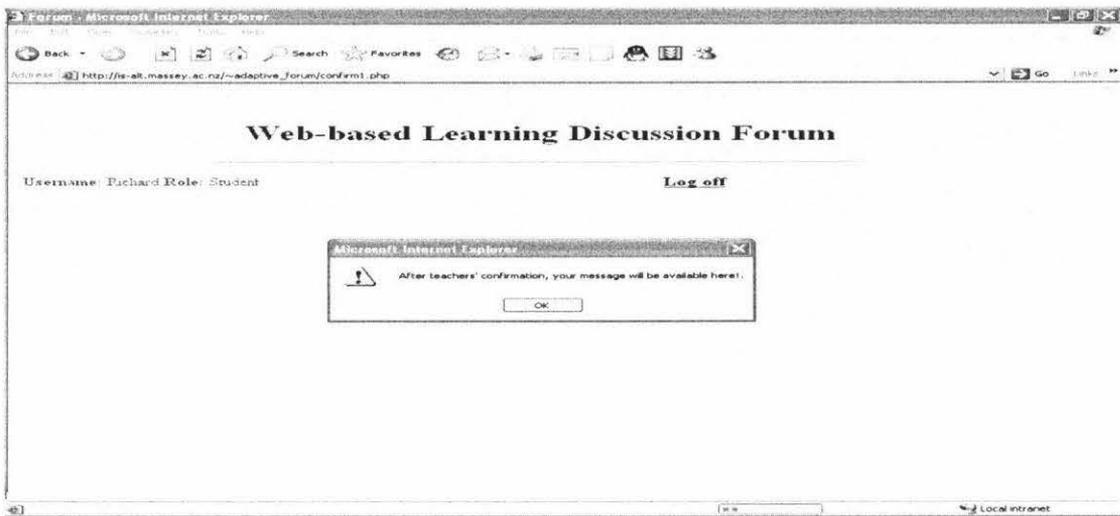


Figure 4-14: Users confirm posting their new message

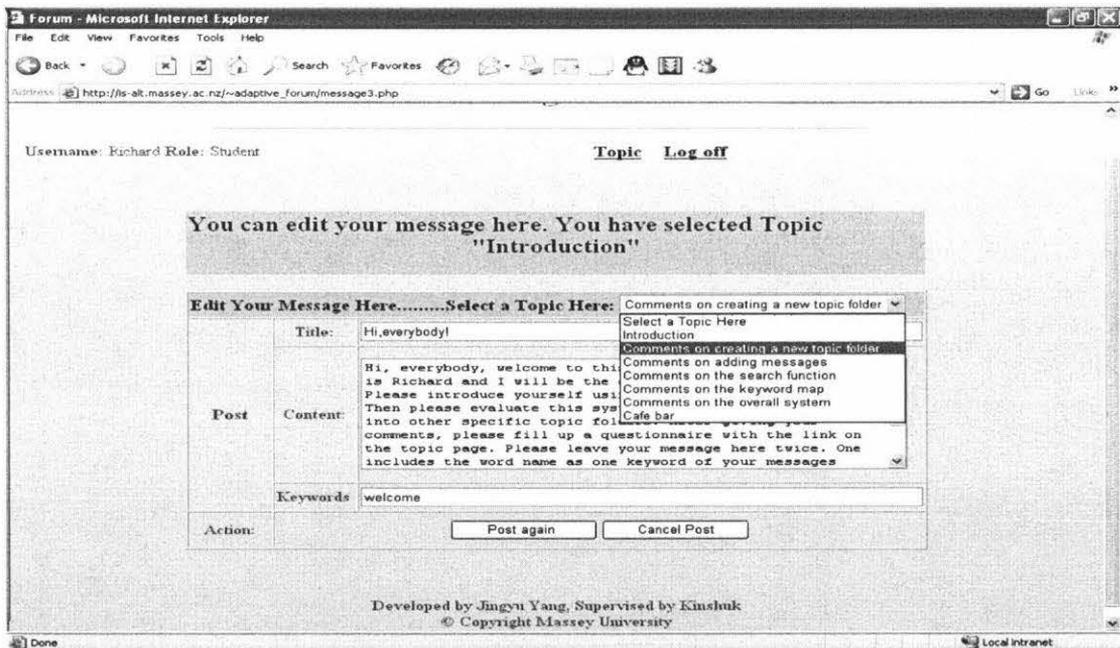


Figure 4-15: The “Message Editing” Page

### 4.4.3 The *New Topic Creation* Page

If users do not find any existing topic folders in the discussion forum suitable for their new message, they can go to the *new topic creation* page from the *topic* page in the discussion subsystem (Figure 4-15). In the *new topic creation* page, users need to input the new topic ‘title’, and the first new message ‘title’, ‘content’ and ‘keywords’. After submission, users are notified that their new topic folder has been sent to the teacher for confirmation and it will be available to all users as soon as teacher has confirmed it (see Figure 4-16).

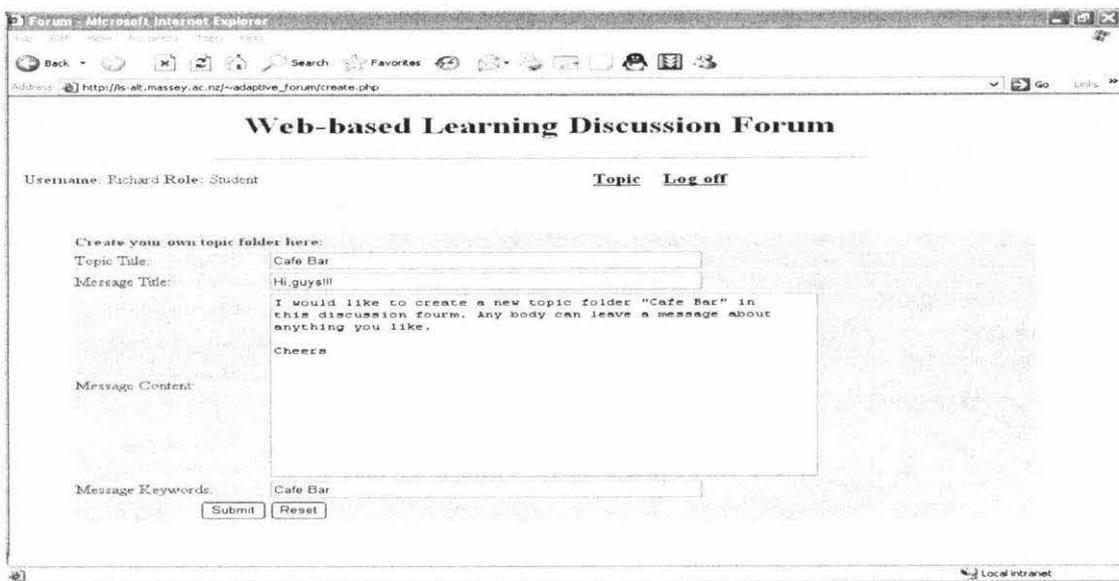


Figure 4-16: The “New Topic Creation” Page

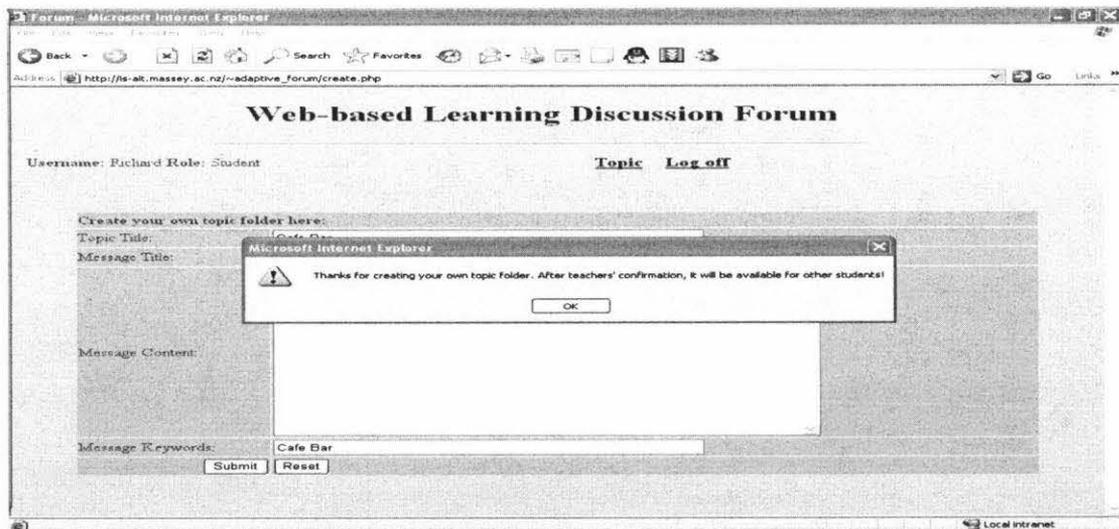


Figure 4-17: A System Warning Message

#### 4.4.4 Search Functions

In the discussion subsystem, there is search functionality for users to capture and retrieve knowledge and information in a fast manner. There are two search function page links on the *topic* page in the discussion subsystem: *Keywords Search* and *Keywords Directory*.

##### 4.4.4.1 The *Keywords Search* Section

In the *keywords search* section (Figure 4-17), users can input a word to find all previously posted relevant messages related to that word (see Figure 4-18). A keyword map is also available for users to find the relationship among those different topics folders that include the searched word in their topic keyword bases (see Figure 4-19). Figure 4-19 shows an example in which the searched word is “comments”. There are five topic folders that include the word “comments” as one of the keywords in their keyword bases. The keyword map shows all of the keywords in these five keyword bases.

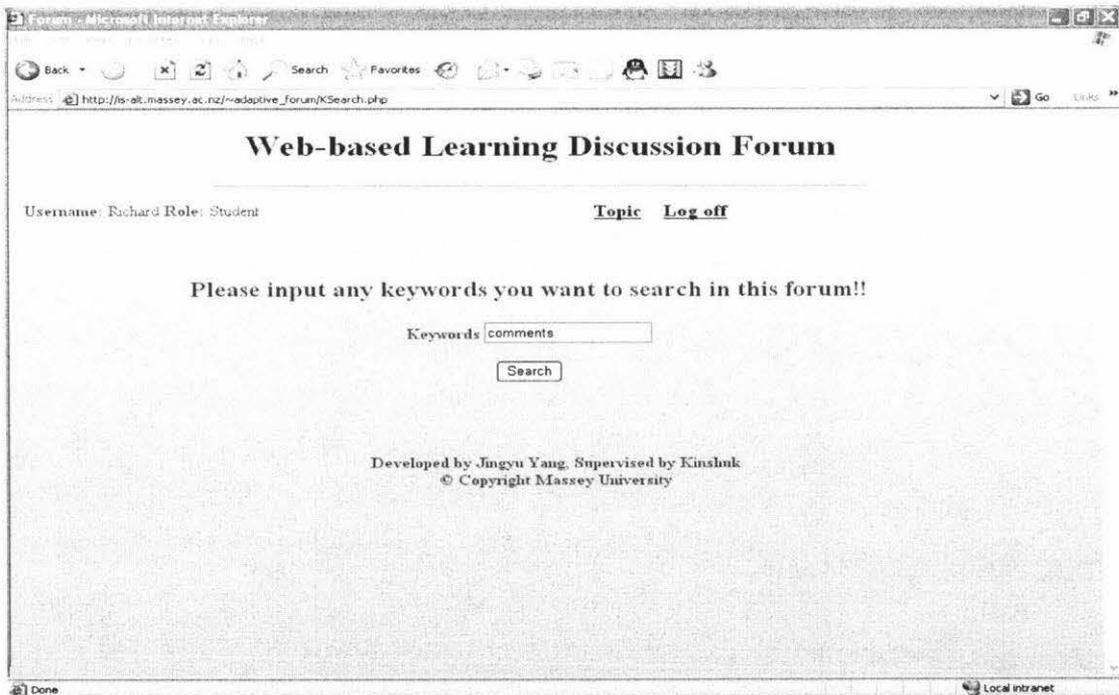


Figure 4-18: The *Keywords Search* Page

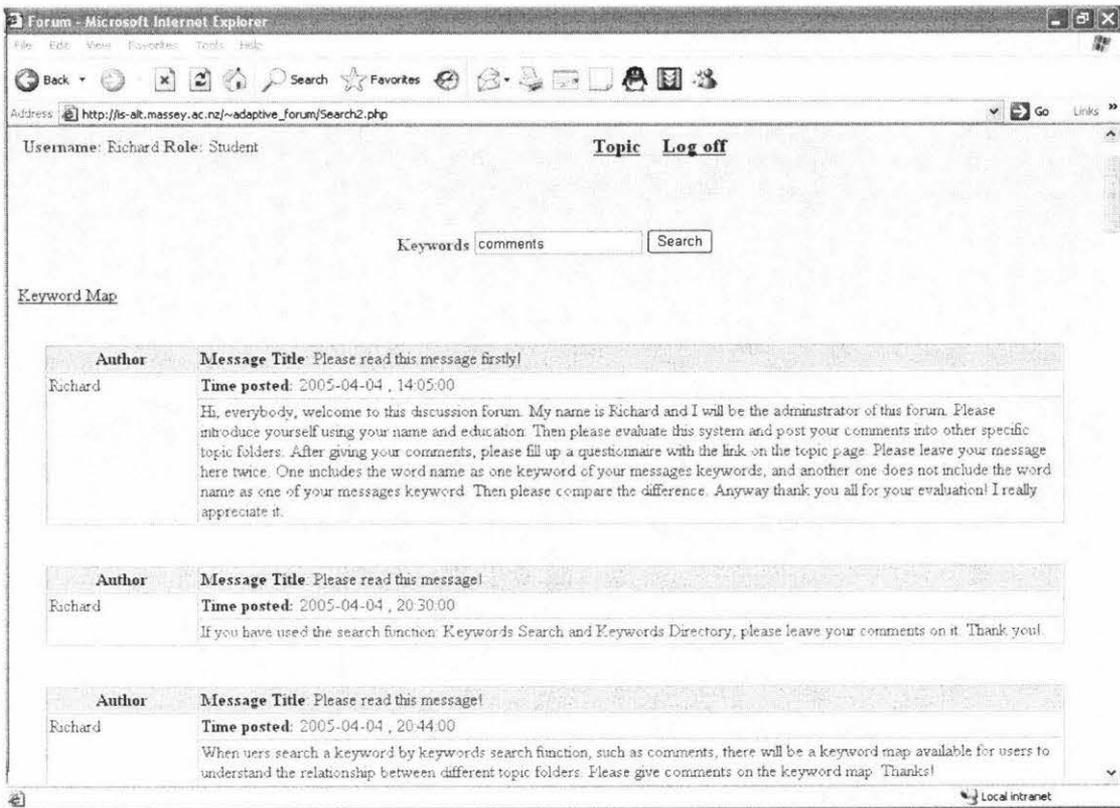


Figure 4-19: The Searching returning Results and the *Keyword Map* Link

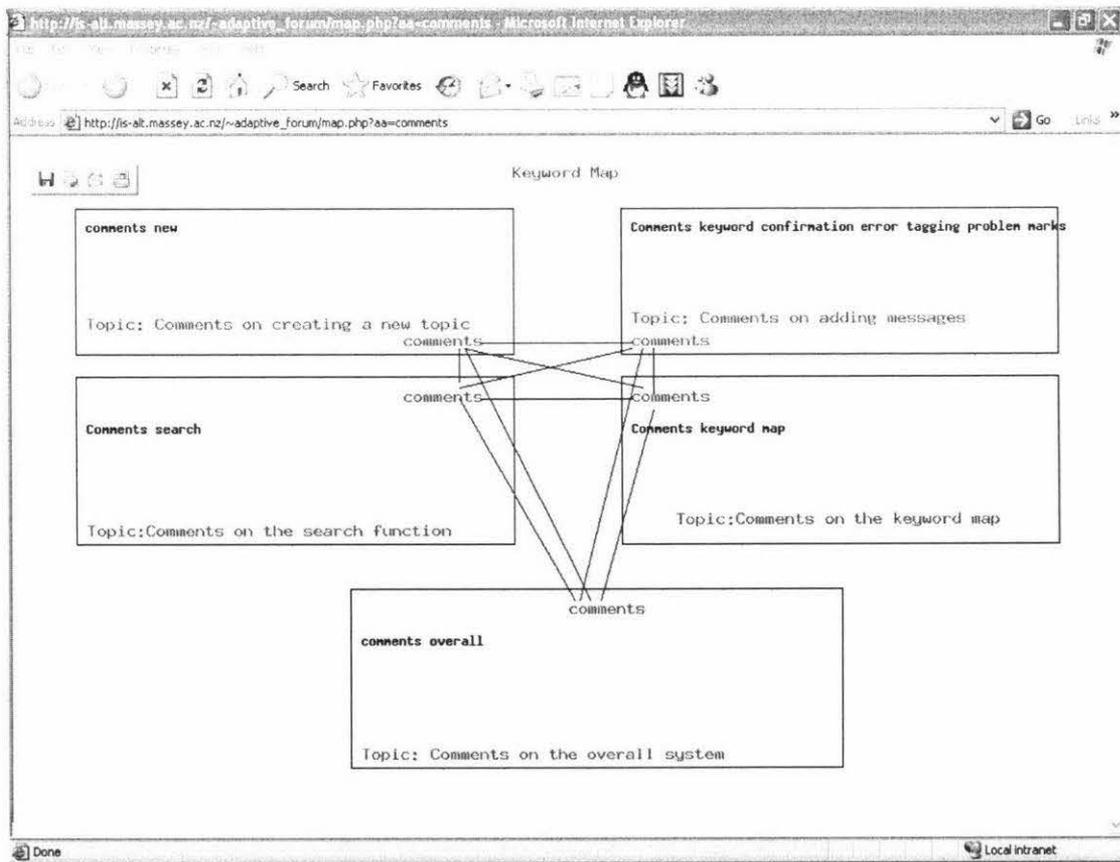


Figure 4-20: The *Keyword Map* Page

#### 4.4.4.2 The *Keywords Directory* Section

In the *keyword directory* section (Figure 4-20), there is keyword directory which shows all keywords in the discussion forum. User can find all posted messages that include a particular keyword by clicking that keyword link on the *keyword directory* page (see Figure 4-21).

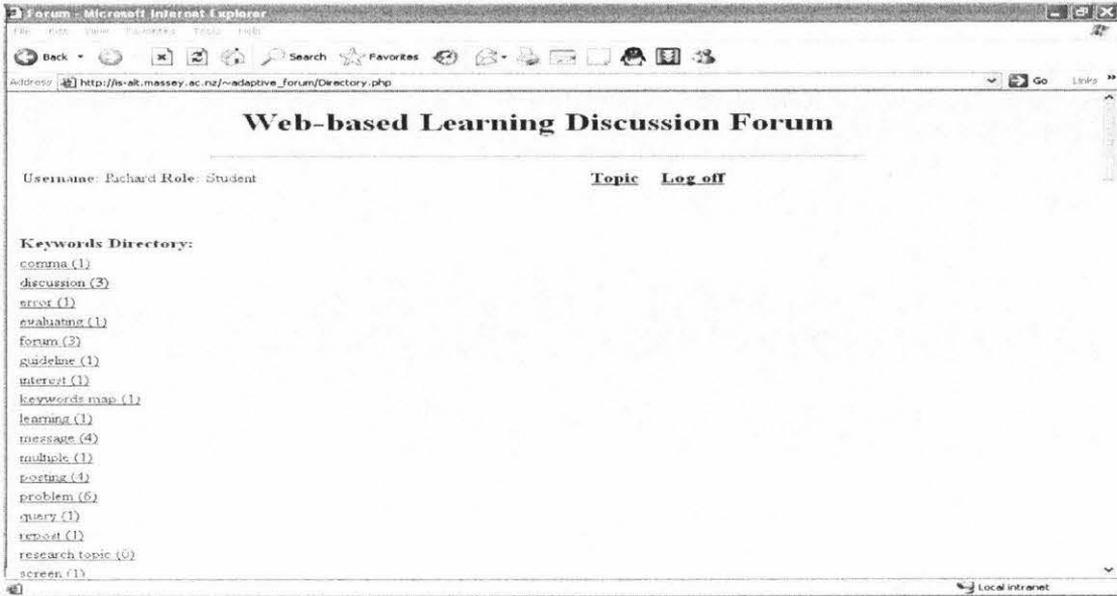


Figure 4-21: The *Keywords Directory* Page

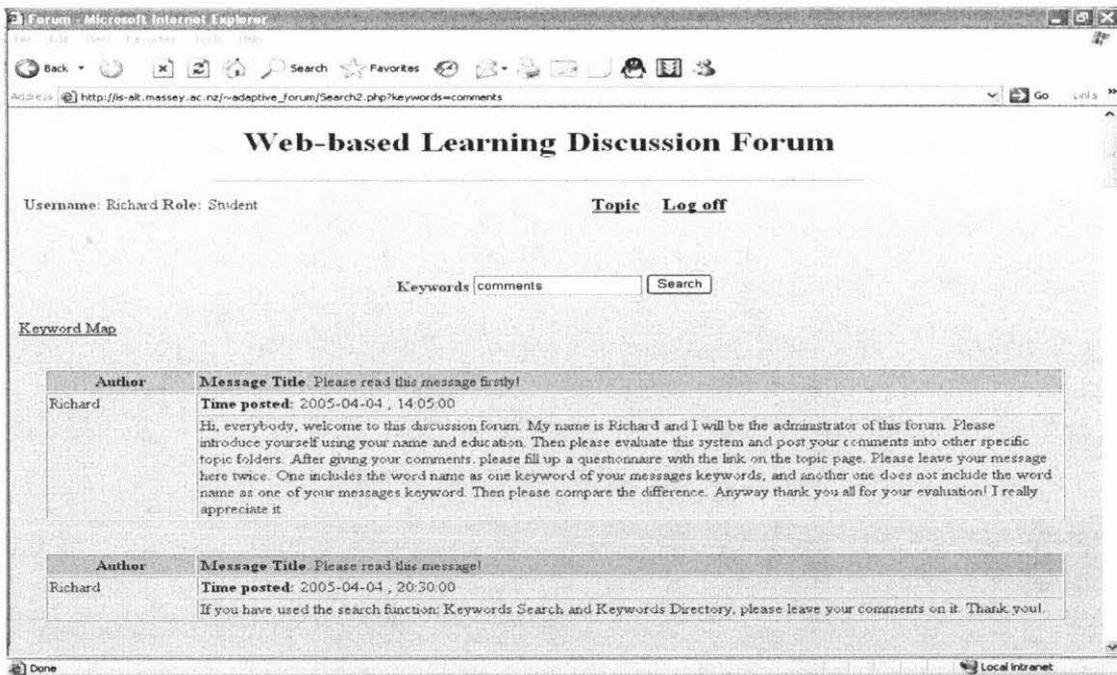


Figure 4-22: The Searching Returning Results Page

## 4.5 The Management Subsystem

### 4.5.1 Introduction

After teachers log into the system, they can view two subsystem options on the option page: discussion subsystem and management subsystem (see Figure 4-22). The management subsystem is for teachers to manage the discussion forum and students accounts. After teachers enter the management subsystem, there are four sections: user administration, topic administration, new topics confirmation, and new messages confirmation (see Figure 4-23).

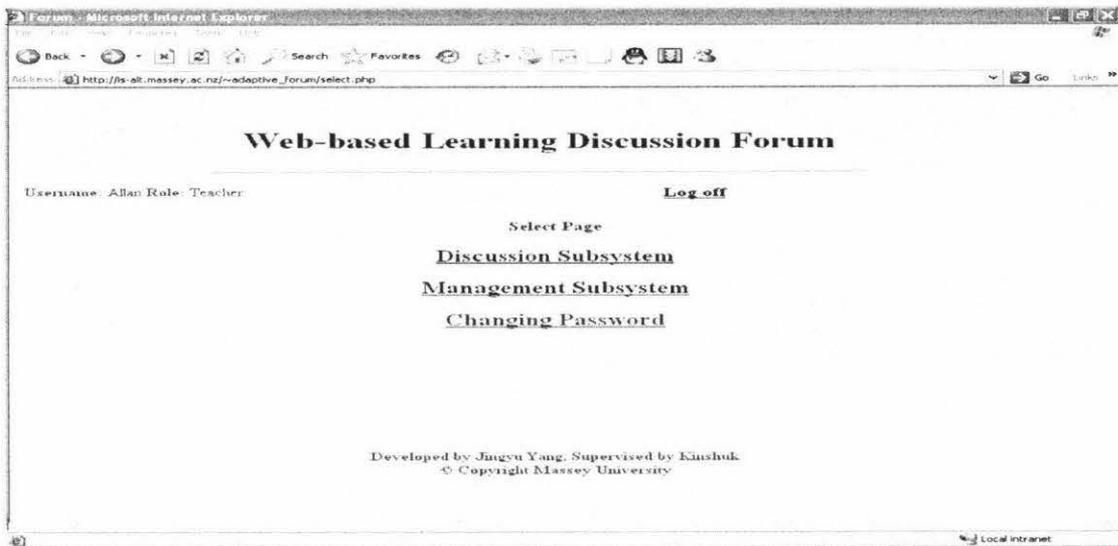


Figure 4-23: The *Option* Page for Teachers

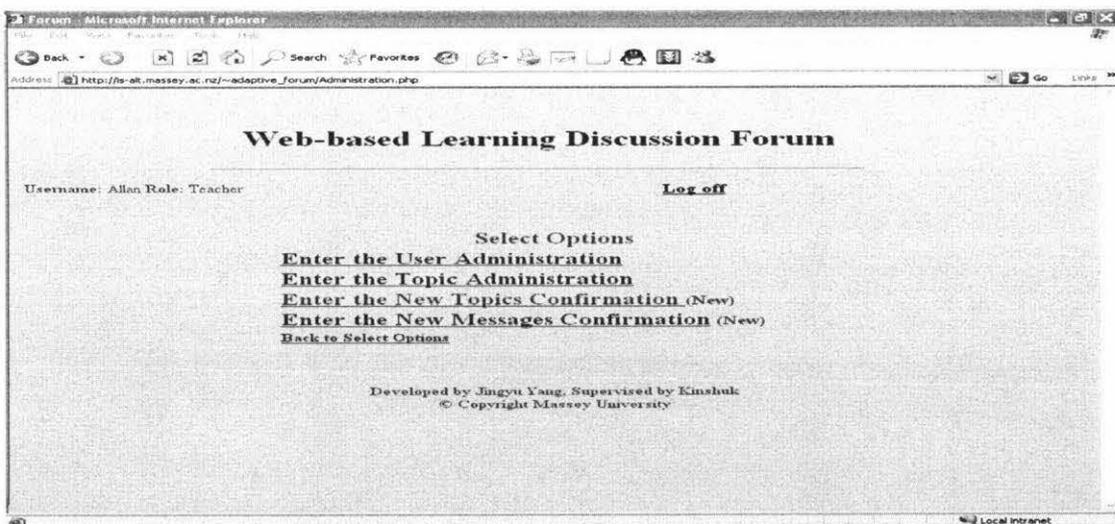


Figure 4-24: The *Option* Page in the Management Subsystem

## 4.5.2 The User Administration Section

If teachers want to manage student accounts, they can enter the user administration section (Figure 4-24). This section contains a table showing the information of all student accounts, such as username and registration date. Teachers can delete an existing student account or change password of a student account.

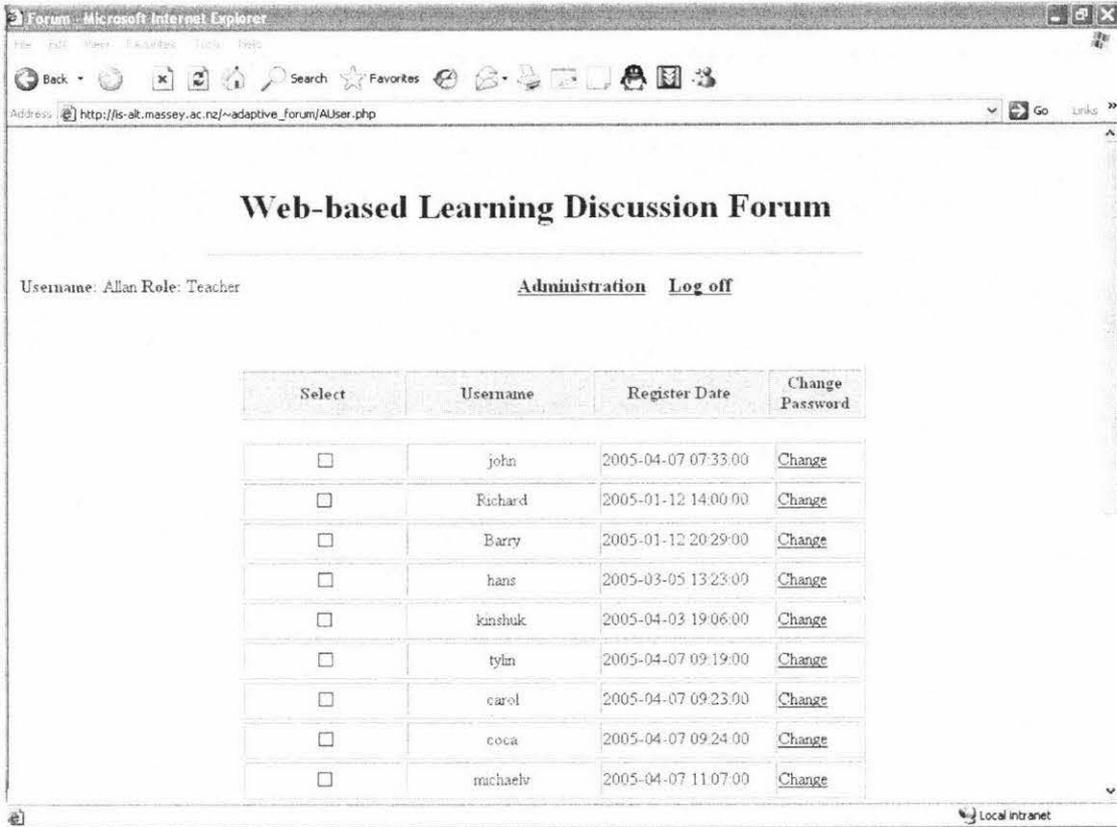


Figure 4-25: The User Administration Page

## 4.5.2 The Topic Administration Section

If teachers want to manage the discussion forum, they can enter the topic administration section. The *topic administration* page (Figure 4-24) displays a table showing the information of all existing topic folders in the discussion forum (see Figure 4-25). Teachers can manage the existing topic folders, such as deleting an existing topic folder. Furthermore, they can click the topic title links to enter the *message administration* page. On *message administration* page, they can view all

previously posted messages in that topic folder and delete an existing message if required (see Figure 4-26).

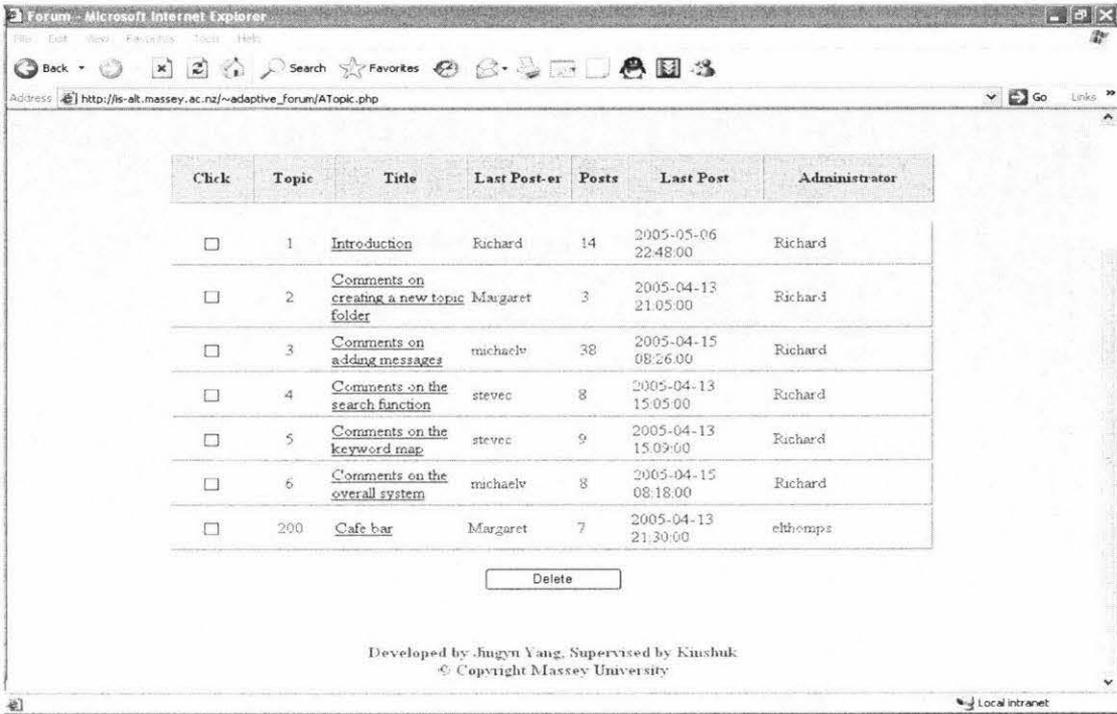


Figure 4-26: The *Topic Administration* Page

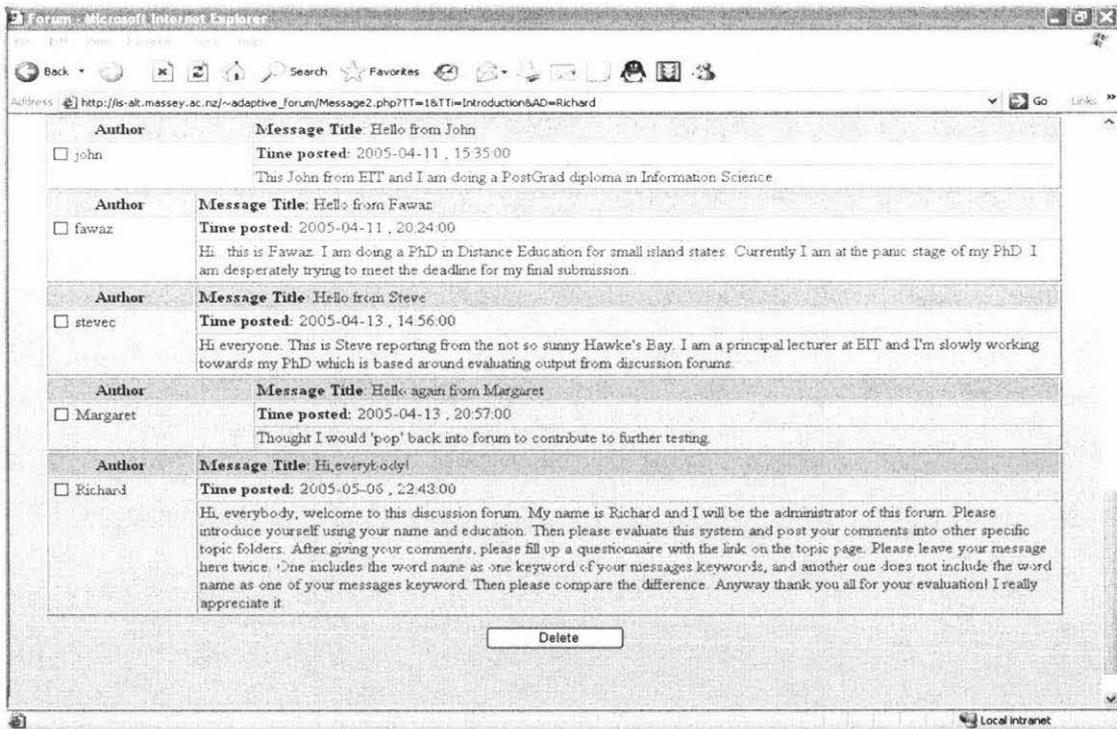
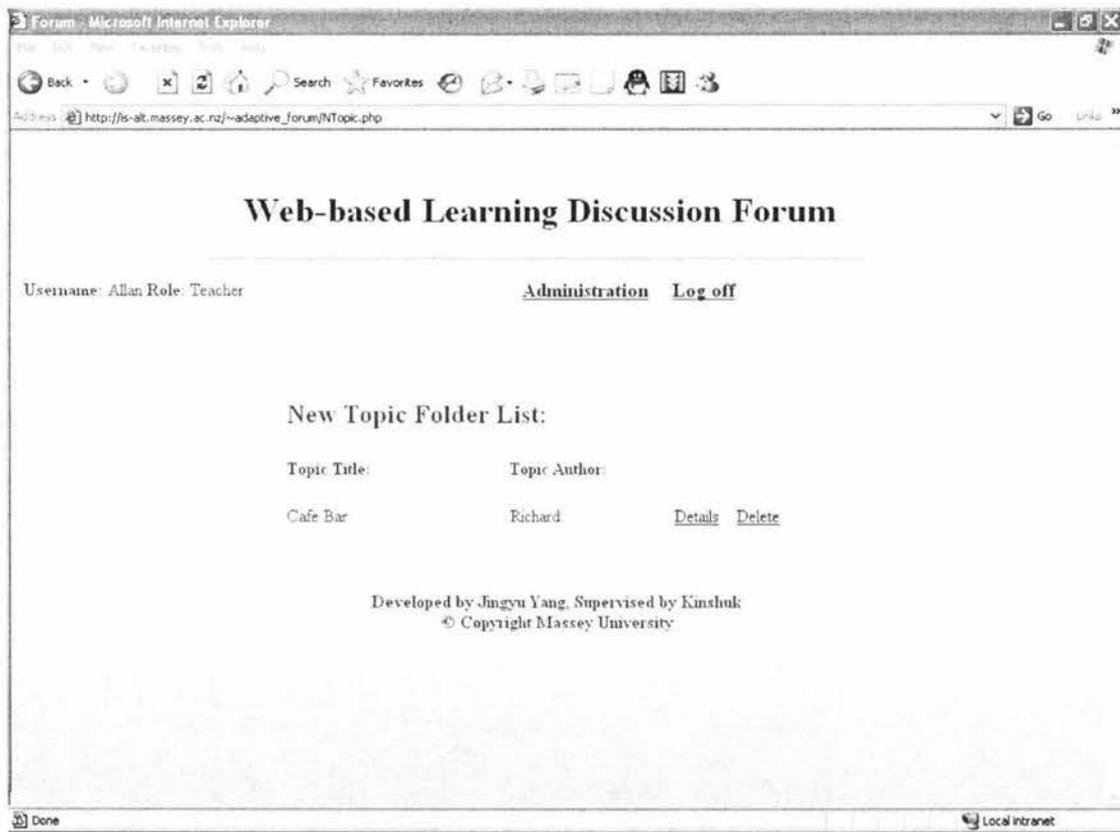


Figure 4-27: The *Message Administration* Page

### 4.5.3 The New Topics Administration Section

The new topics administration section is for teachers to manage all new topics that have been created by the students. If students have submitted a new topic which requires teacher's confirmation, the word "New" will appear beside the *new topics confirmation* page link on the *option* page to remind teachers to confirm it (see Figure 4-23). On *new topics administration* page, a table shows the information of all the new topics that students have submitted, such as title of the new topic and author. The teachers can either delete a new topic or view the details of the new topic folder (see Figure 4-27).



**Figure 4-28: The New Topics Administration Page**

If teachers want to view the details of a new topic, they can click the 'details' link to go into the *details of the new topic* page (Figure 4-28). On the *details of the new topic* page, teachers can view all details of the new topic and the new first message of that topic which the student submitted. If teachers consider that the new topic and the first message are suitable for the discussion forum, they need to fill the 'topic keywords'

field and then confirm it. The new topic folder and the first new message will then be available to all users in the discussion forum.

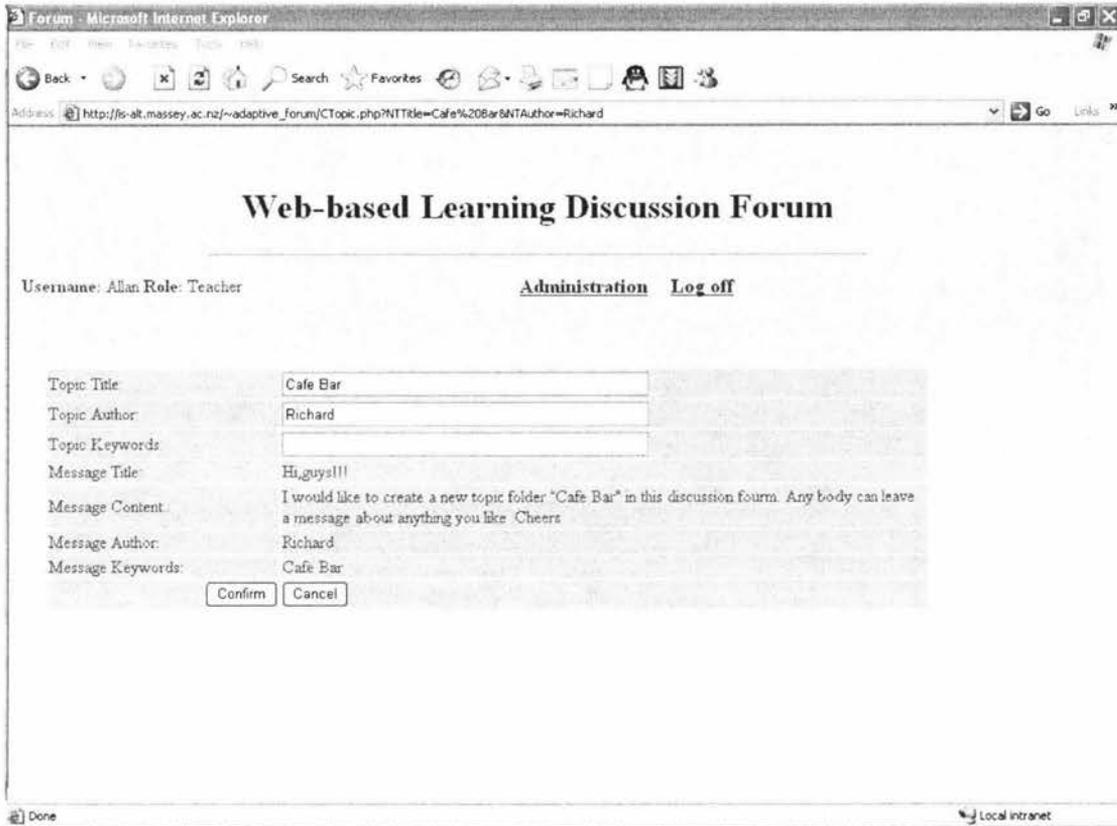
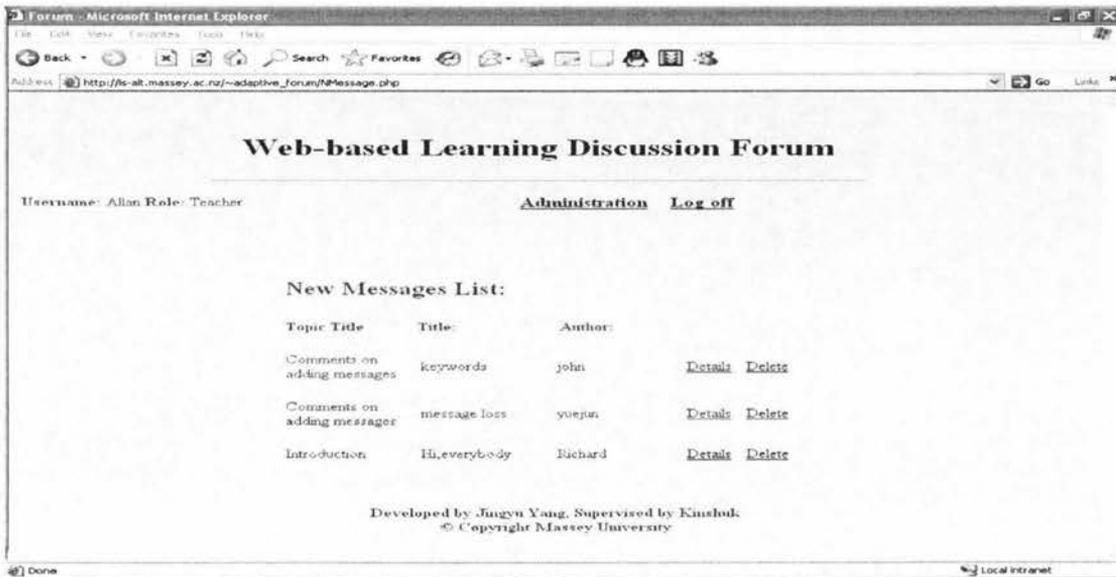


Figure 4-29: The Details of the New Topic Page

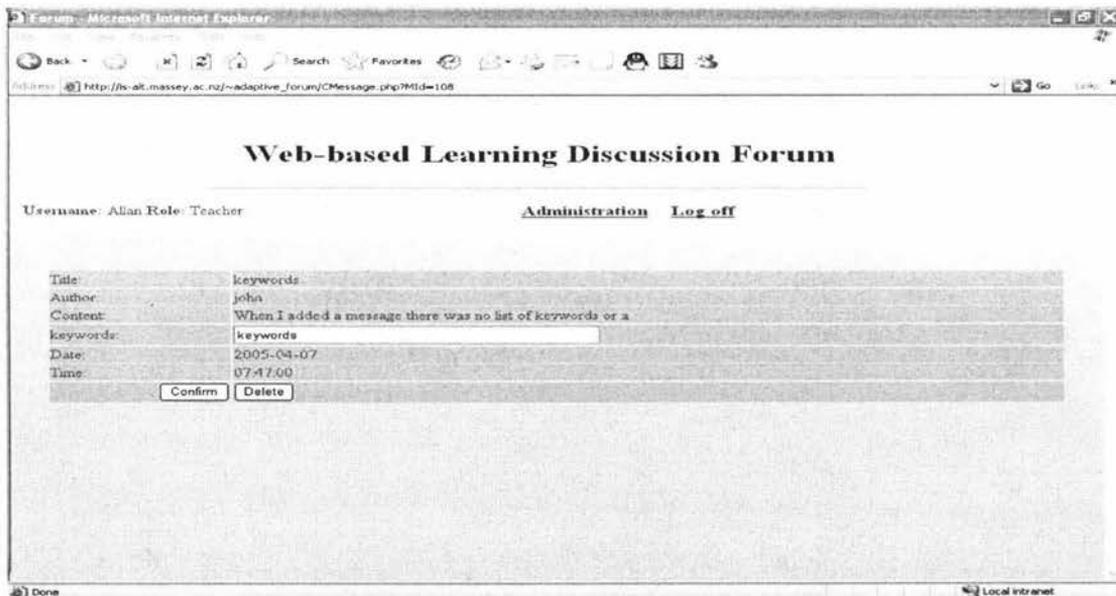
#### 4.5.4 The New Messages Administration Section

The new messages administration section is for teachers to manage all new messages which the system identifies as not belonging to those particular topic folders where students wanted to post them. If any such new messages are waiting for teacher's approval, the word "New" will appear beside the *new messages confirmation* page link on the *option* page to remind teachers to confirm them (see Figure 4-23). On *new messages administration* page, a table shows information of all new messages which students have submitted, such as title of the message, author and title of the topic folder where students wanted to leave their new message. On the *new messages confirmation* page, teachers can either delete an existing new message or view the details of the new message (see Figure 4-29).



**Figure 4-30: The Details of the New Message Page**

On the *details of the new message* page (Figure 4-29), teachers can view all details of the new message and edit the 'keywords' field of the message. If teachers consider that the new message belongs to that particular topic folder where the student wanted to post it, they can confirm it and then the message will be available in that particular topic folder to all users.



**Figure 4-31: The Details of the New Message Page**

## 4.6 The Administration Subsystem

Only the system administrators can enter the administration subsystem after they log into the system (see Figure 4-30). In the administration subsystem, administrators can either create a new teacher account or delete an existing teacher account (see Figure 4-31).

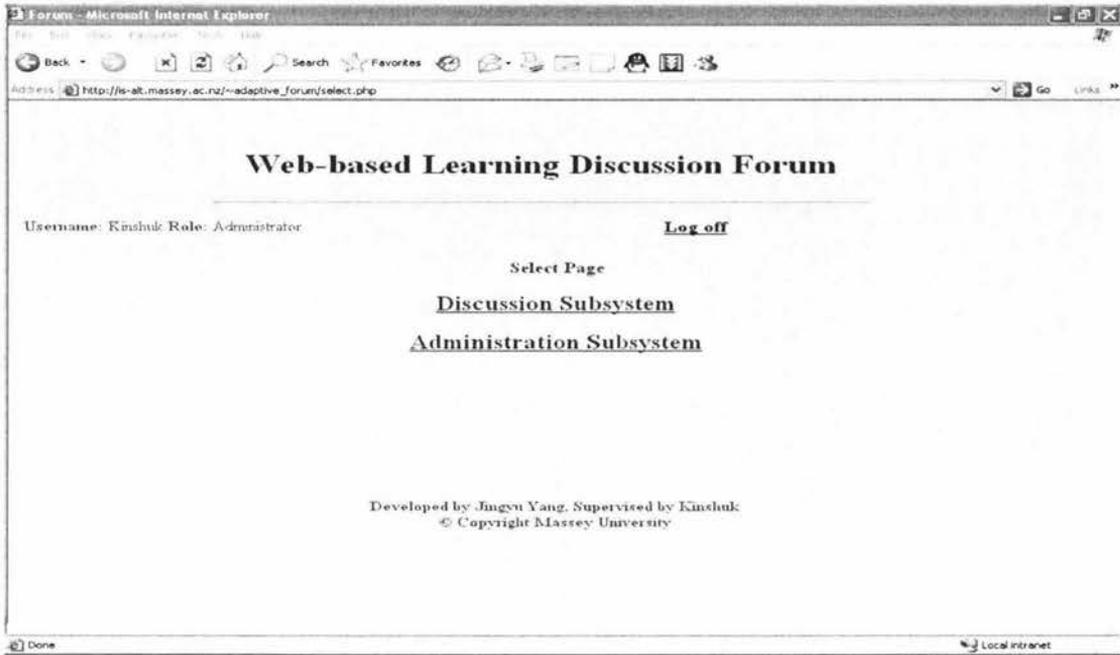


Figure 4-32: The *Option* Page for the System Administrators

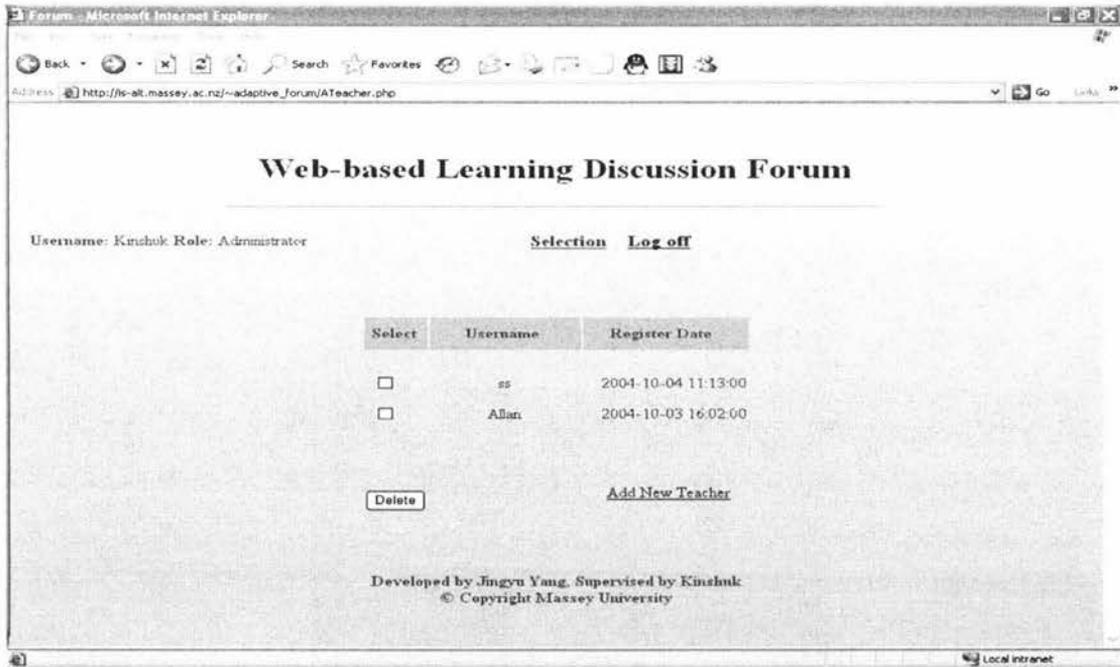


Figure 4-33: The *Administration* Page

## **4.7 Summary**

The prototype system enables students to capture, retrieve, and share knowledge and useful information. Teachers should first create some topic folders for students to post messages in the discussion forum. Then the students can access the discussion forum at anytime and anywhere via the Internet. They can leave messages in existing topic folders, create new topic folders and search useful information. When students try to post a message into a particular topic folder, the system automatically checks whether the message belongs to that particular topic folder or not. If it does, the system will show all relevant messages to students to view. Otherwise, students need to confirm their message and wait for teachers' confirmation before their message can be available to all users in the discussion forum. The system also provides a search functionality for students to retrieve knowledge in a fast manner.

In the next chapter, the evaluation of the prototype system by both teachers and students is provided. Then the conclusion and future work are discussed.

## Chapter 5 System Evaluation

### 5.1 Introduction

This chapter focuses on the experiences gained during the design and implementation of the system. The chapter starts with how the objectives of the project were achieved, and how various problems during design and implementation were tackled. Then we describe the formative evaluation of the prototype system by both teachers and students. Participants first used the system for few days, discussing various aspects of the system itself. Subsequently, a questionnaire methodology was used in the evaluation process of the prototype system. At the end of the chapter, the problems of the prototype system are analysed according to the evaluation feedback and solutions are suggested to solve these problems in future work.

### 5.2 Discussion

The key objective of this project is to enhance the ability of students to capture, retrieve and share useful knowledge and relevant information by using web communication technologies. The prototype system developed in this project aims to fulfil that objective. The prototype system not only contains the benefits of the traditional Web communication tools, but also overcomes various shortcomings of current discussion systems, such as too many messages left in inappropriate topic folders, too many duplicate messages and queries in the discussion forum; difficulties for students in finding relevant and useful information from overwhelming amounts of previously posted messages, and difficulties for teachers in managing the discussion forum. The following discussion describes how the prototype system overcomes these shortcomings.

The prototype system consists of three subsystems: the discussion subsystem, the management subsystem, and the administration subsystem. Each subsystem is implemented with the *distributed*, *three-tier*, and *client-server* architecture. This type of system architecture is flexible and easy to manage and maintain.

### **5.2.1 Objective 1 – To overcome the shortcoming of too many messages in inappropriate topic folders**

In traditional discussion forum systems, students typically leave their message in inappropriate topic folders. This is because when students enter into a topic folder, sometimes they are not concerned with the fact that different categories of messages should be left in different topic folders, and they typically leave all of their messages and questions in the same topic folder for their own convenience. In the prototype system, the keyword search methodology is used to identify whether a message belongs to a particular topic folder in which the student wants to leave the message. If it does not belong there, the system asks the student to confirm the message, and after that, the system requires the teachers' confirmation. This way, the appropriateness of message for a particular folder is verified. Subsequently, any further similar messages could be posted to that topic folder without requiring any further validation.

### **5.2.2 Objective 2 – To overcome the shortcoming of many duplicate messages and queries in a topic folder, which makes it difficult for students to capture and retrieve knowledge in the discussion forum**

Traditional discussion forum systems suffer from duplicate messages and queries in topic folders. In particular when the number of messages is high in a particular folder, and if many of them are duplicate or not related to that particular topic, it becomes overwhelming for students to read all those messages. It is more difficult for students to capture and retrieve relevant knowledge and useful information in such a scenario. In the prototype system, when the students post messages, they need to fill up "keywords" field attached with the messages. Moreover, after the students submit the messages, the system provides some relevant words from the content of the message. The students can select any or all of these words to be used as additional keywords and then resubmit the message. According to the keywords of the message submitted, the system then shows all of the previously posted relevant messages in that particular topic folder. At this stage, users can decide whether or not to continue posting the message. Also, there is search functionality for students to search useful and relevant information in the prototype system. Students can use two types of search functions: keyword search and keyword directory. Furthermore, there is a keyword map

available when users utilise search functions. Users can have a clear understanding regarding the relationship among different topics so that they may view more keywords related to the searched word and obtain more relevant information by searching those relevant keywords.

### **5.2.3 Objective 3 – To overcome the shortcoming of too many topics or not enough topics in the discussion forum**

In traditional discussion forum systems, if students are allowed to create their own topic folders, it is possible that students would create separate folders for their various queries, without realising that similar topic folder may already have been created by another student. However, if students are not allowed to create topic folders, it is possible that in certain circumstances, students will not find any of the existing folders appropriate for their queries. Therefore they would either hesitate to post or they would leave their messages in inappropriate topic folders. In the prototype system, students can create their own topic folder if they think that their message does not belong to any of the existing topic folders. However, their new topic folder will be available to all users in the discussion forum only after the teachers' confirmation. This way, the system provides a checkpoint to avoid the creation of any unnecessary folders.

### **5.2.4 Objective 4 – To overcome the shortcoming of difficulties for teachers to manage the discussion forum**

As a result of the problems experienced in traditional discussion forum systems, teachers typically end up managing too many unnecessary topic folders and duplicate messages. Sometimes they have to answer similar queries more than once because the student who asked at a later stage would be expecting an answer despite the fact that similar queries may have been answered before. The prototype system can automatically check the message that students try to post in a particular topic folder whether it belongs to this topic folder or not. If it does not belong, teachers have the right to decide whether this message can be available in this topic folder for all users or not. Meanwhile, all new topic folders, which are created by students, need to be

confirmed by teachers as well. The prototype system may help teachers avoid the heavy burden of incessantly managing the discussion forum.

### 5.3 Evaluation

In order to evaluate the prototype system, a total of fifteen people (Table 5-1), five teachers and ten students, were asked to use the system and then complete a questionnaire. The evaluation at this stage is of formative nature. Based on the feedback received at this stage, enhancements to the system have been identified. The summary of the evaluation has identified future work, which is outside the scope of this thesis.

Five teachers participated in this evaluation: three lecturers teaching both undergraduate and postgraduate courses, one assistant lecturer teaching undergraduate courses, and one tutor tutoring undergraduate courses. Three of them are male and two of them are female. In addition, ten students participated in this evaluation including five undergraduate students (two females and three males), and five postgraduate students (three females and two males).

**Table 5-1 Summary of Evaluators**

Category	Number	Gender	
		Male	Female
Teachers	5	3	2
Students	10	5	5
Total	15	8	7

#### 5.3.1 Evaluation for the System's Details

All interface and functionality of the prototype were evaluated with the help of a questionnaire (enclosed in appendix A). The questionnaire contained five sections. The results of the questionnaire are analysed in the following sections.

#### Section 1: Log on and Registry

In order to evaluate the usability of the “Registry” and “Log in” section, three questions were designed for users to respond to: **Is it easy to register as an authorised user? Is it easy to log on the system? And is it easy to understand which option to choose?**

Fourteen evaluators felt that it was easy to register as an authorized user and easy to understand which option needed to be selected when users register. Additionally, fourteen respondents considered the system was easy to be logged on to. Only one male teacher did not feel the system is convenient for him to register and log onto.

## **Section 2: Creating New Topic Folder Function**

In order to evaluate the usability of the “Creating a new topic folder” section, five questions were designed for users to respond to: **Is it easy to create a new topic folder? Is it easy to understand what should be input? Is it acceptable that students have to wait for teachers’ confirmation before their new topic is available? Can the web pages be accepted as user friendly and clear? And is this function effective and valuable?**

Thirteen evaluators (five teachers, five postgraduate students and three male undergraduate students) felt that this function was easy to understand, and that the web pages were user friendly and clear. Two female undergraduate students felt this function was difficult to understand. A total of nine evaluators including five teachers, three male postgraduate students and one female postgraduate student thought that this function was acceptable and the function of creating new topic folder was effective and valuable. Six evaluators (two male undergraduate students and four female students) thought this function is not acceptable for students. These six students considered that the disadvantage of this function was that it maybe a waste of time to wait for the teachers’ confirmation after students have created a new topic folder. Sometimes students did not like to wait. Meanwhile these six students considered this function to be ineffective and not valuable.

## **Section 3: Adding Message Function**

In order to evaluate the usability of the “Adding messages” section, five questions were designed for users to respond to: **Is it easy to understand how to input the keywords field? Is it useful that the system automatically checks whether the message belongs to this topic folder? Is the web pages user friendly and clear? Is it useful that users can add additional keywords offered by the system before the message is posted? Is it useful and helpful for students that the system show all of the previous relevant messages?**

The questionnaire results showed that all evaluators thought this function was very useful for students to post a message in the discussion forum, and fourteen evaluators considered that showing relevant messages could help students effectively and efficiently in capturing and retrieving knowledge, and only one male teacher had a different opinion. Eleven evaluators (two male teachers, one female teacher, two male postgraduate students, one female postgraduate student, and five undergraduate students) thought the web pages were friendly and clear. The biggest problem of this function is that six evaluator (two male teacher, one female teacher, one female postgraduate student, and two female undergraduate students) did not think that it is easy for students to understand how to input the *keywords* field.

#### **Section 4: Search Function**

In order to evaluate the usability of the “Search Function” and “the Keyword Map” section, there were five questions for users to respond to: **Is it easy to use search function (Keywords Search and Keywords Directory)? Is it useful for users to use Keywords Search function? Is it useful for users to use Keywords Directory function? Is the keyword map useful and helpful? Are the web pages user friendly and clear?**

Fourteen evaluators (except one male teacher) thought that the search functionality was useful for students to find useful and relevant information in the discussion forum. Ten evaluators (two male teachers, one female teacher, three male undergraduate students, two female undergraduate students, and two male postgraduate students) considered the keyword map as useful and helpful. Three evaluators (one male teacher, one female teacher, and one female postgraduate student) thought that the

keywords search engine could be developed as a metadata search engine where users could select different topic categories to search information. All evaluators considered the web pages were user friendly and clear.

### **Section 5: The advantages and disadvantages of the system**

In order to evaluate the advantages and disadvantages of the overall system, three questions were designed for users to respond to: **From your point of view, what are the reasons you would like to use this web-based discussion forum system? What are the advantages of the web-based discussion forum system? What are the drawbacks of the web-based discussion forum system?**

Nine evaluators (two male teachers, one female teacher, two male postgraduate students, two female postgraduate students, and two male undergraduate students) thought that the advantage of the prototype system is that students could easily share and retrieve knowledge. More useful information in the discussion forum is the reason why fourteen evaluators (except one male teacher) liked using this discussion forum system. All evaluators considered that the drawback of the prototype system is that the system was not intelligent enough to judge whether one message belongs to a particular topic folder or not, and the search methodology was not effective enough for finding searching results with high precision. The current implementation may require teachers to confirm too many messages which the system identifies as not belonging to the topic folders in which students have posted them. If the system could not provide more accurate search results for students, students would post the similar messages and queries again in the discussion forum. Therefore, the objective of the project to enhance the ability of capturing, retrieving, and sharing knowledge would not be fulfilled.

#### **5.4 Limitations and solutions**

According to the feedback from the questionnaires, the biggest limitation of the current prototype system is that it is not intelligent enough to identify accurately whether one message belongs to a particular topic folder or not, to reduce duplications in the discussion forum, and to find most relevant information for users. The teachers

still have a burden to manage the discussion forum because there may still be too many new messages which need to be confirmed. Moreover, keyword search methodology and concept-based search methodology which are used as search methods in this prototype system are not effective enough to help users find most accurate and relevant information in the discussion forum. The problems suggest that the system still needs a better solution to help users capture, retrieve, and share knowledge in effective and efficient manner.

To solve these problems, artificially intelligence technology can be used in the discussion forum system to analyse the words of each message so that the system becomes more intelligent like humankind to correctly judge whether a message belongs to one particular topic. Furthermore, a more advanced search methodology, namely natural language processing, can be used as the main search method in the discussion forum system to help users obtain more accurate and relevant information, when they post a message or use search functions.

## **5.5 Summary**

This chapter introduced the evaluation process of the prototype system. The prototype system has been developed to fulfil the goal of enhancing the ability of knowledge management by using Web communication technologies. According to the feedback of the questionnaire, the prototype system is considered as a better solution in helping students easily capture, retrieve, and share knowledge and relevant information compared to the traditional discussion forum system. Furthermore it reduces the heavy burden of teachers to manage the discussion forum. However, the biggest limitation of the prototype system is that it is not intelligent enough to understand all messages, and the search methodology is not effective enough to help users find the most accurate and relevant information in the discussion forum. Artificial intelligence is suggested as a better solution to improve the usability of the prototype system in the future works. In the next chapter, the conclusion of the thesis and future possible work will be introduced.

## **Chapter 6 Conclusion and Future Work**

### **6.1 Conclusion**

In the tertiary educational area, the web communication technologies have been used for a long time for communication among students and teachers. The discussion forum system is one important type of web communication tools. This thesis suggested an advanced category of web-based discussion forum system to enhance the ability of knowledge management in the tertiary educational area. There are some particular characteristics of the web-based discussion forum system developed in this project that put it apart from traditional web-based discussion forums: When the student posts a message into a particular topic folder in the discussion forum, the system automatically identifies whether the messages belongs to that particular topic folder or not. If it does, the system shows all previously posted relevant messages for students to view before the message is added into this topic folder. Students can decide whether or not they still want to post their messages after viewing all relevant messages. It reduces the duplication of messages in the discussion forum. Moreover, there are two search functions for students to find knowledge and relevant information in a fast manner rather than suffering from a large amount of previously posted messages in each topic folder. It reduces the heavy burden that teachers encounter during managing traditional discussion forums. According to the formative evaluation, the prototype system is considered to be able to help students capture, retrieve, and share relevant knowledge and useful information by an easier and faster method.

### **6.2 Future Work**

Although the prototype system achieves all the anticipated objectives and has some additional advantages over the traditional discussion forum system, the system can be improved in many ways. The most important thing, which needs to be improved, is to adopt a better methodology to make the prototype system more intelligent, not only for judging whether a messages belongs a particular topic folder, but for a better search methodology to find more accurate and relevant information. In future work,

the natural language processing technology will be suggested for message processing in the discussion forum system. The future system will be more intelligent like humankind to correctly understand the meaning of the message to judge whether a message belongs to one particular topic or not, though context will still be an issue for long time to come. Furthermore, the system will provide more accurate and relevant information to users, when users post a message or use a search function. It means students can capture, retrieve, and share relevant knowledge and useful information by a more effective and efficient method in the future system.

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## Appendix

### A1. Questionnaire

#### Section 1: Log on and Registry

To what extent do you agree with each of the following statements regarding Log on page and Registry page in this discussion forum system?

**5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, 1 = strongly disagree**

1. It is easy to register in this system. <b>Answer:</b> _	5	4	3	2	1
2. It is easy to log on in this system. <b>Answer:</b> _	5	4	3	2	1
3. It is easy to understand which option to select after log in. <b>Answer:</b> _	5	4	3	2	1

#### Section 2: Creating New Topic Folder Function

To what extent do you agree with each of the following statements regarding creating new topic folders page in this discussion forum system?

4. It is easy to create a new topic folder. <b>Answer:</b> _	5	4	3	2	1
5. It is easy to understand what should be input to create a new topic folder. <b>Answer:</b> _	5	4	3	2	1
6. It is better to have teachers' conformation for creating a new topic folder to allow students to create any topic folders anywhere in this system. <b>Answer:</b> _	5	4	3	2	1
7. The format of pages for creating new topic folders is user friendly and clear. <b>Answer:</b> _	5	4	3	2	1

**Section 3: Adding Message Function**

To what extent do you agree with each of the following statements regarding adding messages pages in this discussion forum system?

8. It is easy to understand how to input the keywords. <b>Answer:</b> _	5	4	3	2	1
9. It is useful that the system automatically checks whether the message belongs to a particular topic folder. <b>Answer:</b> _	5	4	3	2	1
10. The format of message pages is user friendly and clear. <b>Answer:</b> _	5	4	3	2	1
11. It is useful that system offers additional keywords by checking the message’s content. <b>Answer:</b> _	5	4	3	2	1
12. Before the message is posted, it is useful and helpful for students that the system shows all previously posted relevant messages. <b>Answer:</b> _	5	4	3	2	1

**Section 4: Search Function**

To what extent do you agree with each of the following statements regarding search function pages in this discussion forum system?

13. It is easy to use search function (Keywords Search and Keywords Directory). <b>Answer:</b> _	5	4	3	2	1
14. Keywords Search function is a useful functionality. <b>Answer:</b> _	5	4	3	2	1
15. Keywords Directory function is useful functionality.	5	4	3	2	1

<b>Answer:</b> _	
16 The keyword map is a useful and helpful functionality. <b>Answer:</b> _	5    4    3    2    1

**Section 5 advantages and disadvantages of the system**

17. From your point of view, why would you like to use this web-based discussion forum system? (Choose one or more options: 1, 2, 3) **Answer:** \_

- Less useless information
- Faster to get useful and valuable information
- Easy to use

**Other reasons:**

18. What are the advantages of this web-based discussion forum system? (Choose one or more options: 1, 2, 3). **Answer:** \_

- More efficient and effective in obtaining useful information
- Knowledge can be easily shared and retrieved
- In a long run, it can be less burdens for teachers to manage the discussions

**Other advantages:**

19. What are the drawbacks of this web-based discussion forum system?

(Choose one or more options: 1, 2, 3). **Answer:** \_

- The system is not intelligent enough to judge whether the message belongs to a particular topic folder.
- The search methodology is not good enough for users to obtain most accurately relevant information.
- Difficult to understand how to use the system

**Other drawbacks:**

**Section 6: General Questions**

20. How familiar are you with discussion forums? **Answer:** \_

- 1 Never used
- 2 Really used
- 3 Often used.

21. How familiar are you with search engines? **Answer:** \_

- 4 Never used
- 5 Really used
- 6 Often used.