國 立 交 通 大 學

資 訊 工 程 系

博 士 論 文

一個植基於歷程檔案的學習系統架構

A Framework of Portfolio Based Learning System

研 究 生：林獻堂

指導教授：袁賢銘 博士

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摘要

本文提出一個以學習歷程為基礎的整合式平台，藉由這個平台的機制，讓學生，尤其是學習成效不佳的學生，可以得到課前、課堂、與課後的協助。知識經濟時代的來臨，使得知識成為保有個人與國家競爭力的必要條件之一。知識的取得可以透過學校中正規劃的學習，以及終身學習來達成。在這個資訊通訊科技發達的時代，知識的產生、累積、與汰換正以無比快速的步伐發生。這使得學校教育必須要提供讓學生可以得到更好學習成效的策略，讓學生可以具備更多知識。此外，更需要讓學生培養出如何學習的能力，使得學生離開校園後，可以透過終身教育與自我學習的方式，保有自我競爭力所需要的知識。

要達到這個目標，本論文所提出的方式為藉由下列的方式來達成。1:)課堂內老師與學生之間的互動性，會顯著影響學生的學習成效。老師會藉由各式方法來提高互動性，其中一種為藉助藉由教室即時回饋機制來提升教師與學生的互動性。本文所提出的策略有別於傳統的方式為：除了是非選擇之外，也具有其他的互動內容(如填充)，以及提供個別化的協助與提醒。2:)以學習歷程來蒐集與記錄學生的學習狀況，此紀錄過程包括客觀的形成性與總結性評量，以及主觀的學習反思。本文提出以代表性的社交運算(social computing)平台─部落格來建置學習歷程，文中提出了 Blogfolio 的架構。3:)以學習歷程檔案的內容，對於學生學習的成效與方向，給予立即回饋，讓學生可以及時的修正自己的學習成效，也讓老師可以及時的介入。4:)補救教學是教學的重要一環，尤其在此教育普及，學生基本能力差異性比以往擴大的情形下，補救教學更形重要。本文提出透過網路化精熟學習的機制，讓學生進行補救教學，以達到學習的目標。5:)學生的學習歷程檔案，是一個最具代表性的內容，比起傳統的成績單或是老師評語更具代表性，因此本文提出透過電子簽章的方式，讓學生的學習歷程資料具有認證的能力，可以作為過渡到下一個時期，例如求學或是就業的依據。

A Framework of Portfolio Based Learning System

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Abstract

In this thesis, a networked integrated learning platform on the basis of learning portfolio is introduced. Students, who have poor learning outcome, receive suitable assistance in pre-class, in-class, and after-class learning. Knowledge is one of the key factors to keep national and personal competitiveness in this knowledge economic era. Knowledge is acquired through formal education in school and lifelong learning after leaving school. The generation, accumulation and phase out of knowledge are in an ever fasting pace in this information communication technology era. As a result, school education should provide a system so that student gets a better strategy to promote learning outcome and learn more knowledge. In addition, students should have the ability of learning to learn, then they may have the contemporary knowledge to keep their competitiveness through lifelong or self learning after leaving school.

To achieve the objective, an integrated learning platform is proposed in this paper, it consist of following approaches: 1:) The interaction in classroom significantly affects student's learning outcome. Teachers sometimes promote interactivity with various approaches, one of which is classroom response system. In this paper, an approach differs from traditional one is proposed, it includes not only yes/no or multiple choices problem but also other forms (such as fill in blank). In addition, an in-class discussion called message loop is also introduced, it allows students and teacher make bidirectional discussion in an anonymous, convenient, and easy manner. 2:) A learning portfolio, which is an essential and central part of the proposed platform, is used to collect and record student learning situation. It consists of student's learning reflection, homework assignment, quizzes, files, etc, and can be used for formative and summative learning. In this thesis, a portfolio framework based on blog, which is a social computing platform, called blogfolio is introduced. It has many advantages over traditional ones. 3:) A recommendation message inferred from learning portfolio

is given to student; it reflects student's learning effect and direction in time. So that student can adjust learning, and teacher may notify student learning in time. 4:) Remedial learning is an important part of teaching. In this thesis, a mastery learning approach is adopted to allow student gets mastering learning content after class. 5:) Finally, a learning portfolio represents a student's learning outcome, and it is more authentic than traditional one. To allow students present this learning portfolio as an evidence of learning outcome and achievement when seeking a job or entering higher education system, a digital signature is attached on this learning portfolio for official certification.

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Introduction

Learning activity is not only in class, but also before and after class. To leverage student learning outcome, issues associated at these stages should be taken into consideration. In this thesis, an integrated learning platform on the basis of learning portfolio is presented. This platform adopts classroom response system (CRS), mastery learning, learning status report, and learning reflection to provide student a comprehensive learning assistance.

1.1 Background

The education level of a nation affects its competitiveness. Providing pervasive education opportunity to its citizens is one of key issues a nation should address (Garelli, 2003). In general, people receive formal education through school system. Once upon a time, the knowledge people acquired at school is valid and extended for a certain time in their career. Recently, the accumulation and progression of knowledge is increasing at a rapid pace never seen before due to the proliferation of information and communication technology (ICT). Consequently, school education is no longer enough; people not only should learn more at school but also keep learning after leaving school. Therefore, a school should adopt more effective approaches to promote student learning outcome, and provide opportunity for learning to learn.

In addition, the more pervasive of education the more people get into school to learn. The deviation between students is enlarged. There are about one million and three hundred thousands students in higher education at school year of 2006 in Taiwan, and the gross enrollment ratio is about 83% for this stage, while there were only half of students and the gross rate of in-school was about 35% at school year of 1992

(DBGAS, 2007). The proliferation of higher education causes more students have opportunity to enter higher education system, however the rapid increasing in quantity of students enlarges the divergence between students. As a result, some students may not catch up teacher's teaching pace, as the majority of students do. In such circumstance, remedial learning opportunity should be given to those backward students. Furthermore, School learning does not merely contain activity in class; it starts at student previews material to be taught. Afterward, the main learning activity happens at classroom where students and teacher interact with each other. Consequently, it induces a bigger challenge for education system which should spend more effort on this issue, so that students can get the sufficient domain knowledge to fulfill the requirement of career life.

Learning motivation is one of the key factors that affect learning outcome. If students do not have strong learning motivation or learning is a mean for deferring career life, then it will have negative impact on learning outcome (Harlen, & Crick, 2003). Chen (2007) point out that, currently, there are about twenty-three million students in higher education in China, a certain amount of them came from rural area or western China and have the responsible for glorying their whole families. Therefore, Chinese students sometimes have stronger learning motivation than Taiwanese students. Consequently, they may become stronger competitors. Accordingly, educational system should provide some ways to stimulate student's learning motivation and leverage learning outcome.

Nowadays, students take more time on extracurricular activities, and the difference between peers may enlarge which increases the barrier on learning. On the other hand, students normally have higher acceptance than their elder generation on the technological products or services provided by technology, and they take less time to

familiar with these products or services. It opens an opportunity to achieve the goal of leveraging student learning outcome with technology. In this thesis, information communication technology is used to leverage student learning outcome, such that students not only learn domain knowledge but also have the ability of learning to learn. Besides the activity in class, learning activity also includes one before and after class. The learning deficiency in classroom should be covered by previewing and/or reviewing. However, students, who need preview and/or review their learning content, sometimes rarely do that. Consequently, it results in worsen learning situation. In addition, people normally assume university students are adults and have self regulated and managed ability, therefore they seldom remind students. As a result, students may be not quite sure about their learning situation. When they notify the learning difficulty, it sometimes has been a certain period of time, and the learning is far behind others. Therefore, it is important to be alert against situation gets worse. Accordingly, students should get information about their learning situation in real time manner, so that they have sufficient time to adjust their learning before getting worse.

Traditionally, teacher conveys knowledge to students with oral or some forms of demonstration most of the time at classroom. This paradigm has being gradually shifted to an active approach in which students construct knowledge actively while teacher no longer acts as a knowledge conveyer but a facilitator to assist student knowledge construction. In addition, some activities have being introduced into class to promote interactivity at classroom. Even a talent can not thoroughly grasp all content taught in class, students should allocate time to review material has been taught. There are two issues about reviewing. First, it should make sure students do take time on reviewing. Second, it should be effective on this reviewing. If the above

two issues can't be fulfilled, the effectiveness is discounted. A semester usually takes around tens of weeks; therefore students sometimes ignore their learning tendency towards failure in some courses. As a result, students may need to retake same course again, or they may be banned for studying subsequent courses. At the end of course, students usually get a mark on the basis of their learning outcome. This mark gives a general idea about student learning outcome, but lack of detail information on learning process.

The characteristics of the computer network have had positive impacts on learning (Lin, Kuo, & Yuan, 2004; Kearsley, 2000; Jonasson, Peck, & Wilson, 1999; Relan, & Gillani, 1997). They include: a) learning tools: treating the computer network as a tool for acquiring knowledge and for collaborative study, with a shift from acquiring knowledge from the computer to acquiring it with the computer. b) Connectivity: linking the network and e-mail to enable interactivity among classmates, teachers, parents, and domain experts. c): student-centered: placing the learner at the center and treating the teacher as the information provider. The teacher's role is to feed motivation and provide direction, with the student as the active thinker and learner. d): knowledge sharing: delivery of knowledge is expanded and innovative inspiration encouraged. In this way, ICT becomes a tool for promoting knowledge acquisition, a vehicle for learning by doing, a platform for collaborative learning and even a mechanism for assessing and presenting learning performance through the network.

1.2 The issues

In this thesis, the issues concerning learning before class, in class and after class are addressed to leverage student learning outcome at school learning with ICT technology. It can say that ICT may act as a mean to persuade and engage students in learning. Fogg (2003) defined persuasive technology as any interactive computing

system designed to change people's attitudes or behaviors. The emergence of the Internet has led to a proliferation of web sites designed to persuade or motivate people to change their attitude and behavior. Web sites are the most common form of persuasive technology today. With regarding to education issue, computing system, especially web-based system, provides tremendous advantages on persuading student to learn. By incorporating simulation or multimedia content into learning material student gets easily understanding. The earliest signs of persuasive technology appeared in the 1970s, when a few computing systems were designed to promote health and increase workplace productivity. One of the earliest examples is a computer system named Body Awareness Resource Network (BARN), developed in the late 1970s (Fogg, 2003). This pioneering program was designed to teach adolescents about health issues such as smoking, drugs, exercise, and more, with an ultimate focus on enhancing teens' behaviors in these areas. Fogg stated six distinct advantages computing system over human persuaders: be more persistent than human beings; offer greater anonymity; manage huge volumes of data; use many modalities to influence; scale easily; go where humans cannot go or may not be welcome.

The approaches, which are used to assist students learning, center on learning portfolio. A learning portfolio contains learning records a student generated in learning; it imports or accepts any material, which is associated with a student, gathered by learning tools and provides information to any learning tool that needs it. Pedagogically speaking, portfolio is a process which systematically and purposefully collects artifacts or works created by students. These works and artifacts not only can be treated as a reference to improve students' learning process, but also as a learning outcome when passing into next learning stage or seeking a job. The content of portfolio may be built by different approaches. In traditional way, portfolio consists of

printed material such as writing, painting, or audio/video clips which are all put into a document file folder. At this information technology age, traditional file folder is replaced with computer file system in which works or artifacts are archived in a more convenient manner. This kind of portfolio is called e-portfolio or digital portfolio. The issues related with before, in and after class are described below.

Before class

It is recommended that a student should comprehend material has been taught and preview material is going to be taught before class, then the learning outcome can be maximized. It assumes that students understand this concept and take appropriate action accordingly. However, the true is that not many students follow this rule, especially for those students who are backward and must follow. To assist or persuade them, first of all a suitable tool should be given. In this thesis, a learning status report is given to provide students comprehensive information about their own learning situation. Then, they can adjust their learning pace accordingly.

In class

The key issue in class is to engage students into learning activity, so that they can concentrate on lecturing topic. Classroom response method is one of the approaches to this issue. It can adopt many methodologies and technologies to construct classroom response. In this thesis, a survey on existing methodologies was conducted. Then, a new approach was proposed.

After class

The mastery learning approach is proposed in this thesis to assist students learn after class. The basis of mastery learning partially originated from Carroll's concept

(Carroll, 1963). The general concept about teaching and learning had radical change after Carroll advocated a new teaching concept. His teaching concept suggested that teaching should focus on individual student needs different time to learn same material. This suggestion is in contradictory with traditional model which allocating same period of time to all students to learn same material. Afterward, when Benjamin Bloom took part in a research called "effectiveness of individual difference to learning", he was deeply affected by Carroll's concept which leads to the concept of mastery learning (Bloom, 1981, 1968). He gave a further elaboration: 1:) because aptitude might be used to forecast learner's learning rate, a predefined learning content might be set 2:) therefore, attention should be paid on teaching variables controlled by teacher, such as opportunity of learning and quality of teaching, 3:) finally, teacher should guarantee every student can achieve predefined course objective. In summary, Bloom claimed giving sufficient time and good quality of teaching, almost every student learns well.

The issues accompany with mastery learning are: 1:) a way to verify student learning outcome; 2:) a remedial learning opportunity should be provided to students who did not mater the content; 3:) this learning material should provide comprehensive contents to allow students learn by themselves after class; and 4:) it should guide students reflect their learning. For issue 1, the information received from CRS unit is a reference about student's mastery. A customize mastery learning unit dedicates for issue 2 and 3. This unit provides content about material has been taught in class with substantial extra material and hints to assist students take remedial learning. A learning reflection, which is on the basis of social computing, is for issue 4. One of the most suitable media is blog. The framework and implementation detail are at subsequent chapters.

Portfolio package

After the student has completed the course, all records were kept in database. The student can copy, download, retrieve, and access his/her records in a portable package form for continuing education or job employment. Since the packaged records can be used as a pass along portfolio or part of a resume for a job application, they will have to get a certificated copy for accountability and highly credible if they are to be presented as an objective reference. In this thesis, the MD5 (Message Digest) is chosen to accomplish this goal. The MD5 (Rivest, 1992) was developed by Professor Ronald L. Rivest at MIT. The algorithm can transform a data chunk of any length into a 128 bit fingerprint or message digest. The basis of this algorithm comes from the following assumption. Two chunks of data will never produce the same message digest, and given a message digest, it is impossible to reverse it back to the original data. Basically, MD5 is a way of checking data integrity and is more reliable than other methods, such as Checksum.

1.3 An integrated learning platform

On the basis of issues stated above, a portfolio centric integrated learning platform is proposed in this thesis. The learning portfolio serves as repository for other units, such as mastery learning, learning status report, and classroom response system which are associated with after class, before class and in class learning respectively. The learning status report unit takes student's learning portfolio as input parameter, and forecasts student's learning trend, then gives suggestion to student before next class comes. If a student can have such information before learning gets worse, he or she may adjust learning attitude. On the other hand, the CRS unit serves as a tool to promote interactivity in class, and consequently leveraging student's learning outcome and satisfaction. The data generated by students are archived into portfolio. When a

student did not get mastery on material taught after class, the mastery learning takes its role to assist student get mastering the subject.

1.4 Outline of thesis

The remainder of this thesis is organized as follows. The integrated framework is introduced in next chapter. The third chapter introduces classroom response system which promotes the interactivity in class. Forth chapter gives detail description and implementation of mastery learning which serves as a way for remedial learning. Portfolio package and a customizing learning management system are presented in chapter five. The chapter entitled “reflective journal” discuss some implementation issues and findings. The conclusions and suggestions are in last chapter.

Chapter 2

The portfolio framework

2.1 Introduction

Pedagogically speaking, creating a portfolio is a process which systematically and purposefully collects artifacts, works, learning process details and achievements created by students. The contents of a typical portfolio are lecturing notes, homework assignments, extended learning material, learning reflections, and files archives. The purpose of such a collection is to archive documents, showcase student performance, and to be a reference for further usage. Meyer, Schuman, & Angello (1990) defined a portfolio is a purposeful collection of student work that tells the story of the student's efforts, progress, or achievement in the given areas. Sharp (1997) suggested that most portfolios share three key elements in common: students must collect, make selections from and reflect on their own work. The content of a portfolio may be collected and recorded by traditional or electronic approaches. It is called e-portfolio in electronic version. In the traditional approach, a portfolio consists of printed material such as written works, paints, or audio/video tapes which are all put into a document file folder. In contrast, an e-portfolio consists of computer files. Barrett (2003) stated that an electronic portfolio allows the portfolio developer to collect and organize portfolio artifacts in many digital media types (audio, video, graphics, and text). Teachers assess students' learning performance by the content of their portfolios instead of traditional paper and pencil tests gradually. It is called "portfolio assessment". It has been proved that portfolio assessment is more effective and authentic than traditional approaches (Mason, Pegler, and Weller, 2004; Lin, Liu, and Yuan, 2004). Lawson, Nestel and Jolly's (2004) evaluation result showed that students reported that the

e-portfolio was relatively easy to use. They have expressed mixed levels of confidence in the technology. Writing up reflections was an unfamiliar concept to these students and this created additional challenges. Pullman (2002) described an electronic portfolio called **efolio** which enables students to concentrate on writing rather than on technology and to create an electronic environment conducive to student-outcomes and program assessment. Although an e-portfolio is richer than traditional and is also easer, it can be further enhanced with the advanced of information and communication technology (ICT).

ICT provides powerful computing and communication approaches which facilitate information gathering, sharing, analyzing, and archiving. The blog is one of the most popular services on the web, especially on web 2.0. Gordon (2006) described a blog as a mini website where individuals can record their activities, thoughts, musings, and ramblings for others to read and comment on. The simplified blog architecture is shown in figure 2-1. A blog consists of articles which can be organized into different categories, archives, photos, and system setting. To explain the concept of Web 2.0 to the public, O'reilly, one of originators of web 2.0 term, stated that a personal web site is an example of web 1.0, whereas blogging is in the era of web 2.0 (O'reilly, 2006). Karger and Quan (2005) pointed out that, blogs turn web content consumers (end users) into web content producers, which is one of initial goals of the web.

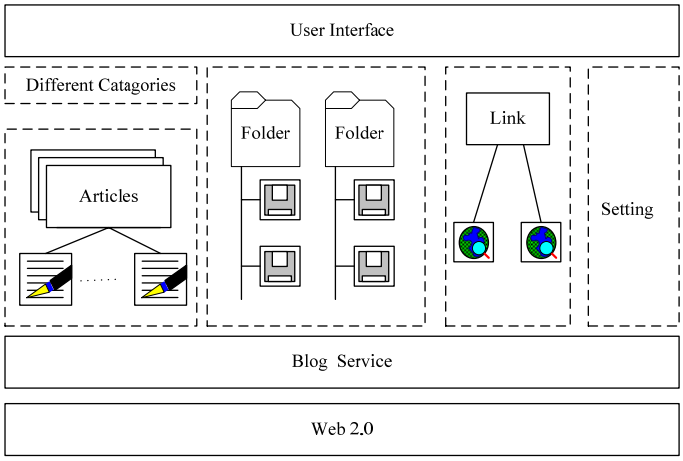


Figure 2-1: blog architecture

Blog is a kind of social computing or social networking. Social computing is defined as any type of computing application that serves as an intermediary or a focus for a social relation (Kwai and Wagner, 2007; Schuler, 1994). Kwai and Wagner (2007) review weblogs and their role as a social networking device for young people. They categorized participants into four types which are labeled as habitual, active, personal and blogging lurker on the basis of usage intensity. They derived the needs-technology fit model in which the relation between needs and technological feature is clarified from the task-technology fit model. With regard to learning, students who maintain portfolios on blog should be at least personal type, and promoted to active or even habitual type with technology used fits their needs.

2.2 The Portfolio

There are many well definitions about portfolio, we do not create a new but adopt an existing one to the proposed framework which is based on the e-portfolio expert Barrett's definition. The reasons for choosing Barrett's definition are: it clearly defines the process of a portfolio should be. It does not emphasize assess, as many portfolio definitions do, too much but on reflection and projecting. It fits the above mentioned advantages of a blog system. Barrett said:" ….electronic portfolio….is to

get students to **collect** (create their digital archive), **select** the key pieces, **reflect** on their growth over time, **project** their future goals, and **respect** their work through sharing with a wider audience" (Barrett, 2003). The proposed framework provides suitable functions to fulfill the collect, select, reflect, project, and respect task. The relationship between a portfolio and participants is shown at figure 2-2. No matter what technology is used, in order to align to traditional portfolio, an electronic portfolio system should at least have following functions:

- Provide suitable interfaces for different users, such as authors, teachers, and administrators to perform their task;
- Keep with the advance of technology;
- Provide integration capability with other educational systems, such as a campus wide administrative system, or a curriculum scheduling system

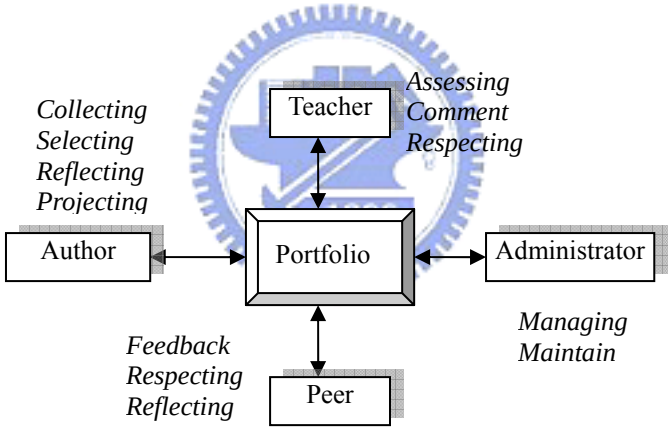


Figure 2-2: relationship of a portfolio with participants

To illustrate the usage of portfolio, a simple usage flow is shown in figure 2-3, and listed below:

1. First of all, Authors collect all material, files, articles, notes, or assignments into a portfolio, then
2. Authors select the collected material they are willing to showcase to peers or teachers and place them in categories,

3. Authors usually reflect on their learning situation by self assessment, teacher comments, and viewing content of their portfolios, then
4. Authors project and adjust their learning attitude and approach according to the results of the self reflection,
5. Authors present their portfolios to peers or teachers, and are willing to receive comments from peers and/or teachers.

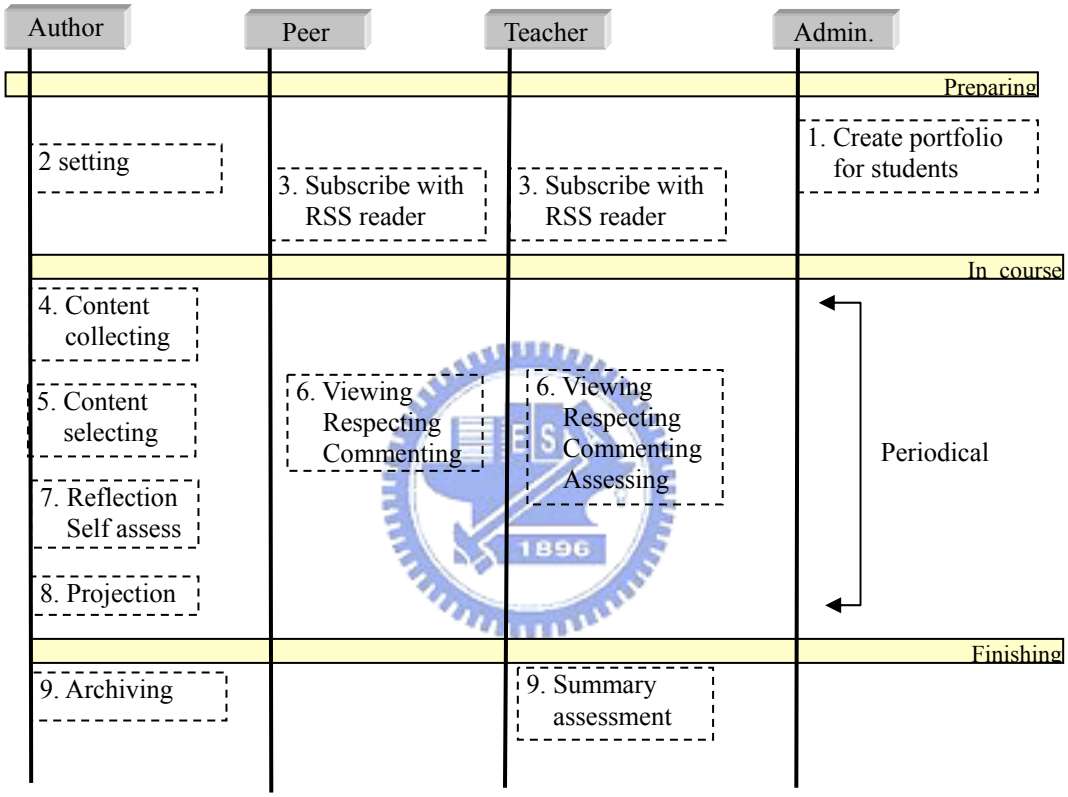


Figure 2-3: usage flow of a portfolio

2.3 System Framework

The propsoed framework is shown at figure 6-4. It consists of four levels: course, module, system, and user level. Each level is decsribed as follows.

Course level:

As stating in previous chapter, learning activity is involved before, in and after class. Learning activity has different task at each stage. Preparation is main task of before

class stage, while interactivity and engagement is important in class, and reviewing and getting mastery is task of after class stage. This framework provides modules for each of stage.

Module level:

Three modules, which are learning status report (LR), classroom response system (CRS), and mastery learning (ML) module, are at this level. These modules have their own functional unit and database. Each of them emphasizes on one stage, namely LR for before class, CRS for in class, and ML for after class. These units will be described in following chapters in detail.

System level:

System level serves as platform for users and modules. There are three units inside the system: learning management (LMS), portfolio, and database management unit. LMS provides functions for managing student and course related information such as syllabus, lecture notes, student marks, etc. The content of LMS comes from users such as student, teacher, and school administrator through user interface, as well as modules such as CRS, ML, and learning reflection through system interface. The portfolio focuses on collecting, selecting, reflecting, respecting, and presenting student's learning. The detail description on the architecture and implementation of a portfolio has been discussed at previous section. Generally speaking, the web 2.0 focuses on good user experience and customization. The major web service providers such as Google and Yahoo gives customers free to customize their user interface and arrange the information presentation style. In this framework, such a user interface is proposed. Selecting and arranging the portfolio content to peer or teacher in a customized style is another way students show and share their learning outcome. The

database unit serves as central repository for LMS and portfolio.

User level:

User level takes care of user interface for participants of a portfolio. It is the main portal for all participants. As stated at previous paragraph, web 2.0 is the core technology of user interface, especially blog, tag, and syndication.

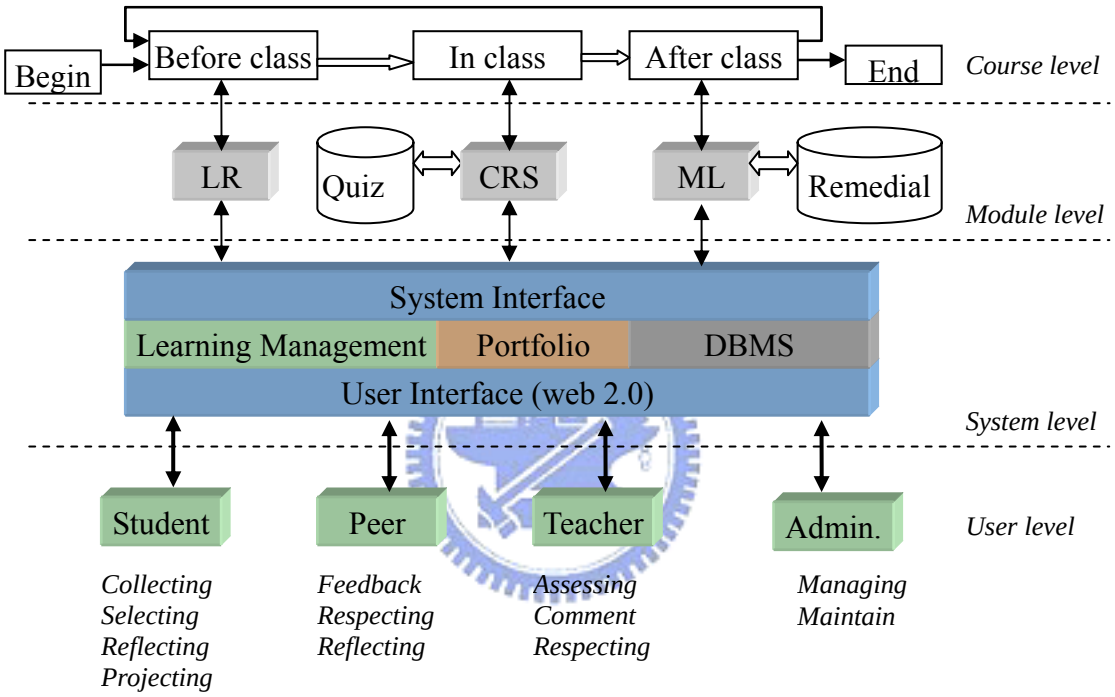


Figure 2-4: the system framework

2.4 Portfolio Implementation

With regarding to implementation of a portfolio, Lin, Kuo and Yuan (2007) proposed a kind of portfolio built on blog service called blogfolio. A blog basically does not fit exactly to a portfolio, some modifications which are stated at table 2-1, should be made. The blogfolio does not establish a new type of virtual community beyond Henri and Pudelko's four types of virtual communities. It fits into the learners' community because of the maintenance of a portfolio strongly depends on the tutor (Henri and

Pudelko, 2003).

Table 2-1: functions added to create blogfolio

	normal blog functions	functions added
collect	A password protected interface lets author adds/modifies/deletes posts, articles, links. All the posts, articles, links issued by author are open to public.	A new function is added to let author decides if a post, article, link, etc., will be open to public or not. The default is yes.
select	No such function	A new function is added to let authors select items from blog they are willing to showcase in their showcase category.
reflect project	A password protected interface lets author adds/modifies/deletes posts which are for learning reflection and projection purposes	A default folder called reflection is added to the blog for collecting reflection/projection.
respect	Visitors can view all content issued by author, and freely give comments to all posts.	Visitors can view contents in the showcase category. If the author uses default setting, the content is shown automatically.

A comparison between traditional portfolios, electronic portfolios and blogfolio was made. The items compared are collection, selection, reflection, projection, versatility, and ease of use. The result of the comparison is shown in table 2-2. Blogfolio is superior to other types of portfolios although the lack of authentication is an obvious shortage.

Table 2-2: a comparison among traditional, digital and blogfolio

item	advantages	disadvantages
traditional	Easy to implement, Basically without any extra devices such as computer. Authentication with ease, Keep privately	Difficult to maintain, showcase, and long term storage, Many different type of medias such as paper, video/audio tapes, pictures, photos,…

electronic	Easy to maintain, showcase, and long term storage, All content are in digital format, Ease to transfer to other location, Has multimedia capability Good authentication	Need computer system, Most of the systems are tailored made system with own data or database format Difficult to upgrade to keep the advance of technology
blogfolio	Based on web 2.0, Ease to build with open source solution, Easy to maintain and upgrade system functions, Easy to maintain, showcase, and long term storage, All content are in digital format, Ease to transfer to other location, Easy to interact with others, multimedia enriched content, Ease to interface with mobile or telecommunication devices	Lack of authentication

2.5 Summary

The portfolio centric framework was presented in this chapter. Four levels are classified at this framework with regarding to learning activity. The objective of this framework is to provide a comprehensive learning portal for student, so that student learning outcome is significantly increased. The detail about a portfolio was also presented. The framework adopts a definition of portfolio which includes activity of collecting, selecting, reflecting, respecting, and projecting. A blogfolio which consists of blog and portfolio was proposed and introduced in this chapter, and a comparison between different implementations was made. The blogfolio has many advantages over other implementation except lack of authentication. It is not a problem in this framework, because the authentication process goes through the learning management unit.

Chapter 3

Classroom Response System

The interactivity is one of key factors that affect learning effects in class. To promote interaction at learning, a classroom response system, which has been shown that is an effective way, was introduced around 1980s. Its nature of simple but effective makes it becomes popular nowadays. Although, simple is one of its advantages, it is inadequate to cover some kinds of activities which need functions such as bidirectional interaction and items other than yes/no or multiple choices. To address such problems, a hybrid way which combines SMS and web-based approaches to promote interactivity in classroom is presented in this chapter.

3.1 Background

Some research results showed that interactivity in classroom helps leveraging more active learning environment, constructing learning community, providing more detail feedback to teacher, and promoting student's learning motivation (Markett, Sanchez, Weber, & Tangney, 2006; Muirhead & Juwah, 2003; Anderson, 2002). In addition, interactivity is one of the key factors that affect learning outcome in traditional classroom (Chou, 2003). There exists significant relationship between learning outcome and learning activity, a better activity in learning environment leads a better learning outcome. The best interactivity in teaching is that teacher knows student learning situation well instantly, students have deep participation in classroom, and a convenient communication channel exists between teacher and students. Learning can be more effective through promoting interactivity (Erickson & Siau, 2003). There are many definitions of interactivity. Bannan-Ritland (2002) classified interactivity into five categories: interactivity can be defined as 1) learner's active participation, 2)

interactive template between learner and teacher, 3) the communication between learner and teacher, 4) the social, cooperative, or collaborative interchange, and 5) scope of teaching activity and technology. Sims (2003) claimed that communication and engagement are the most important characteristics of interactivity. From the viewpoint of learner's relationship, Moore (1989) defined three major interactivities: learner-content, content-instructor, and learner-learner. Moore adopted a more general and concentrated structure to define interactivity. Yacci (2000) defined interactivity with message loop which is initiated both at beginning and end by students. The content of message loop must keep consistency from beginning to the end. To reach the goal of interactivity, teacher usually keep watch student's learning situation and engage student into learning situation with some adequate activities in classroom. Traditionally, teacher may implement interactivity through observing student reaction, posting question and answer, or asking students whether they understand content or not. There are several problems in traditional approach:

- Students sometime are not very sure whether they comprehend learning material taught by teacher, therefore they can't form a concrete question or express their comprehension confidently.
- Even students have questions about learning material, they may hesitate to rise due to they feel embracement or are afraid of laughing.
- Teacher may make sure student comprehension with in-class quiz, but it may delay the teaching schedule and needs to take time grading.

3.2 Classroom Response System

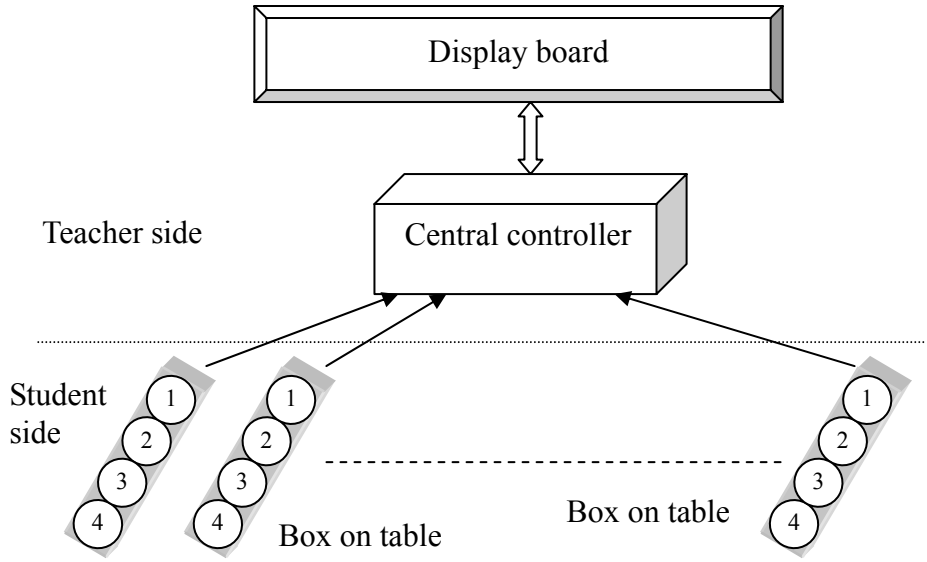


Figure 3-1: concept sketch of a classroom response system

To promote interaction at learning, a classroom response system was introduced around 1980s (figure 3-1). Traditionally, this system consists of a large displayer which is connected to a central controller located at teacher side, an answer box, which contains several buttons, allocated for each student, and wiring for connecting answer box with central controller. In such implementation, when a teacher wants to check whether students understood lecturing content, he or she may post multiple choices or yes/no question to all students, then students submit their answer with the answer box anonymously. The central controller automatically connects answer posted by each student, since every answer box is wired to it. The displayer shows that how many students answer for each choice in various forms. Teacher can understand student comprehension about the content just taught. On the basis of this result, teaching may proceed if the majority of students have understood, or launch another activity such as discussion or further explanation if the majority of students have poor comprehension. Because it does not show each student's answer, no one feels embarrassment even though the answer is wrong.

The emergence of classroom response system may track back to a study initiated by IBM in 1980s. To educate newly appointed managers have knowledge to take charge of new position, IBM arranged a serial courses which were an essential part of new jobs, for them at headquarters. In general, these newly appointed managers had strong motivation to learn. IBM performed a study to investigate the effectiveness of such trainings in 1984-85. In this study, there were five classes, each of having 20 students. Because IBM considered having these managers study well is important, it carefully studied many aspects of the classes.

As a result, the observers found that most students exhibited attentive behavior at the beginning of each class, but that attention diminished rapidly within 20 minutes. In addition, to understand whether student was attentive, observers watched each student and marked, the result which is formed an index that was equal to 100 when every student was paying attention, 50 when half were, and so on. The observation result showed that average number of students paying attention during a standard lecture was 47. Alternatively, the attention average rose to 68, when the teaching was changed to a style in which the teacher actively engaged students with questions. Besides, the observers also found that in a typical class, the discussion was dominated by 10–20% of the students, while the remaining 80–90% contributed only occasionally. Consequently, IBM decided to build a prototype interactive classroom in which a student response system allowed every student to respond to teachers' questions to improve students' participation. In such a classroom, student responses were immediately displayed on a computer system with graphical form. As a result, the attentiveness index was increased to be 83 when the same criteria used to measure students' attentiveness were applied to the classroom with student response units. The statistics showed that the students in the class with the response system scored

significantly higher than the students in the traditional classroom. In addition, a user satisfaction survey was conducted, in which students were asked to rate how much they liked the response system, on a scale from 1 to 7, and the average was 6.6. (Duncan, 2004)。

Besides, many universities in America adopt classroom response system into teaching; the result showed that it has outstanding effect on teaching and contributes to the promotion of student learning outcome. Professor Mazur at Harvard University discovered that student's perception on learning material is toward and converging to the right direction not the wrong side trough the discussion with classmates. Professor Duncan at University of Colorado introduced classroom response system into teaching activity on science and technology education; he found the significant effect. Furthermore, when classroom response system cooperates with classroom discussion; the teaching effect is increased significantly (Duncan, 2004). Professor Rogers at University of Massachusetts had the same conclusion after he introduced classroom response system into teaching. Professor Siau at Lincoln University found that classroom response system obviously promoted interaction within classroom through quantitative and qualitative analysis. He also pointed out that the teaching effect may decline if there is poor interaction in classroom (Siau, Sheng, & Nah, 2006).

3.3 The Implementation Issues

We know that classroom response system definitely provides help to teaching and does not occupy too much time on the basis of above description. At the beginning, there are few school adopted such systems due to cost and wiring problem. Gradually, the system with wireless connection capability came to its stage. The most common type of wireless classroom response system is infrared and RF (radio frequency) type. These types of systems have following advantages: 1) since its remote unit (student

unit) contains only several push buttons which correspond to 1~4 or a~e on a multiple choices problem, students can master its usage instantly; 2) it provides flexibility on implementation due to the omitting of wiring. However, the obvious disadvantage is that its student device is too simple to provide more sophisticate functions such as fill in the blank problem or bi-direction communication. With regard to question type, such a system usually accommodates for yes/no or multiple choices problem because it provides nothing else but only few push buttons. For simplicity, the signal transmission between central controller and student unit is unidirectional. The basic idea of such arrangement is that students build up their comprehension on learning material through discussion with teacher or classmates, therefore it is not necessary to provide specific information for individual student. When portable smart device becomes popular, people begin to consider the possibility about constructing such a system with it. Recently, some schools adopted smart device based classroom response systems gradually. The common technologies used to construct communication are Infrared, RF, and WiFi (IEEE 802.11). The most advantages of infrared over others are easy to sue, inexpensive, and low technology level. The obvious disadvantages are short distance, orientation requirement, and unidirectional. The implementation with RF is similar to infrared, but it does not have orientation requirement and a longer distance. Due to the functional limitations, people begin to adopt smart device, such as PDA, as a user device of a classroom response system (Roschelle, 2003). It is more suitable for higher education system which usually teaches advantage knowledge. However, its obvious disadvantage is much more expensive than infrared or RF counterparts. A brief comparison between different implementations is listed in table 2-1.

Short Message Services

Recently, the major content of a mobile phone, which is one of most popular personal digital belongings, is changing gradually from voice to data. The short message service on mobile phone provides a possibility to implement classroom response system. In such a way, students send message or answer with SMS to server located at teacher side through cell phone system provider, then server program processes and analyzes the coming SMS message accordingly. Researchers recommended the possible applications of SMS on education are: in-classroom discussion, language learning, and learning supporting. Markett, Sanchez, Weber, & Tangney (2006) adopted mobile phone with SMS to promote classroom interaction because the ubiquity and interaction potential of SMS.

Regarding to adopt mobile phone as a tool of information gathering, the easiest and most convenient one is SMS. Virtually, all mobile phones can send and receive SMS message, but not all of them can send and receive MMS by way of GPRS service. Consequently, SMS is the most potential one to perform ubiquitous information gathering. Information gathering system based on SMS service lets users get instant information that they need. There are tremendous such applications. For example, Awwad et al. implemented a simple information gathering system based on SMS system in which visitors can get instant relative information on touring (Awwad, Lin, Lin, & Yuan, 2006). Nokia, a mobile phone maker, supplies a kind of wireless monitor that can receive SMS message, snap picture on monitor according to command in SMS message, and then send this snapshot to mobile phone with MMS handling capability or email through MMS service (Nokia, Taiwan，2006). Thornton and Houser taught English with SMS message, and found the effects on language teaching on the basis of result of experiment (Thornton, & Houser, 2004).

Markett, Sanchez, Weber, & Tangney (2006) constructed a SMS-based interaction

activity with referring to message loop proposed by Yacci (2000). In the project of PLS TXT UR Throughts, they proposed three kinds of interaction model: learner-learner in class, lecturer-learner after class, and learner-learner after class. In these three models, SMS plays the role as message dispatcher. This message loop lets students initiate and conclude a discussion session. That is, a discussion in class or after class is initiated by a student with SMS message; consequently it may induce serial interactions in class with oral or after class with SMS between lecturer and learners; finally this discussion session may be concluded by the student who initiated this discussion.

Kadirire demonstrated how to successfully immerse SMS service in group discussion within a campus or a company. In such an activity, participants are free to express their ideas because of the anonymous nature of SMS message and easy to use. In their system, a small frame called Stickie contains SMS message, sender information, and arrival time, etc. The message contained in a Stickie may be displayed on a computer screen or a LCD projector to remind tutor or lecturer. This Stickies is associated with a color attribute which fade with time to indicate how long have it been stayed (Kadirire, 2005). In addition, people may use SMS message to access various information such as banking, traffic, or weather forecast (Garner, Francis, and Wales, 2002).

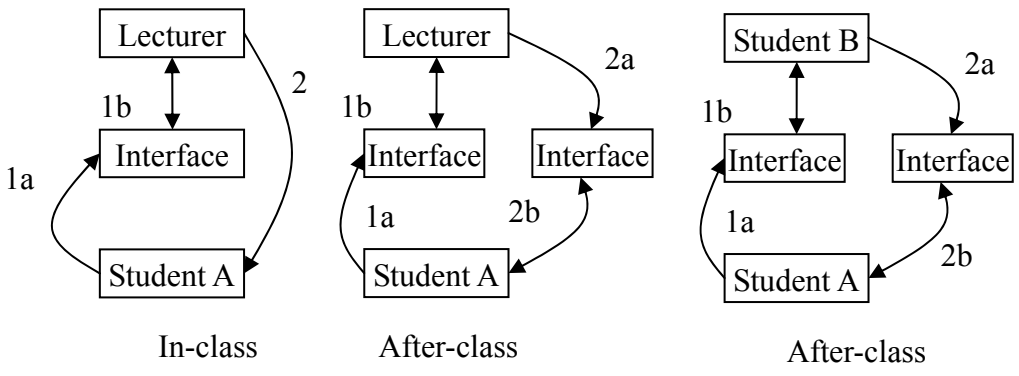


Figure 3-2: message loop (Markett et al, 2006)

Table 3-1: the comparison between different implementations

Technology	advantages	disadvantages
IR	easy to use, inexpensive, robust, durable	less alternative(only yes/no, multiple choice), unidirectional communication, short distance, orientation requirement,
RF	easy to use, inexpensive, robust, durable, without orientation requirement	less alternative(only yes/no, multiple choice), unidirectional communication
PDA	bidirectional communication, many alternatives (fill in blank, essay..),	expensive, more sophisticated, must exist wireless network access
Mobile Phone	bidirectional communication, many alternatives (fill in blank, essay..), familiar with devices	extra cost for SMS, expensive, more sophisticated, must exist network access
Desktop	bidirectional communication, much more alternatives (fill in blank, essay..), cooperative with other e-learning functions	must conduct at a place with network and desktop equipment

3.4 A Hybrid Approach

On the basis of above discussion, a hybrid approach for prompting student learning with SMS message and web-based is present in this section. It is no doubt on the importance and necessity of classroom interaction. Researchers and educators contribute their effort to promote classroom interaction with ICT technology. I summarize that an ICT technology that elaborates classroom interaction should have following characteristics:

- Provide bidirectional communication between teacher and students: by reminding student's individual needs with the cooperating of remedial teaching system.

- Providing versatile interaction ways: by adding fill in blank and short assay problems.
- Easy to input: the user interface tends to complication when more functions are added, it is better to adopt the interface with which people are familiar.
- Providing user-friendly display: traditional CRS does not provide display, at most only few signal lamps, which indicate the status of CRS and signal transmitted, are provided. The interaction is increased, when a CRS adds some simple display interface.
- Adopting the most convenient communication channel: with the easiest and most convenient communication channel.
- Incorporating interaction tracking capability: to avoid ignoring student's questions by tracking the interaction between teacher and students in time.
- Providing system integration capability: with the functions that bridge CRS with backend learning management system or learning portfolio system.

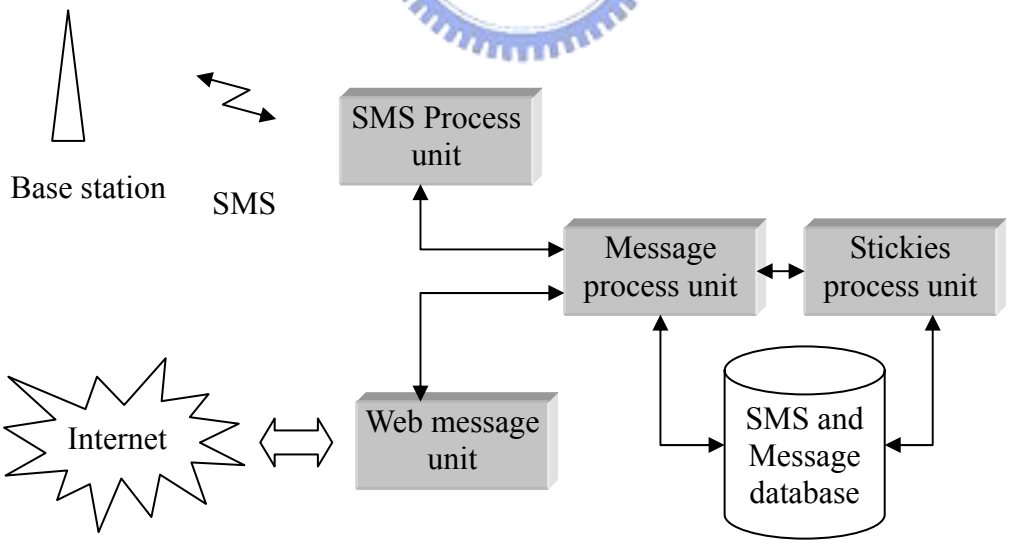
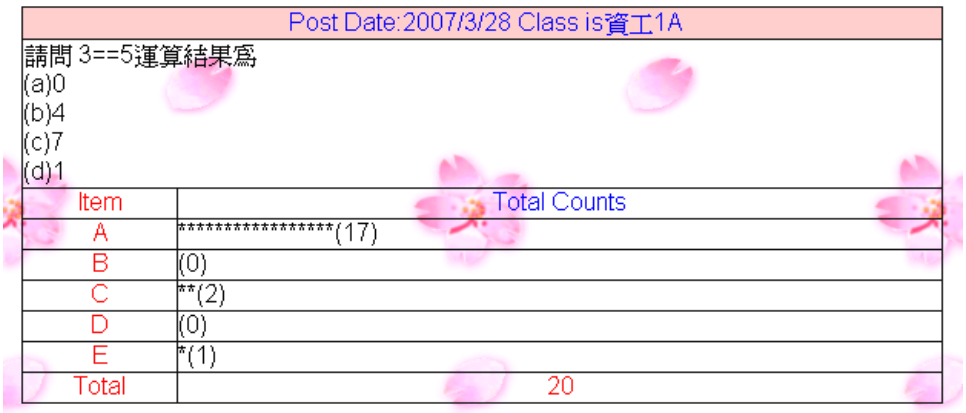


Figure 3-3: message processing loop

The message processing loop is shown at figure 3-3. The message sources come from SMS service and Internet depends on whichever is available. Then the incoming

message is processed according to its purpose which may be an in-class discussion or a CRS message. If this message is an in-class CRS answer, it will check this answer and display the statistics information on screen (figure 3-4). On the other hand, if this message is an in-class discussion initiated by a student, it will be put into the message loop for management and tracking. At the same time, it will be displayed on screen at teacher side (figure 3-5). This message associates with a time stamp which indicates the duration of its message, and a color which fades proportional to elapsing time. Teacher may delete this message after answering it. If the student who initiated the previous question has another relative question, he or she may raise and index the new question with the previous serial number. This procedure may be continuing as long as student does not comprehend. If a student does not comprehend in class, the question will be put into database and retrieved at next time.



Post Date:2007/3/28 Class is資工1A

請問 3==5運算結果爲
(a)0
(b)4
(c)7
(d)1

Item	Total Counts
A	**********(17)
B	(0)
C	**(2)
D	(0)
E	*(1)
Total	20

Figure 3-4: a snapshot of CRS display

The in-class discussion is on the basis of Stickie, which was proposed by Kadirire (2005) and message loop, which was proposed by Markett, Sanchez, Weber, & Tangney (2006), to construct the proposed classroom response system. The major channel for in-class interaction between student and lecturer is SMS, and the minor one is a web-based system. In other words, if teaching activity is on a classroom

without computer facility, the SMS message is adopted. On the other hand, if teaching activity is on a classroom with computer and network connection, the webpage is adopted. This system not only has bidirectional CRS functionality but also has in-class and after-class discussion. Similar to traditional CRS, if a lecturer wants to probe student's comprehension about material just taught, he or she may post question and gather answer, and puts the statistics information on the screen (figure 3-4). In addition, teacher may also decide whether a hint or message will be sent back to individual student. This function, which needs bidirectional message sending, is never seen before on a traditional CRS system. In such a circumstance, when most of students have comprehended, the teaching activity may be continue, but a specific message or hint may leave for each individual student who does not comprehend yet.

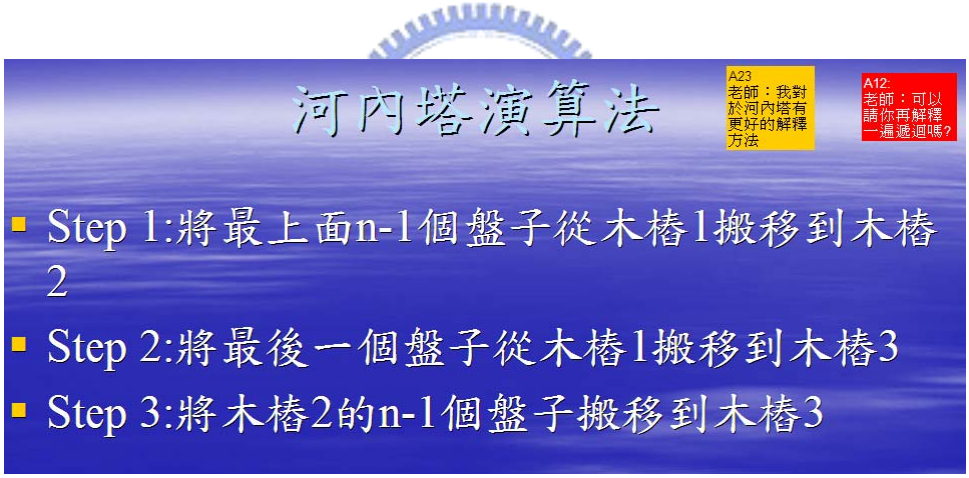


Figure 3- 5: a snapshot of Stickie

3.5 Pilot experiments and results

Experiment description

Two pilot teaching experiments were conducted at an institute of technology to understand student attitude about CRS on these two implementations. Other types of implementations (such as IR, RF, or PDA type) were not included in these two experiments. The purposes of these two experiments were: investigate student attitude

on using SMS in class; check the implementation issues about SMS; and check the effectiveness on student learning. One experiment was on the course entitled "Introduction to Computer Science", in the fall semester of 2006 and the approach used was SMS, and the other experiment was on the subject entitled "Programming Language and Practices" in the spring semester of 2007 and the approach used was web-based. Students participated at these two experiments are freshmen and at the same class, but the number of students is 48 and 45 respectively. At the experiment associated with SMS, students were asked to bring their mobile phone to classroom, which is a normal classroom without computer and network facility, and participated learning activity by sending SMS message based on teacher's instruction. The teacher paid students small amount of money to compensate the SMS fee. The objective was to understand implementation issues; there is no formal arrangement for quantitative or qualitative measurement. In contrast, the experiment associated with web-based was on a classroom with computer and network facilities. The objective of this experiment was to let students have experience on both implementations

Results description

In "Introduction to Computer Science" course during the first semester, 97% of the students in the class had mobile phones. The experiment's data shows that at the beginning 53% answered the quiz via there phones SMS regardless correct or wrong answer, while the other 47% did not answer due to error in the format or students were not enthusiastic to participate in the discussion. The high failure percentage forced us to add new function in the server to know the reason by tracing the message flow. At the end of the semester, students became more enthusiastic and involved in the discussion. Records in the database shows that 86% participated in the sessions, 70% answered successfully, 30% failed to answer due to the format restrictions. 14%

did not participate because some of them were absent and the others did not bring their phones to the class room. Obviously, the message format had restricted students since they had to write the answer in a very specific format which reduced the number of the successfully received answers. Other reasons such as text input function in phone SMS and screen size made the answering process not easy.

In “Programming Language and Practices” course during the second semester. The students that 3 of them are female were randomly assigned into control group and experiment group. There are 22 students in control group, while 23 of them in experiment group. At the experiment period, which extends for five weeks, the instructor taught programming knowledge of C program to both of groups. The teacher used conventional methods with the control group while the experiment group was asked to use the online system.

An independent sample t-test was conducted prior to experiment begin to verify the difference between these two groups before and after the experiment. The t-test result is shown at table 3-2. The mean value where calculated for the average scores before the experiment. There is no difference between these two groups statistically ($t_{(43)}$=-0.376, n.s.) before the experiment.

Table 3-2: T-test of average scores – before the experiments

	Levene's Test		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
Pre-test score	.004	.951	-.376	43	.709

A t-test was applied after the experiment for these two groups (table 3-3). The result indicated that it achieved significant difference statistically between these two groups with ($t_{(43)}$=2.254, n.s.) after the experiment.

Table 3-3: T-test of average scores - after the experiments

	Levene's Test		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
Post-test score	2.642	.112	2.254	42	.029

The web based system includes the exam sessions and the discussion sessions. The teacher showed a satisfaction of his students' results after using the system. He mentioned that students have become more interactive. The pre-class test and post-class test have developed students' revision and preparation for the class. Discussions questions and answers always unknown, so when the teacher displays the answers chart, students will start to think and discuss together to find the correct answer which achieve better cooperation among students.

Student survey

At the end of second experiment, a survey was made to collect student's opinion. About two thirds of students prefer online type of CRS. Only one tenth students prefer SMS. Students were asked what kind of discussion they prefer: oral, online, or SMS. The majority of students (about 60%) prefer oral discussion. The least preference is SMS. The possibility is oral is the most natural communication channel and SMS message needs to type message with a simplified keypad. About ninety three percent of students said SMS or online type activity improved their understanding of the topic. Most of students (93%) agree that such activities improve interactivity. About 96% of students feel that such activity makes them more engaged and involved in the class. about 98% of students like to receive a feedback or advice from their teacher about their learning.

Students always afraid of others criticism, shy and would not want to ask if they think it is obvious and they should know. The system provides a tool for students to come over their shyness. In the first stage of the experiment, students used to send their

comments or feedback by SMS. While in the second stage, they used the online system or their emails since they are connected to the internet. Students preferred to use the online system to send their comments on the SMS system. The reason for that is that they used to type using the PC keyboard. Mobile phones have limited screen size, limited input characters. The majority of students see that the online and the SMS feedback system are better than the oral discussion.

Students need hints related to their assignments or exams. At the same time they need an advice to show them their mistakes in the exams and tell them where o find the correct answer. The SMS and email advice functions were accepted by all students. Some students preferred the email on SMS because of the message length. Students would like to receive a more detail advice in their email inbox from their tutors. On the other hand, most of the students try to avoid the oral advice.

Chapter 4

Web-based Mastery Learning System

For the learning of consecutive courses, student's learning outcome may be affected by learning performance of previous course. In other words, if student does not learn something well, say integer addition in mathematics education, then poor learning performance of following consecutive course, say integer multiplication can be expected. Bloom advocated concept of mastery learning in 1960s (Bloom, 1968). Bloom claimed that giving sufficient learning time and good lecturing quality, almost every student learns everything taught by teacher well. In this manner, if student gets mastery at every learning unit, then it may solve problem stated above. The very important part of mastery learning is remedial learning. In remedial learning, teaching content will be tailored to meet each individual student's need. It will put a lot of burden on teacher if students who need remedial learning are not a few. In this thesis, a web-based mastery learning system is introduced to make mastery learning process more practical and more effective. An experimental study has been done on an Institute of Technology in Taiwan. The result showed students appreciated this system, and almost all students got mastery based on predefined criteria.

4.1 Mastery learning

The general concept about teaching and learning had radical change after Carroll (1963) advocated a new teaching concept. His teaching concept suggested that teaching should focus on individual student needs different time to learn same material. This suggestion is in contradictory with traditional model which allocating same period of time to all students to learn same material. In fact, Carroll claimed aptitude is a major measurement of learning time (Carroll, 1989). He used a formula

called LR (Learning Rate) to stand for degree of learning:

$$LR = f(\text{time spent learning} / \text{time need to learn})$$

Carroll's viewpoint based on all learners have potential to learn anything well, but require different period of time to achieve. When taking learner's aptitude as content of learning rate, student is not longer a good or bad learner, but a faster or slower learner (Guskey, 1997). Carroll also pointed out two factors which affect student's learning rate: student's perseverance and chance to learn. The former factor is controlled by students themselves, in other words, how much time them spend on learning. The later is how long or how much learning material teacher allocates for student to learn in classroom or after class.

The concept of mastery learning was advocated by Benjamin Bloom (1981, 1968). When Bloom participated a research called "effectiveness of individual difference to learning", he was deeply affected by Carroll's concept. He gave a further elaboration: 1:) because aptitude might be used to forecast learner's learning rate, a predefined learning content might be set 2:) therefore, attention should be paid on teaching variables controlled by teacher, such as opportunity of learning and quality of teaching, 3:) finally, teacher should guarantee every student can achieve predefined course objective. In summary, Bloom claimed giving sufficient time and good quality of teaching, almost every student learns well. The features of master learning are:

- pointing out what to learn and how to assess,
- allowing student learns in his or her own pace,
- assessing student's progression, and providing correct feedback or remediation,
- evaluating whether student achieve final learning criterion

Mastery learning theorem makes teacher's teaching responsibility a radical change. Student's fail in learning should blame on teacher's teaching but not on student's deficiency of ability. In this kind of learning environment, the challenge of teaching becomes to provide sufficient learning time and suitable teaching strategy. In this way, all students can achieve same degree of leaning (Levine, 1985; Bloom, 1981). Mastery learning has been widely applying on school teaching and training, the research results showed that this approach improves effectiveness of teaching (Block, Efthim, and Burns, 1989; Slavin, 1987). In other hand, mastery learning has theoretical and practical deficiency. People indeed have difference on ability, and are prone to different achievement. Besides, the establishment of mastery learning needs a lot of time and effort; it prohibits teachers and school administrative to establish such learning system.

There are many suggestions on how to implement mastery learning, one of these suggestions was proposed by Warren (2003):

- Clearly state the objectives representing the purposes of the course.
- The curriculum is divided into relatively small learning units, each with their own objectives and assessment.
- Learning materials and instructional strategies are identified; teaching, modeling, practice, formative evaluation, reteaching, reinforcement, and summative evaluation are included.
- Each unit is preceded by brief diagnostic tests, or formative assessments.
- The results of formative tests are used to provide supplementary instruction, or corrective activities to help the learner overcome problems.
- Time to learn must be adjusted to fit aptitude. No student is to proceed to new material until basic prerequisite material is mastered.

In school's implementation, one of many examples is Perry public schools in Ohio State of USA (PPLC, 2007). A brief description of the steps to implementing mastery learning is listed below:

- Determine what the student should know.
- Develop a tool or process to check their knowledge.
- Teach the concept.
- Use the tool to check to see if they learned the objective.
- If they master the objective, provide activities or opportunities that stretch their thinking. If they do not master, provide other learning opportunities until they get it.

Assessment in mastery learning is also a criterion-reference assessment. In criterion-reference assessment, student's score is not for comparing with other students but with a presetting criterion. The objective of mastery learning requests all students achieve this criterion. Speaking in terms of mastery learning is mastering this subject. In literature, the criterion is 95% in the highest and 80% in the lowest. In Perry Public Schools, if students correctly answers 4 of 5 items (about 80%), then they get mastery on this learning.

4.2 Persuasive Technology

Fogg (2003) defined persuasive technology as any interactive computing system designed to change people's attitudes or behaviors. The emergence of the Internet has led to a proliferation of web sites designed to persuade or motivate people to change their attitude and behavior. Web sites are the most common form of persuasive technology today. With regarding to education issue, computing system, especially web-based system, provides tremendous advantages on persuading student to learn.

By incorporating simulation or multimedia content into learning material student gets easily understanding. The earliest signs of persuasive technology appeared in the 1970s, when a few computing systems were designed to promote health and increase workplace productivity. One of the earliest examples is a computer system named Body Awareness Resource Network (BARN), developed in the late 1970s (Fogg, 2003). This pioneering program was designed to teach adolescents about health issues such as smoking, drugs, exercise, and more, with an ultimate focus on enhancing teens' behaviors in these areas. Fogg stated six distinct advantages computing system over human persuaders:

- Be more persistent than human beings
- Offer greater anonymity
- Manage huge volumes of data
- Use many modalities to influence
- Scale easily
- Go where humans cannot go or may not be welcome

As stating in previous section, Carroll pointed out one of two factors which affect student's learning rate is student's perseverance. In web-based mastery learning system, student's attitude or behavior may be changed or affected toward allocating more time on learning. Then student's perseverance may be enhanced.

4.3 System Design

With the above discussion, it is obviously mastery learning is an effective and practical teaching approach. To relieve teacher's burden and provide sufficient and convenient environment to student, a web-based mastery learning system is presented in this thesis. The mastery learning process is shown in figure 4-1. In his system, the

process is a cyclical approach which consists of unit lecturing, formative assessment, remedial learning, and advanced learning. In traditional mastery learning process, remedial learning usually takes about 2 times. If any student does not achieve mastery level after second remedial learning, the process is terminated. With the capability of networked system, remedial learning can repeat as many times as it needs. The reason is remedial learning is done by networked system instead of teacher. One of many advantages about Networked system over traditional approach is networked system is more persistent than human beings (Fogg, 2003). The remedial learning may repeat as long as student does not achieve mastery level. The approach also realizes what Carroll mentioned student's chance of perseverance and learning. The chance of students' perseverance and learning can be enhanced through this system; therefore they can achieve course objectives. In this approach, the main purpose of networked technology is to let learning process proceeds smoothly. In traditional classroom teaching activities, there is time limitation. It is hard to allocate suitable time and location for student to interact with teacher or peers after class. With the aids of networked and information technology, student can participate remedial learning beyond time and location boundary.

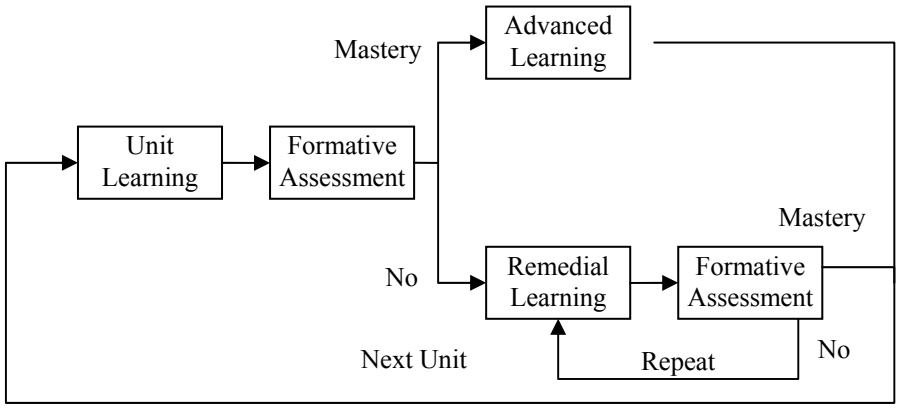


Figure 4-1: mastery learning process

Remedial learning has two dimensions. One is learning activity and another is formative assessment. Formative assessment not only assesses student's mastery level, but also diagnoses student's weak point and insufficient part. Therefore, formative and diagnostic aspects are taken into consideration while designing test items. By way of test items on diagnostic assessment, and inspecting student's answers, then student's learning problem can be revealed. Once identifying student's learning problem, suitable or appropriate remedial material can be presented to each individual student. Each test item of diagnostic assessment addresses an atomic concept. In this manner, student's cognitive process in learning the subject domain can be easily identified. Taking common fraction problem in basic mathematics domain as example, its solving process consists of several atomic concepts. In order to correctly solve this problem, the student should have knowledge of these atomic concepts. If there is misunderstanding on any atomic concept, then it will lead to incorrect answer. While designing test item of diagnostic assessment, teacher identifies all atomic concepts of a specific problem domain, then design a test item for each atomic concept. If student can correctly answer this item, that means he/she has understood it. Furthermore, if student correctly answer all test items relate to a specific problem domain, that means he/she has achieve mastery level for this learning unit or domain. Formative assessment can be in traditional way or web-based. System presented in this thesis adopts a mixed model (Lin, Kuo, Yuan, 2004). In this model, activity such as learning or assessment may be traditional way or web-based relies on practical consideration. If teacher prefers traditional way, then assessment is in paper and pencil form. After collecting and grading student's answer, if any student does not achieve mastery level, teacher will select suitable remedial material on the system, and asks student to take learning. The preferable way is in web-based form. Teacher puts all test items into

system. At the end of each lecturing unit, students are requested to take formative assessment on the web. System will automatically select remedial learning material for students, if they do not achieve mastery level. No matter formative assessment is in traditional form or web-based form, further formative assessment after remedial learning is on the web. Test items for any formative learning after remedial learning are randomly selected by system. Each item has accompanied with a hint or further explanation. If student's answer is incorrect, system will present the related hint to student. This will make student gain immediately assistant.

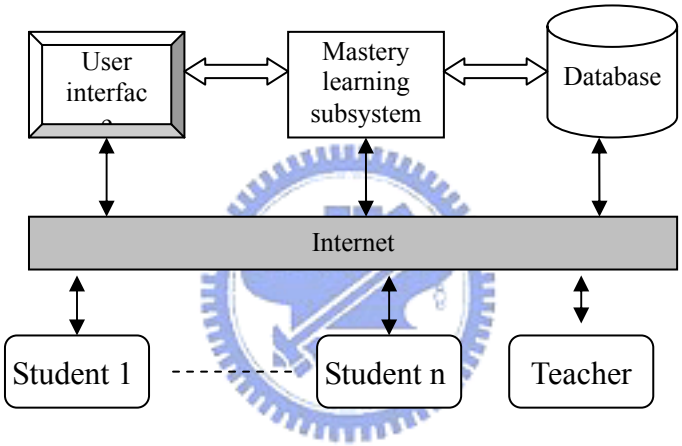


Figure 4-2: system architecture

This system consists of database, user interface, and mastery learning subsystems as shown in figure 4-2. Database subsystem has two contents, one is for student's profile and learning portfolio, another is learning material and test item bank. User interface subsystem also has two forms. One is student's interface which allows to learn, assess, discuss with classmate, build own learning portfolio and communicate with teacher. Another is teacher's interface which allows to enter student's profile, build learning material, build test item bank, set rules for remedial learning, view student's learning portfolio and communicate with students. The functionalities of user interface is summarized in figure 4-3. Mastery learning subsystem is core of this system. It

provides a platform to let student and teacher perform mastery learning process.

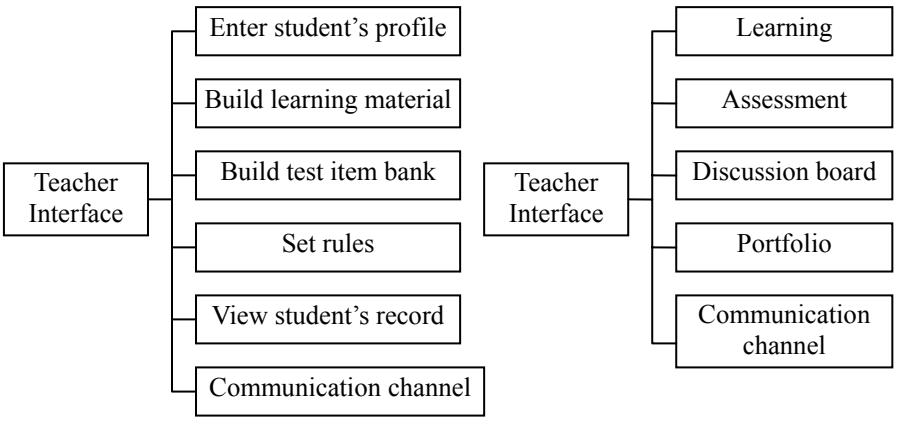


Figure 4-3: user functionality

4.4 Experiment Design

In order to evaluate effectiveness and functionality of this system, an experimental has been conducted on an Institute of Technology located in northern Taiwan. The experimental course was principle of electrical circuitry. Students attended this class were junior and fail on previous study. This kind of classes sometimes is called summer school which means open in summer vacation. Totally, 24 students attended this class in which one was female and others were male. Because of these students had studied same subject but fail on final score, it's more suitable to introduce mastery learning into this class. As per definition of mastery learning, first step is to determine what student should learn. Then, divide learning material into several lecturing units. In this experiment, it is divided into 12 units. For each unit, teacher prepared lecturing material, test items of formative assessment, remedial learning material, and hint for every test item. Normal lecturing was on classroom, assessment was web-based form, and further as well as remedial learning was also through web-based system.

Each unit started with unit teaching. At the end of teaching, student was requested to perform web-based formative and diagnostic assessment. It this experiment, mastery level was defined as correctly answering 85% of test items. If student achieved this level, he/she has mastered this unit, and was encouraged to take further advanced study. In contrast, if student did not achieve this level, he/she was requested to attend remedial learning. The remedial learning material was not exactly same as unit lecturing material. The reasons are (1) in different lecturing approach (traditional and web-based), the lecturing material should be in different form to let student learned most, (2) because of student did not accomplish last learning, the learning material should be amended, (3) the remedial learning material should focus on what student did not understand, in other word did not answer correctly. As mentioned above, diagnostic assessment is part of formative assessment, student's weak point or misunderstanding can be identified through test items. It is teacher's responsibility to clarify a test item should link with which course concept, and what remedial material should be presented if student gave incorrect answer. System presented in this thesis provides a convenient and systematic way to let teacher accomplishes this task. Student who did not get mastery, should arrange and allocate time to attend remedial lecturing after class. Student could attend formative assessment after remedial learning. If student still did not get mastery, the above remedial process should be repeated until student gets mastery. System provides another two features to assist student perform remedial learning. Student can discussed with classmates through discussion board or contacted teacher while encountering difficulty on remedial learning. To encourage students who have gotten mastery share acquaintance with classmate, system will give extra score to these students. For some students who want to apply scholarship or get high rank, this strategy will provide motivation. With

regarding to contact teacher, this system provide a more effective way. Student raised problem on the system, and system will deliver this message with predefined channel such as email and SMS (Short Message Service), etc. set by teacher. The purpose is to let teacher gets this message and provides assistance to student as soon as possible. Teacher can set a learning deadline on this system. If there is any student does not get mastery over this deadline, system will automatically inform teacher. Then, teacher may contact student to provide necessary assistance or teaching.

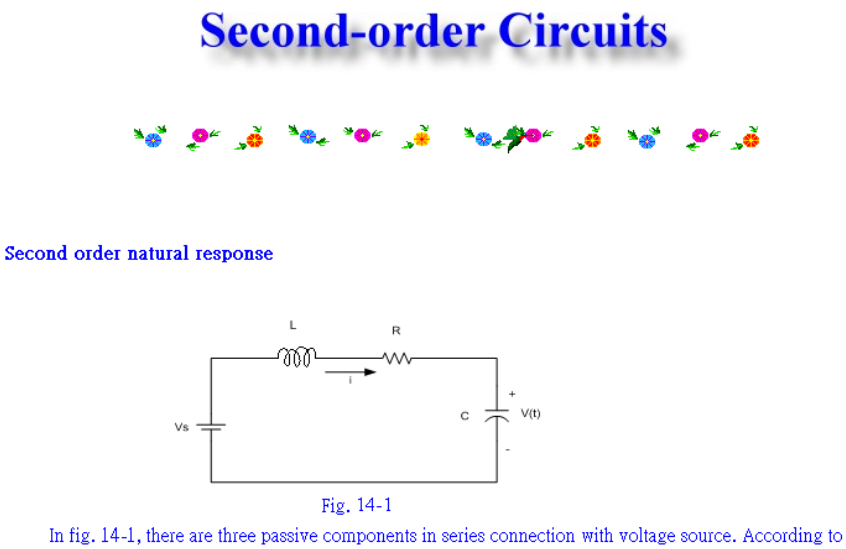


Figure 4-4: remedial learning

Unit 4 Assessment

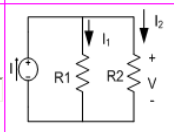
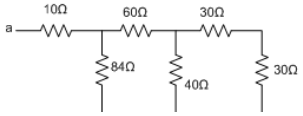
No.	Answer		Item
	Yes	No	
1	○	◉	In parallel circuit, branch with lower resistance value will share more current
2	○	◉	The equivalent resistance value of several resistors in parallel connection will lower than value of any original resistor.
3	○	◉	In parallel circuit, all resistors in parallel connection will have same voltage drop.
4	0		There are 2Ω, 10Ω, and 5Ω there resistors in parallel connection. What is the equivalent resistance value?
5	0		 In this circuit, if I=10A, R1=2Ω, R2=3Ω, what is value of I2=?
6	0		What is voltage value of V?
7	0		

Figure 4-5: formative assessment

Assessment result report		
Item	Correct	
1	Wrong	Learn Study....
2	Correct	
3	Correct	
4	Wrong	Learn Study....
5	Wrong	Learn Study....
6	Wrong	Learn Study....
7	Wrong	Learn Study....
8	Correct	
9	Wrong	Learn Study....
10	Wrong	Learn Study....
4 corrects, the score is 40/100. You don't reach mastery level yet, please study again!		

Figure 4- 6: result of assessment

Hint system of Remedial Instruction	
Unit	Unit 7
Item	Item 5
Hint	First of all, cut off 3.6A current source, that is remove this current source. Connecting 1, 2, 3 Ohm resistor in serial manner, then shut with 3 ohm resistor. You will get an equivalent resistance value. By way of serial circuit methodology to solve current passes 2 ohm resistor. This current will pass through 3 ohm resistor, and 1, 2, 3 ohm resistors. The objective of this item is to solve branch current on 3 ohm resistor. Note on unit of current, it should be in capital form.

Figure 4-7: hint for test item

4.5 Summary

At the end of course, a satisfactory survey was conducted. The questionnaire and the result are shown in table 4-1. In summary, about 94% of students claimed this system has positive effect on their learning. 95% of students claimed this system changed their learning attitude toward more positive. These results agreed on Fogg's viewpoint that computing system may be used as a persuasive technology to change people's attitude. With regarding to provide instant and specific hint to each item student gave wrong answer, about 91% of students thought it gave great help. This is a strength part of web-based mastery learning. In traditional approach, it is hard to accomplish especially if such students are not a few. All of students spent more time on learning. The average time increased on learning is about 2.5 hours per week. These extra hours do not squeeze learning time of other courses. This is another evidence that student's attitude has been changed and willing to spend more time on learning. At the end of course, not all 24 students got mastery, two of them fail in final score. The possible

reasons are as follows. (1) This was a summer school class, students were fail at last semester, that means some of them may have serious learning problem which may not be cured by mastery learning. (2) As stated previously, people indeed have difference on ability, and are prone to different achievement. (3) Although computing system can be a persuasive tool, but not all students can be persuaded. Persuasive effect of this system may not work for some of students.

Several issues need to be pointed out. Whether student gets mastery is checked by formative assessment. Besides, if student does not get mastery, then should attend remedial learning. Therefore, formative assessment should have functionality of diagnostic assessment. How to design a suitable and adequate test items to diagnose student's real learning difficulty, so that suitable remedial learning material can be presented to student is an important issue. For each subject, domain experts or teachers may form a task force to design lecturing units, test items and remedial learning material.

Secondly, the modality of learning material on the web may affect student's learning performance. Fogg's study has confirmed this point (Fogg, 2003). In Fogg's research, attractive material is more persuasive than unattractive one. This is a critical issue on network- or web-based learning system. Same as first point, if teacher or domain expert can spend more effort to design learning material, it may be more effectiveness for student's learning.

Finally, teacher may aware student's learning situation in face to face lecturing circumstance, and necessary intervention or assistance may be applied instantly. In this manner, student may follow teacher's lecturing step as close as possible. In web-based learning circumstance, it lacks in such facility or channel. How to provide a mechanism to aware student's learning status on the web in real time manner, it is an

issue need to be addressed.

Table 4-1: satisfactory survey

No	Question	5*	4*	3*	2*	1*
1	Teacher said every student learns almost everything if time is sufficient and has proper attitude. It gives me confident to my learning.	28.6%	52.4%	19.0%	0.0%	0.0%
2	I feel this system has positive effect to my learning.	33.3%	52.4%	9.5%	4.8%	0.0%
3	In this learning model, I spent more time on learning.	42.9%	47.6%	9.5%	0.0%	0.0%
5	In this learning model, I feel more active on learning.	33.3%	42.9%	9.5%	14.3%	0.0%
6	If I were positive and active as now, I should not attend this summer school.	23.8%	28.6%	42.9%	4.8%	0.0%
8	I intend to spend more time on learning at networked learning environment.	52.4%	38.1%	9.5%	0.0%	0.0%
9	In networked learning environment, it makes me more convenient to access learning material	23.8%	47.6%	23.8%	4.8%	0.0%
10	In web-based assessment, system promptly gives me hint for incorrect answer. It provides great positive impact on my learning.	47.6%	28.6%	14.3%	9.5%	0.0%
11	In web-based learning, it is as teacher is always on my side.	76.2%	9.5%	14.3%	0.0%	0.0%
12	In summary, I like this kind of learning very much.	19.0%	52.4%	28.6%	0.0%	0.0%
	Time spent on learning per week.			2.5 hours in average		

1: very disagree, 2: disagree, 3: no comment, 4: agree, 5: much agree

Chapter 5

Learning Management and Portfolio Package

In this chapter, a web-based course management system is introduced which allows teachers to manage course-related affairs such as, course announcement, grade processing, and learning status of each student. The system also facilitates communication between teacher and student, and provides real time learning feedback messages in a real-time manner which allows students to check their own learning status and make necessary adjustments. At the end of the course, both students and teacher can pack their own portfolio files which contain score trends, lecturing content, the course syllabus, discussion content, collected files, homework, self assessment, and teacher's comment. The system completely records every detail related to student's learning, then packs these details in an organized structure. Students may then carry their own portfolios to the next learning stage. This is the optimal way to evaluate student's learning progress and level. In order to improve accountability and reliability of portfolio files, this system adopts MD5 to construct an on-line verification mechanism.

5.1 Introduction

A broad range of teaching activities and various teaching materials are used within a school system. If their effects are to be maximized, a fair amount of time and energy will be needed by the teachers, students and administrative personnel in order to achieve that goal. The ways of enhancing learning activities with less time and energy, by taking advantage of new information and communication technologies, is becoming a more desired goal as those technologies become a part of everyday life. In a traditional learning environment, interactivities between teacher and student are

usually done through conversations in the class, or written comments and grades on an exam paper. To get a picture of how well they are doing, students look at their exam scores and compare them with other students' scores. It is just about the only way to get a rough idea of how well he or she has done. If the work of providing scores is to be done for every single test and piece of homework, the teacher has to repetitively do the same job over and over. More over, if grades from previous exams were not provided, and temporary information from previous learning activities not preserved, the time and energy spent by the teacher to reference them would diminish the reference value which they should have.

In the web-based learning environment of today, when faced with the situation above, many teachers would put information on the Internet for reference. Since anonymity is uncontrollable on the Internet, it means that the teacher can only post data which can be viewed by everyone and he/she is therefore not able to advise each student based on his or her achievements. If the teacher was to advise a single student, e-mail would be a traditional way of doing it, but this would create a heavy load and create problems of content management on the teacher's side. The possibility of incorrect data being sent is very high because of the quantity of e-mail the teacher needs to manage.

Recent advances in network based lecturing have resulted in the wide-spread availability of web-based course management system for use in all educational endeavors. A web-based course management system is responsible for following major tasks:

- Delivery learning content in a convenient and effective way
- Manage student affairs,
- Manage instructional content,

- Track student progress, and
- Give student learning status in real time manner.

In response to the increasing demand of this type of management work required by teachers, some commercial companies provide services to do just that. The most popular commercial course management systems are WebCT and Blackboard. WebCT is an e-learning systems with a highly flexible e-learning environment developed in US. WebCT includes the following tools: Instructor Tools, Student Tools, Presentation Tools, Communication Tools, and Assessment Tools. Yip (2004) uses WebCT as a platform and tool to teach course online, and found that students generally prefer online teaching to the traditional classroom lecturing because they enjoy the various way to communicate with the instructors, tutors, and fellow students. Mclean & Murrell (Mclean and Murrell, 2002) described that WebCT became an integral part of a problem-based learning, student-centered curriculum introduction in 2001 at a school of medicine. In this implementation, WebCT might serve four possible purposes: communication, resource delivery, the quiz/assessment, and student tracking. Blackboard is another famous course management system provider based in US. As the information shown on website, Blackboard product consists of following tools and features: Course Management, Content Authoring, Adaptive Content Release, Syllabus Builder, Teaching and Learning Tools, Assessments and Surveys, Grade book, and Reporting and Performance Dashboard.

Commercial products such as WebCT and Blackboard are powerful enough to fulfill most of institutes. As Siew & Shepherd (2002) mentioned that systems such as Blackboard and WebCT already exist and provide much of functionality. Why people don't simply use them? The reason simply is WebCT and Blackboard are both commercial products, and thus expensive. In addition, people will gain the maximum

flexibility by building their own system which is built up with their know-how and experiences. There are a set of tools for students and lecturers available. But it lacks on the assessment and learning activity recording facilities.

Yet, there are some commercial web sites which provide convenient tools to assist teachers take care of student's score, especially for teachers whose institute does not provide such web-based facility and expect to manage student's affair with the power of web. MyGradeBook (2000), a subsidiary of Pearson Education, is such a company. It provides password access to your grade book to keep parents informed and involved in motivating students. For students, a structured view of upcoming and past assignments, along with scores recorded to-date, helps to keep them on track throughout the grading period. Reduce the frequency and time spent in one-on-one parent conferences and notes.

Instead of commercial products, many educators are seeking open-source solutions. The most popular open source software is ATutor (2000) and Moodle (2004). ATutor is an Open Source Web-based Learning Content Management System (LCMS) that emphasizes on accessibility and adaptability. Administrators can install or update ATutor with ease, and develop custom templates to give ATutor a new look. Teachers can quickly assemble, package, redistribute Web-based instructional content, easily retrieve and import prepackaged content, and conduct their courses online. ATutor provides an adaptive learning environment which benefits students. Moodle is another open-source course management system which helps teachers who want to teach courses online. Both of Atutor and Moodle are open source software which is similar to system presented in this thesis. The major difference between them is the portfolio functionality and real time learning tracking capability.

Mandal, Sinha & Reade (2004) described a web-based course management (WBCM)

tool that has been developed at Indian Institute of Technology and which manages the submission of assignments. This system provides easily navigable structure to all online submissions and a centralized web-based interface for submission evaluation. A customized online submission interface is generated in accordance with requirements for each assignment as specified by the staff concerned. Student progress tracking, group and individual assignment organization, assignment evaluation and marking, grade maintenance and distribution, online submission, and online attendance are important features of WBCM.

Portfolio is a form of teaching activity, and a way of assessing that has been widely used by educators in recent years. One of its main purposes is to break the traditional way of assessing by quantitative means or written tests, which have traditionally been used to reflect a students' learning process, abilities, and to also keep a record of their work. But for a long time, the requirements, specifications, and development of this type of system have been divergent; the system cannot be further applied to portfolios unless they have additional functions and provide additional services. In order to properly implement a portfolio, more time, manpower, and resources are needed. Research suggests that teachers are already overloaded (Lin, Liu, and Yuan, 2004). Besides normal teaching activities, teachers need to do more assessment. Therefore, how teachers can be assisted to complete a portfolio is one of the goals of this thesis.

In recent years, more and more portfolios display their digital content through the use of web pages in order to overcome the inconvenience of storage and processing associated with traditional paper records. With respect to research on portfolios, some of researchers such as Chen, Liu, Ou and Lin (2001), Chang (2001), and Lin, Liu, and Yuan (2004) in Taiwan have developed complete systems of computer-aided portfolios, and analyzed the use of portfolios that offer proof of their effectiveness in

increasing student's learning ability. The grades and progress of students recorded by course management systems can also be covered by portfolios, by analyzing grades there that makes the system more intelligent (Karjunen, Sutinen, , and Tarhio, 2000).

In order to promote using information and communication technology (ICT) for teaching activities; make activities run in a smoother manner, assuring that students get instant learning feedback; and pack student's learning progress, and teacher's experiences and teaching results in an exchangeable format, so the records can be exchanged by different administrative authorities, we have developed a course management system with portfolio functionality. The goal of this system is to increase teacher's ability to process student's grades more efficiently and conveniently; give advice to students; and allow students to obtain their learning records instantaneously. To develop an efficient learning environment that lets student fully access his/her learning effectiveness during the learning process, in order to correct his/her learning direction, and at the end of the course preserve his/her portfolio for future reference, the system also provides a verification mechanism to increase its accountability.

5. 2 System Design

The system described in this chapter in a web-based system. The system uses an open source as the solution, with MySQL as backend database, PHP as the scripting language for dynamic web pages, Apache as the front-end web server, and FreeBSD for the operating system underlying. The database, scripting language, and the web server can run on Microsoft Windows® under the open source development environment of GNU license, this making the system easier to promote without any licensing or legal issues. For teachers tend to use such a system can easily download and build the necessary software systems. The system has the following features:

- It contains a record of student's on-line learning records.
- It keeps a weekly learning record for every course that a student takes in a semester.
- It has a tool to maintain close communication with students.
- It focuses on the ability of using instant feedback for learning.
- It displays a student's learning progress graphically, making it easier for students to acknowledge his or her progress.
- It displays student's progress relative to his/her classmates graphically, e.g. giving at any point in time, a student's highest, lowest, and average grades. This positive comparison can be used as a motive to inspire learning.
- It displays student's learning and progress graphically, so that student can adjust his/her ways of learning during the course.
- It is capable of storing data on-line. This functionality not only allows students to store their learning results, but also share them with other students, achieving cooperative learning among classmates.
- It has an instant messaging functionality in which students can leave messages on the Internet and the system will notify the receiver by e-mail immediately. Therefore, the students can send their questions to the teacher and get necessary help instantly.
- Data, such as students' grades inputted from the Internet can be outputted in standard format, so teachers can create standard reports. At the end of a semester, teachers can hand in the class grade sheet straight from this system.
- It lets teachers input their teaching schedule and teaching material, which will be displayed weekly according to the schedule.
- At the end of semester, teacher and students can pack the course outline, teaching

materials, grades, learning progress, all kinds of learning files, student's self assessment, and teacher's assessment into one portable file, making it available to students for the next stage of their learning or employment.

- The digital portfolio is in the form of an XML file, so its content can be browsed by an ordinary browser or any environment that can read XML files.
- After packaging, the digital portfolio is digitally signed using MD5, ensuring the integrity of the data.

The system classifies users into three groups: students, teachers, and administrative personnel. Each group has different user interfaces. The system's primary function will be for teacher and student use. This system lets students know how well they are doing at any give time which helping teachers turn simple test scores into meaningful analysis, e.g. current progress, total scores of the tests done so far using high, low, and average scores. It also compares a single student's grades with class average, letting students know how well they are doing within the class.

5.3 Portfolio Packing

After the student has completed the course, all records will be kept at the server. The student may copy, download, retrieve, or access his/her records for continuing education or job employment. Since the packaged records can be used as a pass along portfolio or part of a resume for a job application, they will have to get a certificated copy for accountability and highly credible if they are to be presented as an objective reference. In our system, we chose MD5 (Message Digest) to accomplish this goal. MD5 (Rivest, 1992) was developed by Professor Ronald L. Rivest at MIT. The algorithm can transform a data chunk of any length into a 128 bit fingerprint or message digest. The basis of this algorithm comes from the following assumption.

Two chunks of data will never produce the same message digest, and given a message digest, it is impossible to reverse it back to the original data. MD5's primary purpose is to be used as a digital signature. Basically, MD5 is a way of checking data integrity and is more reliable than other methods, such as Checksum.

To demonstrate the possible usage, a pictogram is showed in figure 5-1, where there are three actors: the course management system with portfolio, the student, and the interviewer. The scenario is as follows:

1. Student packs and downloads the portfolio at the end of semester. At this time, the system generates the MD5 hash and stores it in the system.
2. Then the student goes on an interview, providing the interviewer with the portfolio. The interviewer can use any MD5 validation tool (there is such a tool provided in this system) to obtain the file's hash string e.g. 43b49a3b8ded5da1dd5e6f6136e509ad
3. Next, the interviewer goes to the system's website, and types in the account access code of the student being interviewed without needing a password. The hash string of the student will be displayed.
4. After comparing the hash string for correctness, the interviewer can be sure that the portfolio provided is the one generated by the system without any modification.

Besides packaging the portfolio for students, our system also enables teachers to pack their teaching materials. The packaged data has many useful applications, such as teacher's evaluation and references for transferring to another institute. The system packs different items of data according to whether the user is a teacher or a student. The system defaults to pack everything into the portfolio, but the user can choose

specific items they want to pack.

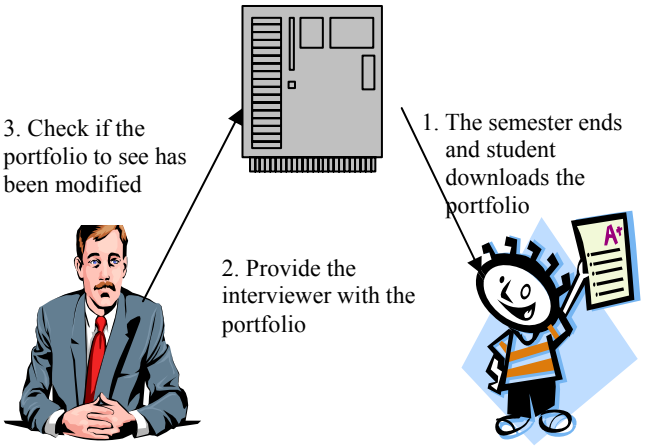


Figure 5-1: packaging and application of portfolio

5.4 Learning status report

The process of learning status report is as follows:

Input:

The parameters are scores of quiz, homework assignment, and any other quantified information associated with a student. The scores may be given by users such as teacher or peers manually or modules such as CRS or mastery learning automatically.

Process:

Whenever a quantified value is generated, do the following computation:

1. Compute the each student's accumulative score by summing the each weighted score of input item;
2. Put the accumulative score into the student record in database;
3. Compute the mean value of whole class;
4. Compute the maximum and minimum score of this computation;

5. Take the each student‘s most recent three scores as parameters, then compute whether the trend is toward the positive or negative direction;

All computed data is stored in database.

Output:

Information provided to students is:

1. A graphic view about a student’s accumulative score, the average score of class, and the two bounds of score,
2. a recommendation message to each student, it comes out with the following rules:
   A. if a student’s score is always above the average score of class, then giving positive message, encouragement and keeping the learning pace;
   B. if a if a student’s score is always above the average score of class, then giving strong warning message about learning and learning attitude and approach should be adjusted ;
   C. if a student’s score oscillates over average score of class, and the learning trend is toward positive, then giving positive message, encouragement and tighten the learning pace;
   D. if a student’s score oscillates over average score of class, and the learning trend is toward negative, then giving negative message, encouragement and suggest adjusting the learning pace;

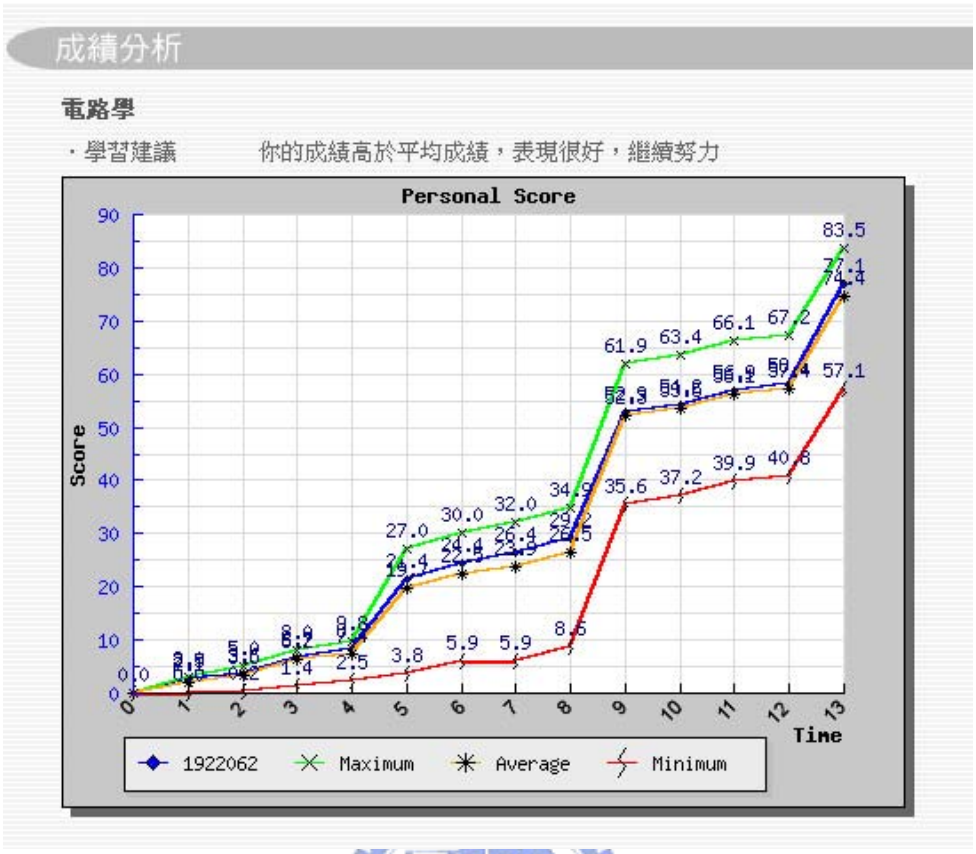


Figure 5- 2: a snapshot of learning status graph

5. 5 Portfolio Package Examples

In order to see if the course management system with portfolio functionality can achieve the objectives, the system was applied to an "Electric Circuitry" summer course at an institute of technology in Taiwan in 2004. We used the content of the portfolio from one of the students to look into the packaging content. The packaged content can be divided into following parts:

- Personal information, grades, and teacher's assessment
- Teaching content of the courses
- Scores of each test and assignment
- Class discussion, and data gathered by the user

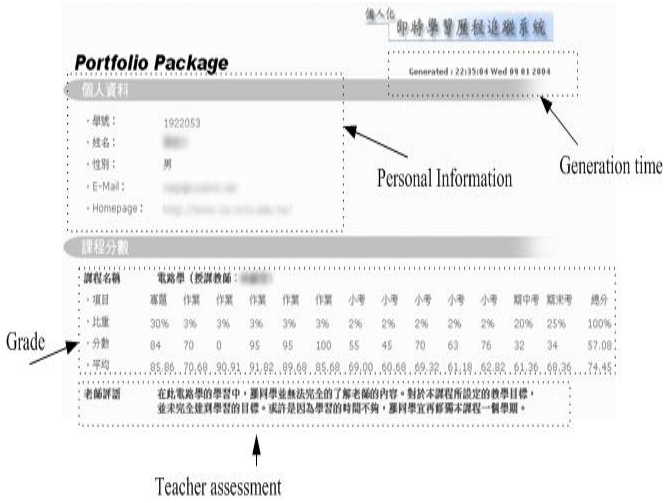


Figure 5-3: portfolio (Personal Information, Scores, Teacher's Assessment)

The first part is personal information, grades, and teacher's assessment. On the top left is the time when the portfolio was generated (figure 5-3). Teacher's assessment contains the evaluation and advice given to the student according to the student's performance. The system was designed to pack the portfolio in zipped XML files, which cannot prevent students from modifying the information. Thus, MD5 is added to prevent data from being modified which makes a portfolio with accountability, hence making it a good reference for job interviews or school application.

The second part contains the content the student has learned during the course (figure 5-4). In order to show the content of the learning activity, the teaching schedule and outline must be included, so the reader of the portfolio clearly understands what was learned by the student during the course. During an interview, the interviewer can ask questions according to the course content to evaluate the student's understanding of the course.

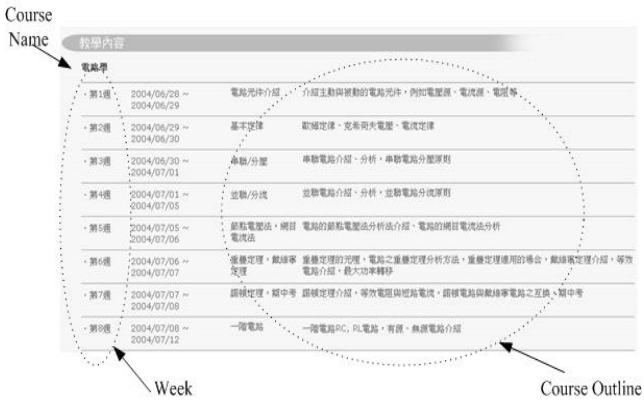


Figure 5-4: portfolio (teaching content)

Figure 5-5 depicts the third part. The system records the accumulated score of each student every time the teacher posts a score. From here we can see that, this student was below the class average at all times, thus the learning advice from the teacher was "Current grade is lower than average, …" (as shown on top of the figure, it is set automatically by system and can be modified by the teacher). From this graph, one can identify the interval between the highest and lowest score, and whether the student is over or below the average, plus whether or not his/her scores are going up toward the highest or down toward the lowest. If the student's score went from below the average line to over the average line, it means that this student is working harder than the rest of the class as shown by the scores. Teachers can then give appropriate encouragement by analyzing the graph.

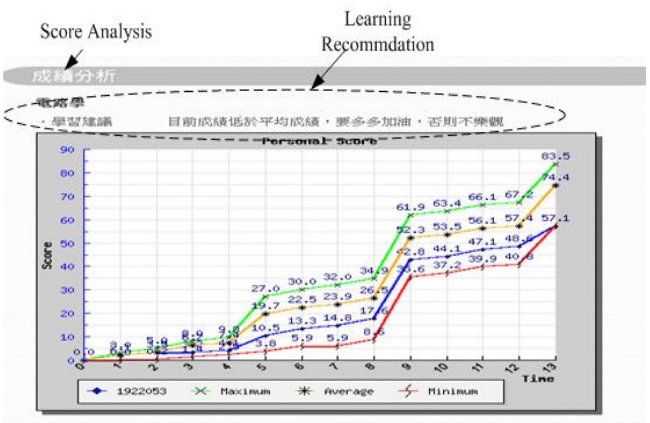


Figure 5-6: portfolio (grade analysis and learning advices)

The last parts are class discussion and the files collected by the student, includes all files that are for public or private use. Other supplemental materials related to the course are also shared using this method. The portfolio with file and data collected by the student shows how involved he or she is in the class and what has been gained from the course.

5. 6 Summary

Besides assisting teachers in managing the basic work associated with course management, the major aim of this system is to include every part of student's learning and teacher's teaching into the portfolio, thus making it a reference for the next phase of education or as a supplement for job applications. Compared with most portfolio systems, which are more focused on the cross evaluation of students, and portfolio assessment, our system is more focused on assisting teacher and students in correcting learning attitudes and changing direction during the course. We have also focused on allowing the teacher or student to pack and download the portfolio at the end of semester, and achieving the portfolio's accountability through verification-which is one goal we accomplishment that other systems have yet been able to achieve.

Our system is different from many others such as WebCT, and Blackboard. Those systems focus on integration of administrative systems, so that departments can use the system to manage student activities such as student registration management, teaching content management, administration management, etc. Some systems integrate with publishers and libraries to provide more convenient formats for teaching and learning activities. Yet, these systems usually need school funding and integrative support from all departments on campus in order to function. For schools

that do not have fund or lack the technical support, if a teacher is interested in using an IT based system to enhance teaching activities, there's usually no way to do it. The system described in this thesis was built with the intent of using free software, which lets teachers access them without cost. Also, our system is more focused on the interaction of students, especially on letting students know their learning status instantly so they can correct the direction of their learning, while also letting the teacher know if the teaching content needs to be changed. Above all, our system specifically focuses on the recording of student's learning and the arranging, packaging, and verification of the portfolio, which is what makes it different from other systems.

On the grade management side, our system focuses on grade management, and provides students with current grades and grade analysis, letting students know their learning status. We also implemented the creation of analysis graphs, so students can see their status within the class easily while viewing their relationship to the class's highest, lowest, and average grade. They can then adjust the pace of their learning, thus increasing the effectiveness of their studies. Finally, the system provides the packaging and downloading function for a portfolio, so that students can preserve a semester's work, which includes course information, teaching content, course announcements, course discussions, grade analysis, teacher's assessment, and files collected with ease. With the verification mechanism designed into the system, providing portfolio for future reference is the first proposed application in portfolio related researches.

Some of the functions of the system described in this thesis will be improved in the future and new ones will be added as they are developed.

The system now focuses on the simple tools needed by teacher to integrate with a

school's administration system. The system will be further developed to use agent technology to integrate with existing campus-wide administrative systems currently used in schools, so that teachers can utilize some of the information acquired from the campus-wide administrative system, i.e. class lists, handing in final grades, etc.

In the current design of the system only the simple method of checking student scores is used to give learning advice. In a more advanced design, the decision would be more intelligent. For example, if two students get the same score at the same time, based upon their learning history, the advice should be different. This requires checking the differences between the two students' records, and using multiple criteria to identify a student's strengths and weaknesses. This part of system requires further research and more complex design to give students intelligent feedback that more closely matches their individual needs.

Chapter 6

Reflective Journal

6.1 Introduction

Conrad & Donaldson (2004) defined engaged learning as a collaborative learning process in which the instructor and learner are partners in building this knowledge base. Engaged learning is not a new instructional approach. It has been named in different terms such as active learning, social cognition, constructivism, and problem-based learning. All of these emphasize student-centered learning within an instructor-facilitated environment. Chamberlain & Vrasidas (2001) stated that learning is interactive when learners are actively engaged in a variety of activities, and along with their peers and teacher, they are coconstructors of knowledge. Constructivism is learner-centered, assuming that learners learn better if they construct knowledge by themselves (Hadjerrouit, 2005). Von Glaserfeld (1994, 1989) advocated constructivism, and held that "acquisition of knowledge is actively constructed by learners". One of the major components of an engaged learning approach is reflection. Reflection can provide insight for instructors on their teaching as well as for students on their learning. Instructors can evaluate the effectiveness of student's experiences in the course by reflective feedback (Conrad & Donaldson, 2004). An effective reflective activity requires students to share a synthesis of the learning experience. Participants should be encouraged to share genuine emotions in a non-threatening environment. Activities that are done quickly are reactive but not reflective. Ascertaining meaning out of a learning situation requires adequate time to contemplate the experience and

synthesize it within the context of other newly acquired knowledge. The instructor must encourage this contemplation to take place as part of the course and the learner must find time to conduct this reflection. In most cases, asynchronous activities accommodate deeper reflection than synchronous activities.

Blog is a very popular service on the web. People can express their thinking, feelings and experiences on blogs and intend to share with anyone who is interested in this blog. This web-based service serves as a platform of many activities. Engaging students into an active learning environment is an objective of this thesis. Lin & Yuan (2006) brought blog into various teaching activities and found that a positive correlation between students' learning performance and the number of learning reflection entries on a blog. They found that students who have better learning performance tend to make more reflections on their learning. In this thesis, we will investigate if high level thinking exists in blog-based reflective journals; will thinking levels affect student's learning attitude, and finally will it result in better learning performance.

In the following paragraph, a brief review of background knowledge is introduced which is followed by methods used for problems stated, then the results of teaching experiment are given. Finally, some conclusion remarks are given.

6.2 Reviews

Chang & Lo (2000) viewed from Von Glasersfeld's point and concluded that if learners do not actively participate in the learning activity, the learning process is hardly to happen no matter how hard teachers work. From a learners' point of view, learners should adjust their learning direction by understanding their learning situation through reflection during knowledge construction process. In this way, the predefined objectives are likely achieved. This viewpoint conforms to Yancy's viewpoint (1998).

Yancy described reflection as simultaneously looking forward (to goal that might be obtained) and looking backward (to see what has been accomplished).

Educational institutions have been implementing 'reflective journals' for more than a decade around the world (Woodward, 1998). Occasionally, people use other similar terms such as learning reflection, learning reflection, log-book entry, diary writing, or simply personal journals. Woodward (1998) developed an assessment procedure through the use of reflective journals and portfolios that allows final semester students to track their growth. In this settlement, students who have accomplished this assessment commented that they have learned more through this assessment than from any other activity. Kember et al. (1999) claimed that successful professionals need to reflect upon their actions has been widely accepted. The reason is that most tasks they perform involve novel elements to which there are no defined solutions. Accordingly, developing students' abilities to reflect upon their actions is one of the points that course educating professionals should aim to achieve. Shuman, Besterfield-Sacre, & Miller (2005) explained that reflective journals could be kept electronically and coded using qualitative analysis software. Lin & Yuan (2006) took a preliminary study on using blogs as a platform for learning reflection and found that students are willing to use such a networked based platform. Using blogs as a platform for reflective journal has at least three advantages over the traditional approach: publicity, citation, and RSS function. From Constructionism and a social learning point of view, share one's own and view other's journal is part of collaborative learning (Bandura, 1989). It is difficult to share with peers and view a peer's journal in a traditional paper and pencil approach. In blogs, articles are arranged in an easy to access and easy viewing manner. People may classify articles into folders in a normal way, or in a chorological view. In addition, bloggers are used

to sharing ideas or thinking publicly, and view other blogger's articles. In such a way, the objective of social learning is achieved. The major difference between blogs and discussion forums is that blogs are a private space in general but belongs to a public domain. People share common space and exchange ideas with other participants at a public area in a discussion forum. In contrast, bloggers publish their articles or thinking on their own blog. A citation (Trackback) function can be used to cross link some articles which have similar content and form a forum. In other words, blogs let blogger be private enough but keeps a flexibility to join a public forum. If any one is interested in someone's blog, he/she may wish to view an article once it is published. For example, a student has a very good learning performance, and he/she always expresses deep thought on learning. If peers want to read this student's article as soon as it is published, then they should always keep watch on this student's blog. With RSS function, peers can subscribe this student's blog with RSS feeds; and they will be notified once a new article has been published. The above three advantages makes a blog a better platform for reflective journal than a traditional one.

6.3 Experiment 1

Experiment description

An experiment was conducted at a college in Taiwan. The course period was 18 weeks during the fall semester of 2004 and the course title was The Principles of Microprocessor. The students were junior and Automation Engineering major. There were 76 students, 75 of them male. At the beginning of the course, the teacher requested that students record in their learning reflection blog weekly. In addition, every student was to give feedback to their peer's learning reflection. The teacher also encouraged the students to extensively study the learning content, and share with

classmates through this mechanism. In order to encourage students to take a chance in reflecting and recording in their learning blog, a reward was promised to all those who participated fully.

The teacher sent students a questionnaire about system usage after eighth week in order to analyze their responses and comments. At the same time, the first assessment of learning performance was conducted. This assessment had two parts. The first part was about the midterm exam and was an ordinary assessment; in the second part, the number of meaningful reflections (messages) or feedback messages each student made were quantitatively counted. The teacher also reminded the students that the activity in the blog was part of the learning activity and would be included in their learning assessment. At the end of course, a second assessment was conducted in which the content was assessed in the same manner as in the first. Data analysis was performed right after the experiment's completion. First of all, the correlation between students' learning performance and student's level of activeness on blog was tested. Learning performance had two levels:

- Learning performance without taking the learning reflection into consideration, which is an ordinary assessment (it includes midterm, final term, quizzes, and homework assignments)
- Learning performance which took learning reflection into consideration. To quantitatively analyze the level of activeness on blog, the data had to be quantification. Only meaningful and learning content-related reflections which were equally distributed over the whole semester were counted and scored.

Experiment result

By using SPSS 10.0, a Pearson correlation analysis was performed to check the

correlation between learning performance with taking the score of learning reflection into consideration and the number of meaningful reflections (messages) or feedback messages each student had made. The results are shown in table 6-1. There was a significantly positive correlation between these two parameters as shown in figure 6-1. To make detail analysis, another Pearson correlation analysis was performed to check the correlation between learning performance without taking the score of learning reflection into consideration and number of meaningful reflections (messages) or feedback messages each student had made. The results are shown in table 6-2. These results also show a significantly positive correlation between these two parameters as reflected in figure 6-2. We can therefore conclude that learning reflection has a positive effect on students' learning performance (positive correlation). The teacher emphasized that blog activity was to be a part of the assessment in the eighth week. To check to see if this announcement had any influence on student performance, a correlation analysis between the difference of accumulative number of reflections before and after the eighth week and learning performance was conducted. The results are shown in table 6-3 and figure 6-3. It shows that for the difference of accumulative reflections there is a positive correlation with learning performance. We can therefore conclude that students who have higher learning performance tend to take more time on learning reflection.

Table 6- 1: a comparison between number of reflections and learning performance

		times	score
times	Pearson Correlation	1.000	.653**
	Significance		.000
	count	76	76
score	Pearson Correlation	.653**	1.000

	Significance	.000	
	count	76	76

** Correlation is significant at a significance level of 0.001 (two-tailed)

Figure 6- 1: a comparison between the number of reflections and learning performance

Table 6-2: a comparison between the number of reflections and learning performance without taking reflection into account

		times	score
times	Pearson Correlation	1.000	.464**
	Significance		.000
	count	76	76
score	Pearson Correlation	.464**	1.000
	Significance	.000	
	count	76	76

** Correlation is significant at a significance level of 0.001 (two-tailed)

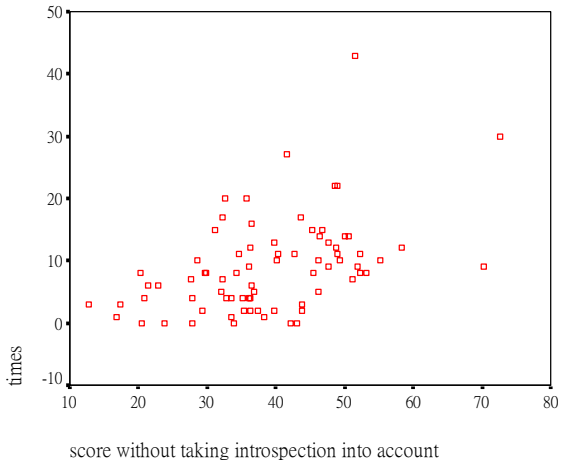


Figure 6-2: a comparison between times and learning performance without taking reflection into account

Table 6-3: a comparison between the difference of the number of reflection and learning performance

		difference	score
difference	Pearson Correlation	1.000	.301**
	Significance		.000
	count	76	76
score	Pearson Correlation	.301**	1.000
	Significance	.000	
	count	76	76

** Correlation is significant at a significance level of 0.001 (two-tailed)

Figure 6- 3: A comparison between difference and learning performance

Questionnaire result analysis

By investigating the questionnaire results, it was found that most of students do not have very much experience in using learning reflection regularly, especially in such a public fashion. To encourage students to take part in this experiment, a reward was given to students who made meaningful reflections. A special reward was given to students who gave constructive and meaningful feedback or made comments on other classmate's reflections. About 88% of the students felt that expressing learning reflections on a blog was a positive experience. About 88% of the students felt that learning reflection had a positive influence on their learning. Over 90% of the students looked forward to receiving their classmates' comments and feedback on their reflections. More than 86% of the students felt that viewing classmates' learning reflection on blog has a positive influence on their learning. In summary, most of students felt that this system had a positive influence on their learning. They also look forward to receiving classmates' comments and feedback. Finally, they felt this system was easy to use. From the results of the survey, the objectives of this system have been achieved.

6.4 Experiment 2

Methods

Another teaching activity was arranged to investigate student's reflective journal. Each student has a blog to make a reflective journal entry. The topic to be studied on the student's reflective journal is about their thinking level. There are some researches that dealt with the definition of the thinking level. In this thesis, Bloom's taxonomy is adopted. Bloom (1956) stated the taxonomy in which cognitive domain can be classified into the following levels in order: knowledge, comprehension, application, analysis, synthesis and evaluation according the development procedure of cognitive ability and complexity of learning. Based on Bloom's model, thinking levels are classified into low and high level thinking. The knowledge, comprehension and application belong to low level thinking, while analysis, synthesis and evaluation belong to high level thinking. To help students catch the core of Bloom's taxonomy, an example was given and explained to students to make sure they do understand the real meaning of each thinking level in Bloom's taxonomy. The purpose is to teach students how to make an accurate reflection. The following problems are to be checked:

- Does high level thinking content exist on learning reflection blog?
- Does high/low of thinking level have a correlation with learning attitude?
- Does high/low of thinking level have a correlation with learning performance?
- Does positive/negative learning attitude have a correlation with learning performance?

The thirty-four senior students that took part in a course were computer and information science majors at a technological college in Taiwan. Two of them are

female and the rest are male. The course was a three credit course called “Artificial Intelligence”. The lecturing period was fourteen weeks. At the beginning of the course, a blog was allocated for each student. Students were asked to replace the outlook (user interface) with templates provided in the system or selected from outside world. This was a mandatory task to ensure each student knew where his/her blog was and how to manage it. Students were requested to fill out a learning attitude inventory on Artificial Intelligence (H=0.83) which were scored on a 5-point Likert Scale, ranging from “most positive attitude” (5 points) to “most negative attitude” (1 point) at the first week. During this lecturing period, students were asked to express their learning reflection on a blog about their learning per week. Teacher encouraged students to make high level thinking on their learning. Student’s reflection was recorded and analyzed to see which thinking level it belonged to. At the end of the course, a final exam was given and the students were requested to fill out the same attitude inventory as when the course began. In addition, an anonymous user satisfaction survey as well as an open problem questionnaire were conducted to understand students’ comments about this system and activity.

Results and discussions

Does high level thinking content exist on learning reflection blog?

First of all, we checked whether the student’s reflective journal contains high level thinking. Based on Bloom’s taxonomy, the content of student’s learning reflection is investigated. The results showed that high level thinking contents existed on the student’s learning reflection. Students not only summarized the learning content in their learning reflection, but also provided critical thinking, made extend learning, and provided viewpoints different from textbook about learning subject. Blog provides

comment and Trackback functions, many students gave comments and viewpoints on classmates' reflection with these functions. Traditionally, students might keep these ideas or viewpoints in mind, or discuss with the teacher or a few of their classmates. With blogs, students can make these ideas or viewpoints public with ease, and discuss with their teacher and as many as their classmates.

Does high/low thinking level have correlation with learning attitude?

We want to see whether students have a high level thinking on reflection is related to whether they are toward the positive learning attitude. That is, are students with high level thinking likely to be toward the positive learning attitude? The student's learning attitude is classified as toward the positive and negative learning attitude. The criterion used to make classification is a mean value of learning attitude survey (M=3.45, SD=0.43 at the beginning; M=3.44, SD=0.49 at the end). The transition of the student learning attitude from beginning to the end of course is checked. If a student's learning attitude remains positive or changes from negative to positive, then the learning attitude is toward the positive. If a student's learning attitude remains negative or changes from positive to negative, then the learning attitude is toward the negative. In addition, thinking levels are divided into three groups:

- High level: a blog contains high level thinking reflections
- Low level: a blog does not contain high level thinking reflection but only low level ones.
- Not available: a blog does not contain any meaningful or course relative reflections. It may contain some entries other than course-related subjects.

A 2x3 contingency table was used to represent the relationship between thinking

levels and learning attitude. With SPSS 10.0, the result of a Pearson chi-square test of independence achieved level of significance ($\chi^2_{(2)}$=6.795, p=.033<.05). Therefore, these two variables are associated. That is, whether students are toward the positive learning attitude depends on whether they present high level thinking on their reflection.

Does positive/negative learning attitude have correlation with learning performance?

To check the effectiveness of learning attitude on learning performance, an independent samples t test was used. The learning performance was score on a student's final term exam; and students were divided into two groups based on learning attitude. The Levene's test for equality of variances was not significant (F=.503, p=.483>.05), the two variances are not significantly different. The result of the t test was significant ($t_{(32)}$=12.69, p=.0 <.05). Therefore, there is a significant difference between the learning attitude and learning performance. Students who are toward the positive learning attitude have significantly higher learning performance than those who are toward the negative learning attitude.

Does high/low of thinking level have correlation with learning performance?

A one-way ANOVA with independent samples was tested to understand the difference of learning performance between three groups of thinking levels. As previous, the learning performance was based on the score of a student's final term exam; and students were divided into three groups based on their thinking levels. The Levene's test of homogeneity was not significant, the homogeneity assumption was held. The result of "between groups test" achieved level of significance ($F_{(2,31)}$=9.275, p<0.001). It means different thinking levels on a blog affects learning performance. With

Tukey's HSD Post-hoc Tests, the score of high level thinking group (M=68.3) is significantly higher than low level thinking group (M=48.5) and not available group (M=31.3). It implied that students who made high level thinking on their reflection have better learning performance. In summarizing the previous analysis, we can conclude that learning reflections and learning performance have a correlation. That is, a student expresses high level thinking on reflection has better learning performance. This conclusion induces an issue about the causal relation between thinking levels and learning performance. That is, whether students made high level thinking on the blog first, then the learning motivation and attitude was strengthened. In turn, it contributes to the better learning performance, or vise versa. We will use user satisfaction survey to verify this.

User satisfaction survey

Upon the completion of the course, an anonymous user satisfaction survey which was arranged with a 6 point Likert scale was sent to students to understand the attitude about this system. An open problem questionnaire was also given to students. Students gave comments and ideas with their name borne on the open problem questionnaire when they return it.

Table 6-4: user satisfaction survey

	Items	6*	5*	4*	3*	2*	1*	mean
1	I feel that it is a good experience for expressing learning reflection on a blog.	14%	50%	35%	0%	0%	0%	4.8
2	I feel that learning reflection has a positive influence on my learning.	18%	32%	43%	7%	0%	0%	4.6
3	I anticipate receiving classmates'	4%	50%	36%	7%	3%	0%	4.2

	comments or feedback on my reflection.							
4	I anticipate receiving teacher's comments or feedback on my reflection.	4%	43%	46%	4%	33%	0%	4.4
5	It doesn't matter if learning reflection is a part of a formal assessment. It does not affect my attitude about blogs.	7%	32%	25%	15%	18%	3%	3.8
6	I feel that it has a positive influence on my learning to view classmates' learning reflections on blogs.	18%	32%	46%	0.0%	4%	0%	4.6
7	I do my best to give comments or feedback on my classmates' learning reflection.	7%	45%	44%	0%	4%	0%	4.5
8	I look forward to having my teacher see the feedback or comments I give to classmates.	11%	35%	44%	7%	0%	3%	4.4
9	I feel that this blog is easy to use.	7%	29%	39%	18%	7%	0%	4.1

*6:strong agree??5:agree??4:little agree??3little disagree??2: disagree??1: strong disagree

By looking into the anonymous survey, almost 88% of students thought that learning reflection has a positive impact on their learning. It can be used to explain the causal relation between the learning reflection and learning performance, in which high learning performance is induced by a good learning reflection. Another finding on this survey is that most of students express highly positive comments on this learning blog; and students eagerly anticipate responses to their reflection on blogs from their teacher and classmates.

There were six students that failed this course, four of them never expressed reflection on their blog, and the rest only made a couple of reflection entries. A questionnaire was given to these students to collect their comments; the result is shown in table 2.

These students' attitudes were not good after viewing this table. Another investigation was done to check these students' learning attitude. These students' value of learning attitude inventory were 3, 2.85, 2.8 and 3.4 (M=3.44, SD=0.49 globally). It is obvious that these students' learning attitude was toward the negative and they were not willing to reflect on their learning, it resulted in their poor learning performance.

Table 6-5: survey result of students who were failing on this course

Question	Under what condition, will you take learning reflection?	Why do you not take learning reflection?	Learning reflection is part of formal assessment
Answer	When I think it is time to cheer up. When it does really need. I do not know.	I do not care. I forget. Without network facility*	I do not care.

* Department allocates a dedicated Notebook to each student since sophomore year, and campus-wide wireless access is available. It is an excuse for their behavior.

In addition, an analysis was made on the top ten students. The result showed that the score of learning attitude inventory of these ten students (M=3.6, SD=0.4) is higher than the mean score that means their learning attitude towards to positive (M=3.44, SD=0.49). Taking the number of high level thinking entries as measure, the quantitative score of these students on blogs is (M=5.2 SD=2.9) higher than global (M=2.3, SD=2.87). It showed that these students actively participated in blog activity. Another open ended questionnaire was sent to these top ten students to understand their comment on blog activity; several positive comments are summarized as follows:

blogs help active learning

…..because of the excitement of blogs, I take time to review what I have learnt and

what I am going to learn….

blogs help me to review the course

…it lets me understand my own learning situation, share my learning experience, understand how others learn, and find out the way to improve my learning….

blogs help cooperative learning

…. Students share their learning experience, raise problems, or discuss on the blog….

…. It always has some additional reward by reading others' reflection, such as missing lecturing content on class or different viewpoint or thinking. Others' thinking sometimes inspires me…..

blogs help me to think about learning

…in addition to think about some things, it helps me clarify what I do not understand. I sometimes objectively thought that I have understood a concept taught in class, but actually have not. With this platform, I can let teacher knows what I do not know, my viewpoint, or thinking, then the teacher may give a further explanation to me…

By viewing the user satisfaction survey, students express positive attitude on this kind of open learning reflection. They not only enjoy suggestions about their learning reflections from classmates, but also comment and response from their teacher and classmates. For such a requirement, it is difficult to realize with traditional paper and pencil style learning reflection.

6.5 Summary

Many students may not make learning reflections frequently; therefore properly

introducing a learning reflection activity into a course with convenient tools (such as blogs) will give positive impact on a student's learning. Assisting student conduct learning reflection with ICT technology not only lets student makes a learning reflection, but also facilitates peer collaborative learning. In this thesis, high level thinking contents are found on student' reflection; and an association between the difference of thinking levels on reflection and learning attitude is found. That is, whether students are toward the positive learning attitude depends on if they present high level thinking on reflection. Consequently, students' learning reflection and learning performance have causal relation in which high learning performance is induced by a good learning reflection; and there is an association between students' learning attitude and learning performance. In short, students who have a better learning attitude on the Artificial Intelligence subject show better learning performance. We also found that learning performance is induced by learning attitude with the analysis of anonymous and open questionnaire.

In summary, it has been shown that learning performance can be promoted with learning reflection at Artificial Intelligence course for senior students. Students make their learning reflection with a convenient blog environment; most of the students showed positive attitude on open and anonymous questionnaires. Students who have better learning performance show more positive attitude than the average, and the quantitative score of learning reflection on blogs is much better than the average value.

Chapter 7

Conclusions

In this thesis, a portfolio centric learning platform was introduced and discussed. This learning portfolio serves as a central repository and information manipulator for other learning modules. Several learning modules at this platform are classroom response system module, learning status report module, mastery learning module, and learning reflection module.

Learning status report on the basis of learning portfolio provides students a valuable reference and information about their learning situation, which is sometimes ignored until too late to adjust. This information is served as a reference before class. A hybrid type classroom response system is a way to leverage student learning comprehension and promote interactivity in class. The results of experiment on the course entitle "programming language and practices" showed that it did promote learning comprehension which was also conclusion of many similar researches (Duncan, 2004; Roschelle, 2003). In addition, it provides a more flexible way, which combines SMS service and web-based approaches, to adopt the learning situation. When students notify that their poor learning situation before class, they may take time to review the taught material and preview the material to be taught. Learning reflection and mastery learning are two approaches for the learning after class. The experiment result shown that learning reflection has positive effect on student learning outcome and learning attitude. In addition, mastery learning provides an effective way to allow students get mastery on the learning material after class.

The learning paradigm shifts from traditional learning, E-learning, M-learning, and currently U-learning. Come with this movement, the learning and/or teaching process

or activity should be transformed or modified to make learner gains better learning outcomes. U-learning paradigm opens a lot of opportunities and challenges for educators and researchers. One of these challenges is how to keep learning portfolio up to date and make portfolio more intelligent, an agent mechanism is a candidate to overcome this problem. With such a mechanism, no matter what the front-end interface learner faces is and what environment learner stays is the learning process and activity can be recorded automatically and efficiently. In addition, the content of learning portfolio not only can serve as a learning record, but also as guideline or recommendation for learner's further learning process. At the assistant of smart portfolio mechanism, the learning activity of ubiquitous learning will have better learning performance and outcome.

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Appendix:

Bloom Taxonomy for educational objectives and coding example for data structures

Main class／ sub class	Relative terms	define	examples
1. remember		retrieving knowledge from long term memory	
1.1 recognizing	identifying	identifying knowledge in long term memory which is consistent with truth	point out the operation of stack is first in last out
1.2 recalling	retrieving	retrieving knowledge from long term memory	speak out the operation of stack is first in last out
2. understand		constructing meaning from oral, written and graphical teaching information	
2.1 interpreting	Clarifying, Paraphrasing, Representing, translating	translating information from one kind of representing form to another (i.e. translating from numerical to verbal from)	drawing the process of stack operation
2.2 Exemplifying	Illustrating, instantiating	finding out specific example or illustration of concept or principle	illustrating examples of stack in real life
2.3 classifying	Categorizing, subsuming	deciding to summarize some things into same class	treating the operation of subroutine as operation of stack
2.4 summarizing	Abstracting, generalizing	abstracting general subject or key points	abstracting the complete operation of stack
2.5 inferring	Extrapolating, Interpolating, predicting	predicting a logical conclusion based on existing information	predicting the a pile of dishes is a kind of stack according to

			operating principle of stack
2.6 comparing	Contrasting, Mapping, matching	inspecting the consistency exists in two viewpoints, things, or other similar things	comparing the difference between pre order and post order
2.7 explaining	Constructing, models	constructing a systematic cause effect model	explaining the stack operation at Hanoi tower
3. apply		applying or using a procedure when facing a situation	
3.1 executing	carrying out	applying a procedure in a familiar task	Applying in-order to post-order transformation to solve problem
3.2 implementing	using	applying a procedure in a unfamiliar task	Applying in-order to post-order transformation knowledge to in-order to pre-order transformation
4. analyze		destructing a whole object into many pieces, and determining the relation between individual pieces and whole structure	
4.1 differentiating	Discriminating, Distinguishing, Focusing, selecting	distinguishing relative and irrelative or important and unimportant from existing material	distinguishing the difference between stack and queue
4.2 organizing	Finding, Coherence, Outlining, Parsing,	confirming suitability and function of element at structure	explaining the operating procedure of circular queue

	structuring		with principle of circular queue
4.3 attributing	deconstructing	making sure viewpoint, bias, value, or intention implied in existing material	describing the meaning of adopting stack structure to recursive technique
5. evaluate		evaluating according to criteria and standard	
5.1 checking	Coordinating, Detecting, Monitoring, testing	inconsistency or error within a procedure or product, making sure inner consistency within a procedure or product, and monitoring the effectiveness of procedure being implementing	checking the consistency of executing result of stack procedure with definition
5.2 critiquing	judging	judging inconsistency of product and external criteria, making sure whether product has external consistency, monitoring the suitability of problem solving approach	evaluating the time complexity of stack operation
6. create		aggregating elements to form a complete set which has coordination or functionality	
6.1 generating	hypothesizing	building hypothesis according to many criteria	creating a new procedure such that several elements can be pushed into or pop from a stack
6.2 planning	designing	creating a operating	modifying

		procedure to complete some tasks	existing push and pop procedure, so that several elements can be pushed into or pop from a stack
6.3 producing	constructing	inventing new product	Changing Push(data) to push(data, n), and changing Pop(stack) to pop(stack, n) where n is number of element