Development and evaluation of a CAI course in *Information Technology for Life* at Nakhon Pathom Rajabhat University, Thailand.

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A thesis submitted for the degree of Doctor of Technology in Science

April 9, 2006

Certificate

I certify that this thesis has not already been submitted for any degree and is not being submitted as part of candidature for any other degree.

I also certify that this thesis has been written by me and that any help that I have received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

Signature of Candidate

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Somporn Sirisawad

Acknowledgements

My deepest gratitude, love and respect go to my late parents, my father Mr Jarong Sirisawad and my mother Mrs Ubon Sirisawad, who sadly did not live to see the completion of my thesis.

I extend my appreciation to all who have helped me to make this dissertation a reality. Foremost in this respect I acknowledge the support of my wonderful principal supervisor, Dr Walter Kalceff, for his valuable assistance, guidance, and encouragement throughout the course of the project. Equally, my sincere gratitude goes to my co-supervisor, Associate Professor Dr Peter Logan and to my external supervisor, Dr Tau-Tong Puangsuwan.

I shall remain forever indebted to Professor Dr Tony Moon, former Dean of the Faculty of Science at UTS, and Associate Professor Dr Les Kirkup, who both helped "beyond the call of duty" in guiding me to the completion of my project.

I thank the UTS Department of Applied Physics for providing me with office and computing facilities during my several visits to Sydney, and especially for their warmth and hospitality in welcoming me to Australia.

My deep appreciation and gratitude go to Assistant Professor Dr Niwat Glin-Ngam, President of Nakhon-Pathom Rajabhat University (NPRU), who provided the facilities and time (in the form of a period of leave-of-absence from my teaching duties) for doing my experiments. I extend this gratitude also to the former and present Deans of NPRU Faculty of Science and Technology, Assistant Professor Ajarn Anuluck Nitirat and Dr Pitakpong Pompranee, respectively, and also to the former and present Directors of the NPRU Central Library, Assistant Professor Ajarn Benjarat Sritongsook and Ajarn Arunee Songpattana. I would like to thank Ajarn Prasarn Sookkhajornni, Head of the NPRU Computer Education Program, for his kindness and help. I also acknowledge the generous support (in the form of a scholarship) with my tuition fees from the Office of Rajabhat Institute Councils (ORIC). I thank Dr Vanida Pongsakchat from Burapa University, Thai-

land, for helpful discussions about my data analysis, and Ajarn Supan Leumsai, also from Burapa University, for his kind assistance with the programming of the CAI for the third experiment.

Special thanks go to my NPRU colleagues for their understanding: Assistant Professor Ajarn Yongyoot Samakchan, Assistant Professor Ajarn Pongpan Chandravarathit, Associate Professor Ajarn Linjong Chandravarathit, Assistant Professor Ajarn Wandee Kaesornmala, Assistant Professor Ajarn Sommai Piatanom, Assistant Professor Ajarn Jongjit Panyarachoon, Assistant Professor Ajarn Sureeporn Pipatthitikorn, Ajarn Praimsook Jaipakdee, Ajarn Kaiyasit Apirating, Ajarn Detch Thammasiri and Ajarn Areerat Kaewprasert. A very big "thank you" for his support and encouragement to my unforgettable best friend Mr Kumjorn Nisaiman, who provided me with generous and excellent hospitality in Suratthani during the coursework component of the Doctor of Technology course.

I wish to thank my two dear lovely daughters, Earth and Arm, who provided me with much moral support and always cheered me up when I was down. Special gratitude is extended to my wife, Panitan, for her support and understanding, particularly in taking full responsibility and care for our daughters while I was away in Australia.

Lastly and very importantly, my heart-felt gratitude goes to my dearest sister, Somsong Sirisawad, who kindly acted as my guarantor and provided me with official recommendations in support of my travel to Australia.

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Abstract

The purpose of this study was to determine whether computer assisted instruction (CAI) in the *Information Technology for Life* course taken by first year students at Nakhon Pathom Rajabhat University (NPRU), Thailand, could be used to teach at least as effectively as traditional methods. Since CAI has been used successfully in developed countries to supplement or replace traditional methods of instruction, it was thought that CAI may present a solution to the lack of instructors in general education courses across the 41 Rajabhat Universities in Thailand. CAI could also facilitate student centred learning, a key goal of the National Education Act (1999).

One hundred and twenty four incoming freshman students enrolled at NPRU for the 2004 academic year participated in a study comparing the two methods of instruction using three topics of the *Information Technology for Life* course. The research questions examined were (1) are there differences between the groups on the achievement factors related to CAI usage? and (2) are there differences between the groups on attitude factors related to CAI and traditional teaching? CAI lessons were developed for the experimental group as interactive multimedia modules loaded from a CD-ROM; the control group received traditional lecture instruction.

Pre-test and post-test scores indicated greater learning gains in the CAI group. Comparison of weak, average and strong students between the two groups showed no difference in learning outcomes for the weak students, but average and strong students in the CAI group did better than those of the control group. The results also indicated that CAI students' retention of content was better than that of students following traditional learning. There was no significant difference in students' attitudes toward their method of teaching. Students of both groups felt that overall their method of teaching was very good. No relationship was found between student performance and their attitude toward CAI.

Chapter 1

Introduction

1.1 Background

Thailand has gradually come to realise that the development of education is very important for the improvement of its quality of life and to enable its people to keep pace with the rapid changes of modern society. Accordingly, the education system has been changing from a system of traditional management in the palaces and temples to a schooling system with specialist-trained teachers and a designated plan and curriculum. Since the Economic Crisis of 1997, there has been an attempt towards further education reform aimed at developing educational management to make it more consistent with the country's needs. Some of the implementations according to this reform have met with a certain degree of success, but some are still in need of further practical application.

This chapter sets the context of the project by giving an overview of the country, Thai higher education, and associated problems. Nakhon Pathom Rajabhat University is discussed, the motivation for the study is identified, and the aims of the thesis are stated.

1.1.1 Thailand in brief

Thailand (formerly named Siam) literally means "Land of the Free" (Vatanavigit, 1984). Thailand is the only South-east Asian country never to have been taken over by a European power (Central Intelligence Agency, 2005).

It covers an area of nearly 513 115 square kilometres, being roughly the size of France. As shown in Figure 1.1, Thailand shares land borders with Myanmar (Burma) in the north and west, the Andaman Sea in the west, Laos in the north and north-east, Cambodia and the Gulf of Thailand in the east, and Malaysia in the south. The shape of the country is said to be similar to the profile of an elephant with a long trunk stretching down the peninsular. At school, students are taught that their country resembles the shape of an ancient axe with the peninsular being the handle (ThaiWebsites.com, 2005).

Figure 1.1: Thailand and its neighbouring countries.

Thailand is composed of 76 provinces, with a population (in July, 2005) of about 65 444 371 people, divided into ethnic groups as follows: Thai 75%, Chinese 14%, others 11% (Central Intelligence Agency, 2005). Bangkok is the capital of the country; Thailand has a constitutional monarchy, with King Bhumibol Adulyadej its Head of State (ThaiWebsites.com, 2005).

1.1.2 Education in Thailand

The Thai Education System provides for three types of education (Office of the Education Council, 2004): "Non-formal" education services are provided by both public and private bodies to those outside the school system, such as pre-school children, school-age children who have missed formal schooling, and adult learners. "Informal" education provides opportunities for the populace to learn on their own according to their interests, readiness and the opportunities available from individual, society, environment, media or other sources. Finally, "formal" education is provided to those inside the school system, by both public and private bodies.

Formal education is further divided into basic education and higher education. Basic education is provided for 12 years before higher education commences. Compulsory

and free education is provided for all children from ages 6 to 15. Pre-school starts at ages 3–5, primary education is for ages 6–11, lower secondary for ages 12–14 and upper secondary for ages 15–17. Higher education, on the other hand, is divided into two levels: pre-degree level and degree level (International Relations and Cooperation Centre for Education Reform, 1999).

1.1.3 Overview of Higher Education in Thailand

The beginning of higher education in Thailand can be traced back to the first medical school of the country, which was established in 1885 at Siriraj Hospital. However, Chulalongkorn University is usually credited as being the first university in Thailand. The medical school at Siriraj Hospital was transferred to this new university and became its faculty of medicine. The original objectives of the university were to recruit and train professional personnel for the civil service.

The second university, Thammasat University, was established in 1934. The university shared the same objectives as Chulalongkorn University, with an emphasis on the disciplines of law, political science and economics. In addition to admitting full time students, Thammasat University also served as an open university by providing opportunities to those already employed but wishing to advance their careers by pursuing a university degree. Both universities have depended almost entirely on budgets allocated by the government for their operation.

Some 88 years have passed since Chulalongkorn University was established in 1917 by King Chulalongkorn (Rama V). It incorporated the existing schools of medicine and engineering with the newly created faculties of arts and sciences, law and political science (Educational Management Information System Centre, 1998). Today the Office of Higher Education Commission in the Thai Ministry of Education has under its jurisdiction 166 institutes (or universities, both public and private), 46 190 instructors, and 1 891 693 students (Bureau of Information and Communication Technology, 2005).

Higher education in Thailand has progressed remarkably since the establishment of Chulalongkorn (Weesakul and Team, 2004). University students constitute 28% of the 18–24 age group of the population; the budget for the operation of these institutions averages US$1 550 million per year, 61% of which comes from the government and the rest from fees paid by students for their tuition and related services. The number of universi-

ties, students and instructors under the jurisdiction of the Office of the Higher Education Commission in the Ministry of Education for the academic year 2003 is shown in Table 1.1 (Weesakul and Team, 2004).

Table 1.1: Number of universities, students and instructors under the jurisdiction of the Office of the Higher Education Commission in academic year 2003.

University or Institute	Students	Instructors
22 Limited Admission Universities	3 100 000	20 300
2 Open Universities	640 000	1 170
41 Rajabhat Institutes[a]	220 000 (Formal) 270 000 (Non-formal)	7 700
1 Rajamangala Institute of Technology (36 Campuses)[b]	94 000	4 600
51 Private Universities and Colleges	220 000	9 500

[a]Became Rajabhat Universities on 15 June 2004.
[b]Became Rajamangala University of Technology on 18 January 2005.

1.1.4 Traditional Learning in Thailand

For much of Thailand's educational history, the teacher has been the centre of the classroom. Research and pedagogy focused on teacher behaviour and specific pedagogical strategies that primarily utilized a "transmission" model of presenting information to students and asking them to recall that information (UNESCO, 2003b). Deveney (2005) found that Thai school children are taught to be silent in class so they can listen to the teacher. She acknowledges that the relationship between student and teacher is very different to that in the US and other more developed countries. Respect seems to be connected with not only the high status of the teacher in Thai society, but also the fear of being hit (with a stick on the knuckles). Thai teaching staff gave some interesting examples of student behaviour: in school, students just follow the teacher and copy; students are more afraid of their teacher; children have more respect for their teacher e.g. they must stop in the corridor and "wei" (a form of respectful salutation) when a teacher goes by, or if the teacher is carrying something they ask if they can help. Also, students are well behaved, talk nicely and listen to the teacher. Deveney claims that the Thai education system is formal and teacher-centred, as well. The conclusion of her research is that Thai culture does, indeed, impact on learning.

Figure 1.2: Wai Khroo ceremony at Nakhon Pathom Rajabhat University (early academic year, 2005).

Comparing characteristics of Thai school children with those of students in universities, there appears to be little difference between the two. Prangpatanpon (1983) emphasized that universities in Thailand are based on a system of faculties— each under a separate dean, as in the United Kingdom. Teaching and course organization, on the other hand, are similar to the American system, with a credit course system being used. However, the relationship between instructors and students follows the Thai school approach rather than any foreign model, which has a strong influence on students' attitudes and academic standards. Rites and rituals in the university reinforce this approach. For example, Thai universities still practice the tradition of paying homage to instructors. At the beginning of each academic year every university conducts an elaborate ceremony called 'Wai Khroo', to honour teachers, as depicted in Figure 1.2 at Nakhon Pathom Rajabhat University.

Most Thai students are used to authoritarian practice, and are willing to accept what their instructors say without question because they see the university as a continuation of their traditional schooling in which they receive information submissively and passively. Irvin (1990), following experience teaching English at Chaing Mai University in northern Thailand, concluded that students often do not have a lot of self-confidence, perhaps because freshman university students are not in class with people they have known for a long time. Irvin asserts that working with Thai students requires a balance of energies, the teacher having to be active enough to stimulate the student's thinking. He found that cul-

tural thinking was the biggest problem; for example, organizing the ideas of argumentation into advantages and disadvantages is not an easy task for Thai students— sometimes they mix them up. Moreover, when instructors try to introduce more creative and critical elements into their teaching, students find it very difficult to adapt (Brickshawana, 2003).

Knee (1999), an American instructor who has had experience teaching Thai university students, claims that when Thai students confront the problem of learning concepts at a university level, they lack the ability of describing deep analysis or criticism of an idea or text while American or Australian students do not. Shoko (1998) talks about what Thai students are like and points out that school life at a Thai university is considerably different from that at a US university. As often observed in many Asian countries, authority and seniority play important roles both inside and outside of the classroom. There exists a definite hierarchy between teachers and students, and students are expected to respect and follow teachers' directions. While questions and discussions are being more and more encouraged by teachers to facilitate students' learning, challenging a teacher rarely occurs.

1.2 Problems in higher education in Thailand

Despite the progress made in recent years, Thai higher education is still faced with many problems. Sakda Prangpatanpon, a USA-trained academic, lists some of these as unclear and ambiguous educational aims, inadequate financing, inability to recruit enough qualified lecturers, and insufficient numbers of graduates in science and technology to serve the country (Prangpatanpon, 1983). Many of these problems, he says, are related to the culture and traditions of Thai society. In the "old days", teachers did not receive any pay but taught their students out of kindness. Their students were grateful and would hold a ceremony every year to show their appreciation and the great respect they had for the teachers. Now, even though teaching is a paid profession, this tradition is still followed at all levels of education. As Prangpatanpon emphasised "The failure to integrate knowledge in various disciplines keeps students from gaining a broader understanding and preparing themselves for a more global society. Often what passes for university education is little more than a capacity for passing successive examinations, regardless of whether there has been intellectual growth". This is why Knee (1999) criticises education in Thailand,

stating that "In Thailand a degree is seen purely as a means of attaining status and employability rather than as a means of intellectual enrichment". This inclination suggests that there is room to further develop the popular understanding of the university's enterprise (Mulder, 1996; Prangpatanpon, 1983).

The Thai higher education system is facing both a qualitative and quantitative crisis. Vatanavigit (1984) concluded that Thai students are expected to be quiet and take whatever the teacher imparts. This is in agreement with what Prangpatanpon stated. Most Thai students are used to authoritarian practice, and are willing to accept what their professors say without question; moreover, most professors use lecturing as their main form of instruction, and students rarely argue or discuss the content in class (Prangpatanpon, 1983). This has resulted in a serious inappropriate learning characteristic, namely students learning by memorizing more than thinking. In the ranking of higher education institutions in 49 countries by the Institute of Management Development (IMD), Thailand ranks 47th and 46th in the overall competitiveness of its education system and its quality of higher education respectively, while universities in Singapore and Taiwan come 4th and 14th respectively in the university education ranking (Weesakul and Team, 2004). According to the Thailand country report on EFA2000 (Education for All) presented to the UNESCO, Thai higher education has encountered management problems and also a lack of quality instructors in some vocational and university level subjects; also, the training of technical staff is not effective due to their obsolete equipment (The Ministry of Education, 1999).

Weesakul and Team (2004) identified two groups of problems in the Thai higher education system:

1. Problems in the quality of the education system, composed of the following categories

    - Government subsidies
    - Inadequacy of public budget
    - Uneven distribution of high quality students
    - Uneven backgrounds of student intake
    - Lopsided growth
    - Poor remuneration for university teaching staff
    - Lack of interest in research

2. Problems in the financial management system:

    - Use of two accounting systems
    - Lack of effort to identify the actual production costs
    - Lack of systematic accounting practices
    - Discrepancy in the budget year and the academic year
    - Decentralization of the accounting system

Identification of the above problems provoked the government to prepare a new approach to Thai education. As stated by UNESCO (2003b), newer educational theories seek to shift the focus from teaching to learning and, thereby, from the teacher to the learner. Emerging models seek to make learning less passive and more interactive and to engage the learner as a solver of real-world problems. Srisa-an (2003) recommends that from a curriculum and instruction point of view, the Thai teaching and learning process must be reformed. Teaching must be student-centred; rote learning must be replaced by training in the thinking process, analytical, and problem-solving skills. He also says that Thai higher education should be reformed. The International Relations and Cooperation Centre for Education Reform (1999), in chapter 4 section 24, states that in organizing the learning process, concerned educational institutions and agencies should:

1. Provide materials and arrange activities in line with the learners' interests and aptitudes, bearing in mind individual differences.

2. Provide training in the thinking process, management, how to face various situations, and the application of knowledge to solving problems.

3. Organize activities for learners to draw from authentic experience; drill in practical work for complete mastery; enable learners to think critically and acquire a habit of reading and a continuous thirst for knowledge.

4. Achieve, in all subjects, a balanced integration of subject matter, integrity, values, and desirable attributes.

5. Enable instructors to create the ambiance, environment, instructional media and facilities for learners to learn and be all-round persons, able to benefit from research as part of the learning process. In so doing, both learners and teachers may

learn together from different types of teaching-learning media and other sources of knowledge.

6. Enable individuals to learn at all times and in all places. Co-operation with parents, guardians, and all parties concerned in the community shall be sought to develop jointly the learners in accord with their potentiality.

Dr Wichit Srisa-an, one of Thailand's foremost educationalists (and former president of Sukhothai Thammathirat Open University, chairman of the Sub-Commission on Reform of the Educational Administrative System, a member of Parliament, chairman of the House Committee on Education, and executive vice president of Chulabhorn Research Institute), stated in his address to the Regional Seminar on Human Resource Management for Global Competitiveness on December 8, 2004 in Bangkok on the topic "Education for Global Competitiveness", that Thailand is in a decade of educational reforms and that the teaching and learning process must be reformed. Teaching must be student-centered. Learning must be replaced by training in the thinking process, development of analytical, and problem-solving skills (Srisa-an, 2005). This is discussed in the new Thailand National Education Act of B.E. 2542 (1999) on learning reform, stating that the government will be attaching the highest importance to the learner. Research and development should be conducted on the learner-centred teaching-learning process, allowing learners to develop at their own pace and in accord with their potential (International Relations and Cooperation Centre for Education Reform, 1999).

1.3 Background to the study

1.3.1 Brief history of Rajabhat Institutes

In 1995, the original 36 Teacher Training Colleges under the authority of the Ministry of Education were integrated to form the Rajabhat Institutes (Weesakul and Team, 2004). Though the curricula offered vary from one campus to another, most are in the field of teacher education and social science. The number of campuses has since increased, in 2001 numbering 41 campuses throughout the country. The Institute is under the administration of the Office of the Secretary General of the Rajabhat Institute, Ministry of Education. Legislation processed by Parliament in 2004 made it possible for all the campuses to

Figure 1.3: Nakhon-Pathom Rajabhat University (NPRU).

exist as separate universities. The combined student population of the Rajabhat Institutes is 480 000. Of this enrolment, 56% are studying in evening programs or at weekends. The teaching staff numbers approximately 7 700.

1.3.2 Brief history of Nakhon Pathom Rajabhat University (NPRU)

Nakhon Pathom is the name of the province, which is 56 km west from Bangkok. It is a city dating back to at least 150 B.C., according to the historians. Nakhon Pathom occupies an area of 2 168 km^2 and is divided administratively into six Amphoes (districts). Nakhon Pathom's population in 2005 is 806 691 (Department of Provincial Administration, 2005).

In 1936 "The Nakhon-Pathom Teacher Training School for Girls" was established at the registration chambers building of Monthon Nakhon Chaisri situated at 86 Tesa Road, Tambon Phraprathomchedi, Amphoe Muang, Nakhon-Pathom province. The school was designated to run courses for elementary level teacher training for girls. It was under the jurisdiction of Teacher Training Department, Ministry of Education.

In 1960, it became a comprehensive school and boys were accepted as joint-attendant students or co-students. The "Certificate of Education" and the Rural Teacher Training Project began. In 1968, the school was renamed "The Nakhon-Pathom Teacher Training School".

In 1969, the school moved from the above address to 85 Malaiman Road (opposite Wat Mai Pinkliaw) and the course was upgraded to be based on the elementary level

teacher training project.

In 1970, the school was promoted to Nakhon-Pathom Teachers' College, promulgated on 16 January 1970. The Higher Certificate of Education commenced.

In 1975, the Teachers' Colleges began to operate in line with the Teachers' College Act, 1975. Many changes were implemented, particularly in its role and structure, which in one way or another paved the way to becoming solely an institute of Higher Education. For instance, the Fifth Article of the 1975 Act specified that Teachers' Colleges would, "... become research institutes and legitimately confer the Bachelor's Degree, deliberately promote the academic standing of instructors/teachers and education personnel, preserve and nurture the arts and cultures, and provide the community with academic services". Despite the new obligations having been undertaken for only five years after the enforcement of the Act, Nakhon-Pathom Teachers' College managed to modify many aspects of its structure and perform its numerous roles proficiently.

In 1978, a two-year Bachelor of Education extension programme began for students who had completed the two year diploma or certificate courses. In the second semester of 1978, the first teacher training and in-service teacher training programmes were also offered.

In 1980, the fourth-year Bachelor Degree commenced.

In 1984, some articles in the Teachers' Colleges Act, 1975, were revised and amended, not only for the benefit of better administration but also to undertake a broader range of significant issues. The amendments to Article 5, for instance, stated that Teachers' Colleges were now required to offer other fields of study than just teacher education.

In 1985, Nakhon-Pathom Teachers' College offered five new major fields of study in two-year undergraduate programmes: two Liberal Arts programmes including Journalism & Public Relations and Art & Design, and three Science programmes including Food Science, Botany and Electronics.

In 1986, a greater number of students in varying fields were admitted, and programmes were extended to the Bachelor's Degree level for both full-time students and those in the in-service personnel programmes.

On 14th February 1992, His Majesty the King offered the name "Rajabhat Institute" to the Teachers' Colleges and Nakhon-Pathom Teachers' College became "Rajabhat Institute Nakhon Pathom". The Department of Teacher Training became the Office of Ra-

jabhat Institute Councils (ORIC).

In 2004, His Majesty the King signed the Rajabhat Unversity Act, which was promulgated under royal decree on 14 June 2004 in Government Gazette No 121, section 23A, and enacted from 15 June 2004 onwards. The name "Rajabhat Institute" was changed to "Rajabhat University". Consequently, Rajabhat Institute Nakhon Pathom became Nakhon Pathom Rajabhat University. The Office of Rajabhat Institutes Council became part of the Office of the Higher Education Commission, the Office of Rajabhat Institutes Council (ORIC).

Nakhon Pathom Rajabhat University comprises 4 major faculties and 1 graduate school, as follows:

1. Faculty of Education
2. Faculty of Management Science
3. Faculty of Humanities and Social Science
4. Faculty of Science and Technology
5. Graduate school.

In the academic year 2004, Nakhon Pathom Rajabhat University enrolled 7 382 students in regular (full-time) classes, 5 197 students in Kaw-Saw-Phaw-Paw (weekend) or part-time classes, 206 community leader students, 182 masters degree students, and 93 students in the Graduate Certificate of Teaching Profession. The joint program, in cooperation with Samuthsakorn Physical Education College, enrolled 138 students in full-time classes and 173 students in Kaw-Saw-Phaw-Paw classes. The University also employed 211 official government instructors, 16 civil-service officials, 117 employed instructors, 41 permanent employees and 118 temporary employees (NPRU, 2004a).

1.3.3 *Information Technology for Life* course

As a general education course, the *Information Technology for Life* course aims to train first year students in the knowledge and skills of computer literacy (NPRU, 2004b). This is described in the course outline below:

- Impact and influence of computers and information technology on social and life studies. Application of information technology, data processing, and data management.
- Computer components and functions.
- Programming and application software usage.
- Application of the Internet, Intranet, LAN, CD-ROM, E-Mail, FTP, BBP, ICQ etc., on studying, reporting and presenting information.
- Efficient living and intellectual property rights.

1.4 Motivation for the study

In view of the problems described above, and in an effort to contribute to the process of educational reform in Thailand, researchers have been considering the issue of more appropriate approaches to teaching and learning for Thai students. In the case of the project reported in this dissertation, the question asked was: "are there specific strategies to help NPRU students improve their learning?".

As a computer education instructor with over 30 years teaching experience at NPRU, the idea of a project trialling Computer Assisted Instruction (CAI) lessons was a natural choice, particularly with the recent expansion of computing facilities to accommodate large numbers of students. Given Frick's remark that advances in technology can cause a paradigm shift in education (Frick, 1991), a project was devised to develop some CAI lessons and make them available to students to learn individually at their own pace, while at the same time preparing them to face today's Information and Communications Technology (ICT) world.

The purpose of this study was to:

1. Investigate students' achievements using CAI lessons as compared with the achievements obtained through traditional instruction.
2. Investigate the impact of CAI on students of different learning abilities.
3. Evaluate the attitude of students toward the CAI approach.

4. Investigate correlations, if any, between previous knowledge and the instructional methods.

1.4.1 Why CAI, why not e-learning or Web-Based Instruction?

Today there is much talk about new educational technologies such as e-learning, "an innovative approach for delivering well-designed, learner-centred, interactive, and facilitated learning environment to anyone, anyplace, anytime by utilizing the attributes and resources of various digital technologies along with other forms of learning materials suited for open, flexible, and distributed learning environment" (Khan, 2005). Horton (2001) and Horton and Horton (2003) define e-learning as "the use of Web and Internet technologies to create learning experiences". Similarly, Web-Based instruction (WBI) is a form of teaching defined as "a hypermedia-based instructional program which utilizes the attributes and resources of the World Wide Web to create a meaningful learning environment where learning is fostered and supported" (Khan, 1997).

These innovations in education are closely tied to the Internet, a network (or web) of interconnected, independently-owned computers (servers) (Bates, 2001). As long as it is connected to the Internet and has the necessary software and access codes, any computer all over the world can act as a connection within the World Wide Web (WWW) by linking to the host server which then forwards messages and finds another appropriate server to relay them on, and so on, until they reach their final destination. Messages are sent in the form of standardized digital data, transmitted across any communications channel (e.g. telephone lines, co-axial cable, fibre optic cable, satellite, microwave, or wireless).

Bates (2001) claims that the first Web-based post-secondary education course took place only in 1995, suggesting that e-learning is still relatively new, even in the USA. Consequently, it is difficult to find many examples of successful practice outside the most economically developed countries. Even in some of these, e-learning hardly exists in any systematic form. Inevitably, then, most examples come from the three developed countries where the application of e-learning has been the most extensive: USA, Canada and Australia. Several European countries, such as the United Kingdom, Norway, Denmark and the Netherlands, have also invested heavily in e-learning.

Physical infrastructure problem

The e-learning catchword claims it is for anyone, anyplace and anytime. However, this only applies if there exists the required infrastructure of Internet connections with the outside world, including ports and other communication facilities installed to enable students in residences or off-campus to access the main university campus or other institutions. In Thailand at present, students are only be able to access the Internet from home using telephone lines. The number of telephone main lines in use in Thailand is 6 617 400 (2003 data), while the Thai population is about 65 444 371 (July 2005) (Central Intelligence Agency, 2005). This means that there is, on average, one telephone line per 10 people. In Nakhon Pathom province the proportion of telephones is 1 per 21 people (1999) (Department of Provincial Administration, 2005). Furthermore, telephones are not equally distributed, being clustered in the cities or big towns and very rare in rural areas. Waitayangkoon (2004) points out that as of August 2003, 70% of primary schools and 17% of secondary schools in Thailand had no telephone line at all. This poor telecommunications infrastructure has seriously obstructed the use of the Internet, users having to call up to 10 times for just a few minutes of connection time. Miller (2001a), who worked on the Thailand-Australia Science and Engineering Assistance Project (TAEAP) in 1999, notes that Internet use in Thailand was mostly hindered by slow connections speeds from universities, with actual experience of 20 bytes per second line-speeds and 2 hours to logon to access email from Australia. Cable and broadband connections in Thailand are still very limited. Waitayangkoon (2004) suggest that for online education the telecommunications network of the country has to be developed and improved to provide services at affordable prices, and Burn and Thongprasert (2005) note that employing modern technology and providing technical support is essential.

These observations support the view that it is not easy for anyone, from anywhere, to be able to access the Internet reliably in Thailand. Meaningful e-learning and/or WBI seem unlikely to take place in the near future in Thailand.

Budgeting infrastructure problem

Adequate financing is a major problem for a developing country like Thailand. Bates (2001) estimates that large research universities may need to spend up to $US 4–5 million per year to develop and maintain the necessary campus technology infrastructure for e-

learning. Comparing this figure with Nakhon Pathom Rajabhat University, in fiscal year 2006 the government through the Ministry of Education subsidized NPRU by an amount of 167.67 million baht (Bureau of Policy and Planning, 2005), equivalent to $US 4.09 million. Up to 75% of the total expense on education in Thailand is for salaries and regular wages (The Ministry of Education, 1999). Horton (2001) acknowledges that developing original e-learning products is complex, difficult, and expensive, but Weesakul and Team (2004) points out that only 30% of the budget can be used for this purpose, the majority having to be spent on maintaining the operation of the university and increasing the number of recruits; the mandatory low tuition fees are certainly not helpful to public universities in their pursuit of academic excellence.

Human support infrastructure problem

Even more important than the physical infrastructure are the people required to make the physical infrastructure work (Bates, 2001). Waitayangkoon (2004) observed that the lack of human resources is one of the major issues in ICT management in Thailand. Good ICT personnel may be pooled to develop a project, but on completion they have to return to their original agencies, leaving no one to oversee the project in the long term. The Thailand country report points out that problems in the management of higher education include lack of quality instructors in some vocational and university level subjects, such as engineering and computer management (The Ministry of Education, 1999). Weesakul and Team (2004) agree with these, predicting that one of the most important projects in the Thai higher education development plan will be the recruitment of more doctoral degree holders into the system, especially into the smaller, less prestigious universities.

Bates (2001) concluded that it is important to understand the necessary conditions or requirements for the successful implementation of learning technologies: "Those countries that are not yet ready for the knowledge-based economy are probably not yet ready for e-learning. Most developing countries do not have the resources, the technology infrastructure or the skilled workforce necessary to make e-learning available on a wide scale, at least for many years. When resources are scarce, they need to be concentrated and very carefully focused".

Practically, Computer Assisted Instruction is the direction that we have to consider, because this technology is not reliant on the Internet and other devices such as leased lines

and expenditure such as paying for telephone services and Internet Service Providers (ISP). CAI is an appropriate learning technology for today's Thai students. With CD-ROMs and stand alone computers, or with a LAN, students can learn at their own pace, using the CAI course either within the university or at home. The final report of the Experts' Meeting on Teachers/Facilitators Training in Technology-Pedagogy Integration (June 2003, Bangkok) states that "CD-ROM is a better medium for distributing e-resources for teacher educators than the Internet since it can be accessed where the Internet is not available; it saves costs on download time; and CD-ROM drives come on all computers nowadays" (UNESCO, 2003a). Waitayangkoon (2004) suggests a solution using a combination of on-line and off-line modes as the most appropriate and flexible for Thailand.

1.4.2 Self-Paced Learning

There are many ways to apply appropriate learning methodologies to student-centred methods of teaching. Clearly, in the modern world computer technology must be considered. Thailand's new education Act, in a chapter entitled "Technologies for Education" (chapter 4), decrees that "The state shall promote research and development; production and refinement of technologies for education; as well as follow-up checking and evaluating their use to ensure cost-effective and appropriate application to the learning processes of the Thai people" (International Relations and Cooperation Centre for Education Reform, 1999). It adds that CAI is one of the education technologies that should be considered a suitable methodology to support self-paced learning; this appropriate strategy of learning will safeguard learners from boredom and stereotyping, both of which are problems of traditional teaching.

1.4.3 Use of CAI

The new Thai education system is moving toward decentralization (Waitayangkoon, 2004), focusing on restructuring the framework of resource allocation, organizational structure, curriculum, the teaching and learning process, and professional development. Information and Communication Technology (ICT) plays an important role as a tool for managing these changes. CAI is part of ICT, but there has been very little use of CAI until now. Though well-known amongst students working on thesis research, in practice it is very rare in Thai schools.

As government policy, numerous pilot projects were established to train school teachers to develop CAI lessons, but most schools never received adequate funding. It is the responsibility of school administrators to manage their own financial constraints (Waitayangkoon, 2004, p. 15). Typically, any resulting CAI mostly consisted of text, with few diagrams, and virtually no audio, animation, interaction or instruction. A common practice was for teachers to post their notes on the Internet and call them CAI or e-learning, even though they were little more than "e-books".

Two commercial CAI authoring systems available in Thailand are the software packages `Macromedia Authorware`[1] (formerly known as Macromedia) and `Toolbook`[2]. There are also at least two authoring system developed in Thai Universities, `CHULA CAI`, developed by Chulalongkorn University in 1984, and `VTAL/THAI` developed by Sukhothai Thammathirat Open University; both were developed to for diversify lessons in distance learning programmes.

In 1995, Thailand's IT Year, Her Royal Highness introduced an initiative called the "IT Project" to serve social development for some "forgotten parts" of Thailand. The purpose of the project was to apply the use of IT to enhance the quality of life and increase education and work opportunities of the under-privileged groups, such as rural school children, disabled persons, and sick children. One of the four goals of the project was CAI development for use in teaching various subjects.

1.5 Significance of Study

The National Education Act of B.E. 2542 (1999), in chapter 4 section 22 states that "Education shall be based on the principle that all learners are capable of learning and self-development, and these are regarded as being the most important issues. The teaching-learning process should aim at enabling the learners to develop themselves at their own pace and to the best of their ability" (International Relations and Cooperation Centre for Education Reform, 1999). CAI provides a student-centred approach to teaching. Woodruff and Brown (1998) point out that CAI is one pedagogy that has long been used for supplementary instruction; one means of incorporating CAI is to offer students com-

[1]Adobe Systems, `http://www.macromedia.com/software/authorware/?promoid=BINL`

[2]SumTotal Systems, `http://www.toolbook.com/index.php`

plete lessons at their own pace and away from the traditional class. As Aikin (1981) notes, CAI offers students almost complete freedom to choose when the instruction will take place; it also both requires and makes possible a competency-based approach to instruction.

Thai education reform has concentrated on the pedagogy of student-centred learning. CAI is a new paradigm of learning for Thai students, because it gives students an opportunity to learn by themselves at their own pace. By its nature, student-centred learning is adaptable to meet the needs of every student (Stuart, 1997). McCombs and Whistler (1997), who employed the student-centred approach to teaching found that not only did student motivation increase, but actual learning and performance did as well. Furthermore, students taught in a student-centred class retained more material for longer periods of time. In order to learn, the brain cannot simply receive information; it must also process the information so that it can be stored and recalled (Silberman, 1996). Not only does CAI increase students' ability of learning, it automatically decreases the instructors teaching load as well. Aikin (1981) explained that CAI offers a way of multiplying the number of students who can be taught by one person.

As explained in §1.3.2, the former 41 Rajabhat Institutes were under the jurisdiction of ORIC. As all Rajabhat institutes followed the same curriculum, it meant that more than 80 000 first year students had to take the *Information Technology for Life* course each academic year. Even though today the Rajabhat universities are independent, pragmatically they are still employing the same curriculum. The problem of simultaneously teaching such a large number of students can be solved by using CAI lesson on a CD-ROM at home or both CD-ROM and local area net work (LAN) on campus. CAI appears to be an appropriate supplementary teaching methodology for instructors.

Today, in developed countries, CAI may not be considered a new educational technology, but in a developing country like Thailand, it is still a new medium in the delivery of instruction. Particularly in the decade of Thai educational reform, enhancing learning and teaching styles is the focus of ICT, as outlined in the new Thai Education Act. While Thailand's finances are limited and some infrastructures are not well developed, CAI is one of the educational technologies that should be taken into account. For these reasons, it was decided to investigate the empirical efficacy of CAI on student knowledge and satisfaction, based on the students' learning styles. The outcomes of the research could be

of particular interest in basic skills courses training high school teachers to develop CAI modules, to meet the Ministry of Education's goals. Waitayangkoon (2004) describes the 2001-2010 National ICT Master Plan, including an e-Education component which aims to:

1. Develop the mechanisms for effective educational policy and management.
2. Improve and develop the ICT infrastructure of the nation to enable education for all.
3. Promote and develop the potential of human resources at all levels.

As part of its professional development goals, the Ministry of Education (MOE) delegates one of the ICT sub-committee to design and develop standard training programmes for school administrators, ICT teachers, non-ICT teachers, and school technology coordinators. It was foreseen that the CAI CD-ROM modules for the *Information Technology for Life* course could be distributed and used in the other 40 Rajabhat Universities. The findings would perhaps also motivate higher education instructors and educators to pay more attention to developing appropriate CAI for teaching and learning. Additionally, this study would assist organizations and educational institutions to develop and justify the use of CAI for teaching and learning. Such findings could be instrumental in recommending virtual classrooms for particular types of students.

1.6 Research questions

This study sought to investigate the possible use of computer technologies in Thai education through the pedagogy of CAI, as part of an effort to gradually shift the emphasis in Thai education from teacher-centred to student-centred. The study also sought to gauge the effectiveness of CAI as opposed to a traditional (lecture) style.

The study used a cohort of first year students enrolled in an *Information Technology for Life* course offered by NPRU. The following research questions relating to students' achievements and their attitudes were formulated for the project.

1. Do students learn more in a CAI class than in a traditional (lecture) class?
2. What are students' attitudes toward CAI and traditional teaching?

3. Is there any correlation between student outcomes and their attitude to the teaching method?

1.7 Conclusion

The overall goal of this research was to develop and evaluate CAI courseware in a first-year general education course, *Information Technology for Life* at Nakhon Pathom Rajabhat University, Thailand, and to compare the outcomes of using it with those of the traditional lecture method.

This thesis is composed of five chapters, the organization of which is as follows:

Chapter 1 discusses the background to the study and its relevance to Thai higher education problems. The motivation for the study is explained and the research questions are defined.

Chapter 2 reviews the literature relevant to this study. The theoretical framework is identified and discussed.

Chapter 3 describes the methods used for the study, including the research design, survey instruments, participants, tools and equipment. The analysis techniques applied to the data collected are also described. Relevant survey instruments, documents and data are provided in the appendices.

Chapter 4 presents the results gathered from the study, including questionnaire survey and focus group findings and their interpretation.

Finally, Chapter 5 summarizes the study and conclusions reached from it. The implications of the study are discussed and recommendation for further research are presented.

Chapter 2

Review of the Literature

2.1 Introduction

For many years, educators have been exploring ways to combine theories of differing learning styles and student-constructed knowledge with the theory of practice-centred learning. Instead of being passive recipients of knowledge, we now consider students capable of constructing their own knowledge with guidance from the instructor. We can offer part of this tutorial guidance by setting up an environment that will provide students with the resources necessary for independent exploration. In using emerging computer-based technology as a resource, students are encouraged to explore their own interests and to become active learners, with opportunities to solve some genuine problems (Berge and Collins, 1995).

This chapter explores and synthesizes various educational theories of learning, including the concepts of adult learning and student-centred learning. There is a discussion on Computer Assisted Instruction, followed by a review of the differences between traditional learning and CAI in general. Literature on previous studies related to CAI employed in classroom learning and teaching is reviewed, and strategies for developing effective CAI courseware are discussed. The chapter ends by considering student attitudes to CAI.

2.2 Theories of learning

A UNESCO Experts' Meeting on Teacher/Facilitator Training in Technology-Pedagogy Integration was held in Bangkok in 2003. The final report stated that "newer educational theories seek to shift the focus from teaching to learning" (UNESCO, 2003b). So, what is learning? This question seems simple enough, but philosophically is very hard to answer (Wilhelhelm *et al.*, 1998), as it is such a broad concept, and learning can occur in many different ways (Long, 2000). Manochehri (2001, p. 29) said that

> "The literature on learning theory consists of many attributes, including, among others, environmental conditions, personal style and motivators, climates of collaboration, variety of instructional methods, and preferences toward instructional tools. Educators are aware that individual differences exists among learners; therefore, they incorporate knowledge of the learning process into instructional design. Researchers indicated that learning becomes more effective when instruction can be linked to the learner preferences and abilities. For this reason, they promote the need to individualize and use different educational tools."

Psychologists and educators have defined learning in a variety of ways. For example, Kimble (1961) described it as a process related to change in behavioural potentiality that occurs as a result of reinforced practice, while Lovell (1980) defined it as a relatively permanent change in potential for performance as the result of past interaction with the environment. On the other hand, Gagne (1985) defined learning as a "change in human disposition or capability that persists over a period of time and is not simply ascribable to processes of growth".

An interesting view on the inter-relation between psychology, education and computer science is presented by Wilhelhelm *et al.* (1998). They describe how developments in educational psychology (e.g. changing views and assumptions of learning) have been influencing the use of technology in education, suggesting that psychology supplies the ideas that affect the "area where education meets technology", the field of Instructional Technology (which includes Computer Assisted Instruction). They also emphasise that the development of IT is heavily influenced by technological developments and by pedagogical methods. This bi-directional relationship is illustrated in Fig. 2.1, showing that

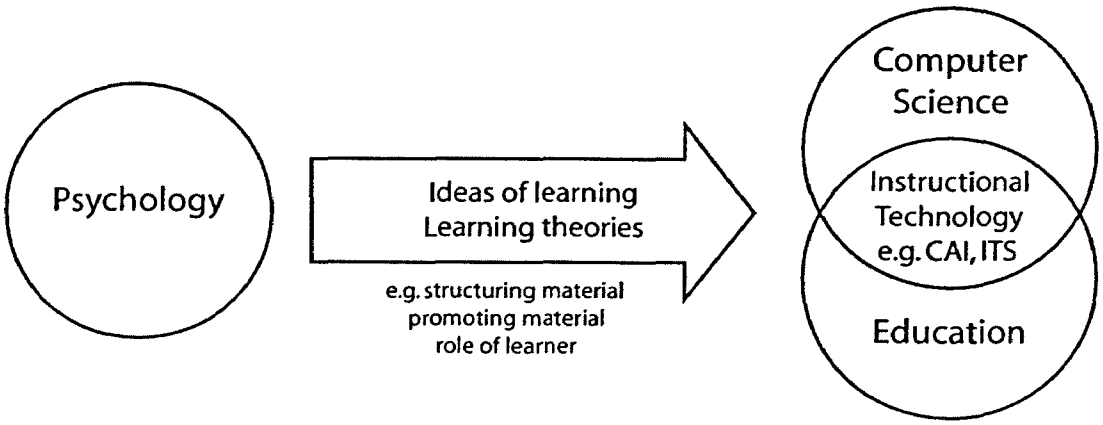

Figure 2.1: Inter-relationship between psychology, learning, and the use of technology in education. Adapted from Wilhelhelm *et al.* (1998).

psychology is an integral part of the theoretical background for instructional systems.

The three dominant views of learning are behaviourism, congnitivism and constructivism. Their key features, strengths and weaknesses are discussed in the following sections.

2.2.1 Behaviourism

Behaviourism is an approach to psychology and learning that emphasizes observable, measurable behaviour. The behaviourist theory of animal and human learning focuses only on objectively observable behaviours and discounts mental activities. Behaviour theorists define learning as a more-or-less permanent change in behaviour. In behaviourism, the learner is viewed as passively adapting to their environment. Two of the most famous experiments upon which proof of learning is based are the "Dog Salivation Experiment" by Ivan Pettrovich Pavlov and the "Skinner Box" experiment with pigeons by B.F. Skinner. Throughout the 1950s and 1960s behaviourism remained influential (Hergennahn and Olson, 1993).

2.2.2 Cognitivism

In the mid-20th Century, a different view of learning began developing. Many theorists disagreed with the observable behaviour approach. The cognitivist basically went inside the head of the learner to see what mental processes were activated and changed during the course of learning. In cognitive theories, knowledge is viewed as symbolic mental

constructs in the learner's mind, and the learning process is the means by which these symbolic representations are committed to memory. Changes in behaviour are observed, but only as an indicator to what is going on in the learner's head. The cognitivist version of the human mind is an input/output model of information or symbol processing. Key people in this field are Jean Piaget (1896-1980), Lev Vygotsky (1986-1934) and Robert M. Gagne (b. 1916) (Hergennahn and Olson, 1993).

2.2.3 Constructivism

Since the early 1990s, the focus on designing learning environments has been based on a constructivist approach to learning Seitz (1999). Constructivism is a theory that equates learning with creating meaning from experience. Even though constructivism is considered to be a branch of cognitivism (both conceive of learning as a mental activity), it distinguishes itself from traditional cognitive theories in a number of ways. Most cognitive psychologists think of the mind as a reference tool to the real world; constructivists believe that the mind filters input from the world to produce its own unique reality. As with the rationalists of Plato's time, the mind is believed to be the source of all meaning, yet like the empiricists, individual, direct experiences with the environment were considered critical. Constructivists do not deny the existence of the real world but contend that what we know of the world stems from our own interpretations of our experiences. Humans create meaning as opposed to acquiring it. Since there are many possible meanings to glean from any experience, we cannot achieve a predetermined, "correct" meaning. Learners do not transfer knowledge from the external world into their memories; rather they build personal interpretations of the world based on individual experiences and interactions. Thus, the internal representation of knowledge is constantly open to change; there is not an objective reality that learners strive to know. Knowledge emerges in contexts within which it is relevant (Ertmer and Newby, 1993).

2.3 Some strengths and weaknesses of learning theories

Schuman (1996, p. 27) proposed strengths and weaknesses of using certain theoretical approaches to instructional design, as summarised below.

2.3.1 Behaviourism

Weakness— learners may find themselves in a situation where the stimulus for the correct response does not occur, therefore the learner cannot respond; e.g. a worker who has been conditioned to respond to a certain cue at work stops production when an anomaly occurs because they do not understand the system.

Strength— the learner is focused on a clear goal and can respond automatically to the cues of that goal.

2.3.2 Cognitivism

Weakness— the learner learns a way to accomplish a task, but it may not be the best way, or not suited to the learner or the situation. For example, logging onto the Internet on one computer may not be the same as logging in on another computer.

Strength— the goal is to train learners to do a task the same way to enable consistency. Logging onto and off a workplace computer is the same for all employees; it may be important do an exact routine to avoid problems.

2.3.3 Constructivism

Weakness— in a situation where conformity is essential, divergent thinking and action may cause problems.

Strength— because the learner is able to interpret multiple realities, the learner is better able to deal with real life situations. If learners can problem-solve, they may better apply their existing knowledge to a novel situation.

A comparison of behaviourism, cognitivism and constructivism, as discussed by Ertmer and Newby (1993) is presented in Table 2.1.

Table 2.1: Comparison of Behaviourism, Cognitivism and Constructivism (following Ertmer and Newby (1993, pp. 50–72)).

Aspect	Behaviourism	Cognitivism	Constructivism
How does learning occur?	• Learning is change in the form or frequency of observable behaviour. • Learning is demonstrated following the presentation of a specific environmental stimulus. • The primary concern is how the association between the stimulus and response is made, strengthened or maintained. • Responses followed by reinforcement are more likely to occur in the future.	• Learning is discrete changes between states of knowledge rather than probability of response. • Knowledge acquisition is a mental activity that entails internal coding and structuring by the learner. • Concern about what the learner know and how they come to acquire it. • Address issues of how information is received, organized, stored and retrieved by the mind.	• Learning is creating meaning from experience. • Mind filters input from the world to produce its own reality. • Learner builds personal interpretations of the world based on individual experiences and interactions.

Continued on next page

Table 2.1 – continued from previous page

Aspect	Behaviourism	Cognitivism	Constructivism
Which factors influence learning?	• Environmental conditions. • The arrangement of stimuli and consequences within the environment. • Which point to begin instruction and which reinforcers are most effective?	• Emphasis on environmental conditions such as explanation, demonstration, examples, non-examples, practice and feed back. • Focuses on mental activities that lead up to a response. • Acknowledges the process of mental planning, goal-setting and organization strategies.	• Both learner and environmental factors interact to create knowledge. • Context is important. Content knowledge must be embedded in the situation in which it is used. • Critical that learning occurs in realistic settings and selected tasks relevant to the student's experience. • Learning must include activity, concept and culture.

Continued on next page

Table 2.1 – continued from previous page

Aspect	Behaviourism	Cognitivism	Constructivism
What types of learning are best explained by this position?	• Prescribe strategies for building and strengthening stimulus-response association, e.g. cues, practice, reinforcement. • Facilitate learning outcomes like discriminations, generalizations, associations and chaining. • Does not adequately explain acquisition of high level skills or deep processing.	• Complex forms of learning like reasoning, problem-solving, information-processing.	• Advanced knowledge acquisition in ill-structured domains.

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Table 2.1 – continued from previous page

Aspect	Behaviourism	Cognitivism	Constructivism
How should instruction be structured?	• Presentation of target stimulus and provision of opportunities for the learner to practice making proper responses. • Use cues to prompt the response. • Use reinforcement to strengthen the association.	• Make knowledge meaningful and help learner organize and relate new information to existing knowledge in memory.	• Model construction of knowledge, promote collaboration, design authentic learning environment.

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Table 2.1 – continued from previous page

Aspect	Behaviourism	Cognitivism	Constructivism
Role of instructor/ instructional designer	• Determine which cue can elicit response. • Arrange prompts to pair with stimulus. • Arrange environmental conditions so that students can make correct responses and receive reinforcement.	• Acknowledge that prior knowledge can affect learning outcomes. • Determine most effective way to organize information to tap into prior information. • Arrange practice and feedback so that new information is assimilated or accommodated.	• Instruct student on how to construct meaning, and how to effectively monitor, evaluate and update their constructions. • Align and design experiences for the learner so that authentic, relevant contexts can be experienced.

Continued on next page

Table 2.1 – continued from previous page

Aspect	Behaviourism	Cognitivism	Constructivism
Goal of instruction	• To communicate or transfer knowledge to the students in the most efficient, effective manner possible. • Use techniques of simplification and standardization. • Assume knowledge can be analysed, decomposed and simplified into basic building blocks. • Stress on design of environmental conditions.	• As in behaviourism: stress on efficient processing strategies.	• As in behaviourism: stress on efficient processing strategies.

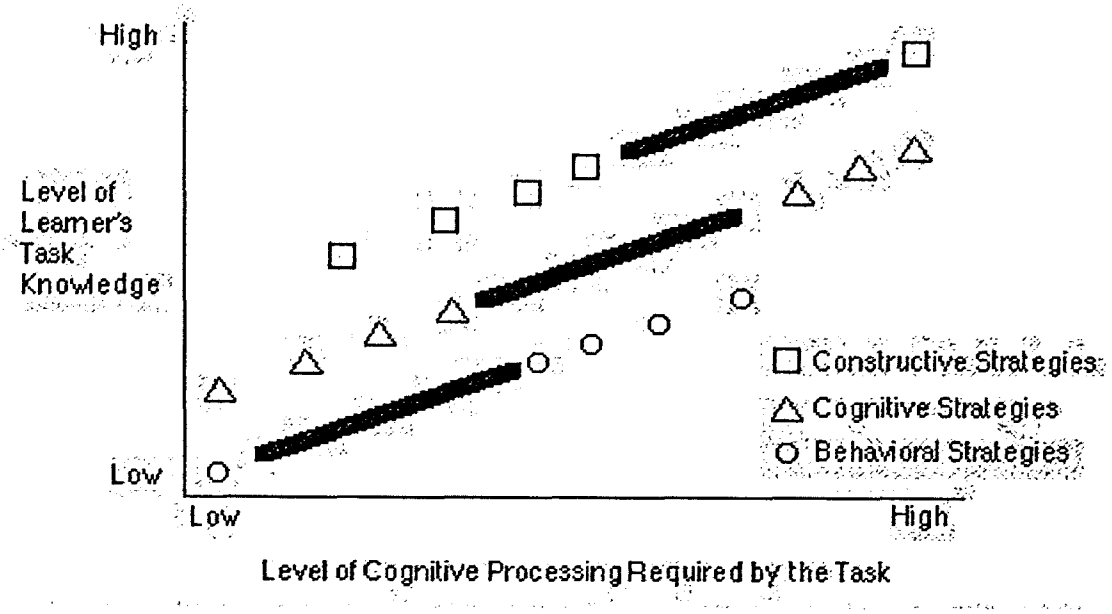

Figure 2.2: Comparison of associated instructional strategies of the behavioural, cognitive, and constructivist viewpoints, based on the learner's level of task knowledge and the level of cognitive processing required by the task (following Ertmer and Newby (1993)).

Ertmer and Newby (1993) suggested that the strategies promoted by different learning theories overlap— that is, they may use the same strategy, but for a different reason— and that learning theory strategies are concentrated along different points of a spectrum, depending on the focus of the learning theory (i.e. level of cognitive processing required). This is illustrated in Fig. 2.2 by the overlapping solid lines, where the extent of overlap increases with the level of cognitive processing demanded by the task. The theoretical strategies can complement the learner's level of task knowledge, allowing the designer to make the best use of all available practical applications of the different learning theories. With this approach the designer is able to draw from a large number of strategies to meet a variety of learning situations.

2.4 Which is the best learning theory for instructional design?

Schiffman (1995) stated that a solid foundation in learning theory is an essential element in the preparation of instructional system design (ISD) professionals because it permeates all dimensions of ISD. Depending on the learners and situation, different learning theories may apply. Whether we realize it or not, the best design decisions are most certainly

based on our knowledge of learning theories (Wilson, 1997). Woolley *et al.* (1999, p. 16) stated that it might be helpful to focus on when to use behaviourist and constructivist learning theories rather than on the superiority of one theory over the other. In addition Woolley and Woolley (1999, p. 13) suggested that teachers will evolve and differentiate in such a way that they may become behaviourist in some areas and constructivist in others. Hergennahn and Olson (1993, p. 452) pointed out that the best teaching technique is the one that allows teachers to meet their course objective most effectively and efficiently. Any teaching method must be evaluated in terms of course objectives. That is, instructors must be able to determine whether or not, and to what extent, the objectives of their course have been met. Schwier (1995) concluded that we must allow circumstances surrounding the learning situation to help us decide which approach to learning is most appropriate. It is necessary to realize that some learning problems require highly prescriptive solutions, whereas others are more suited to learner control of the environment.

2.5 Nature of adult learning

Having completed the 12-year education programme described in §1.1.2, the typical age of the (first year university) student participants in this research project is approximately 18 years. Lovell (1980) describes the characteristics of adults learners around this age as being socially engaged in making a shift from largely dependent juveniles to largely independent adults. It is at this time that the individual is most likely to engage in anti-social behaviour; but it is also the time when individuals are often at their most adventurous, creative, socially-concerned and idealistic. Athanasou (1999, pp. 34–35) describes the social psychology of adult learning as follows:

- Adults select other people as models for learning.
- Adults pay attention to the knowledge, skills and attitudes of the models they choose.
- Adults learn selectively from their chosen models.
- Adults make decisions for learning based on their own perceptions of the relevance and likely application of what they have learnt from models to the adults' own contexts for application of the learning.

- Adults may or may not perform specific learning gained from models because of personal factors (such as opportunities and resources).

Athanasou (1999) also suggested some interesting implications of social learning for adult education practice, including that:

- Instructors can request information from adult learners, prior to and during a learning experience, on expectations about models and past experience, expertise and preferred ways of learning. Individual *Profile* and *Personal Goal* sheets can be designed to provide relevant information to help adults to understand and monitor their learning needs, as adult learners may be seeking a particular type of model for learning specific knowledge, skills and attitudes.

- Instructors should monitor their own education practices and interactions with adult learners, as adult learners may be closely observing the instructors as models for learning specific knowledge and skills.

- Instructors should carefully monitor the congruence of their espoused theory and theory of use: they should practice what they preach, and communicate through congruent verbal and non-verbal means.

- Instructors' demonstrations of knowledge, skill and attitude should be clear and explicit and opportunities and resources for practice should be provided, as appropriate, for adult learners.

- Instructors should create a safe social learning environment where adults can practice learning in a climate of trust, confidentiality and respect.

- Instructors should realise that mistakes are accepted as part of learning.

- Instructors should encourage discussions of relevance and applications of learning for the specific contexts of the adult learners and for possible future contexts.

- Instructors should represent the highest standards of their professional area. The instructor's attitudes (for example, to the topic of learning, to the behaviour and performance of the adult learners present, and their profession) will be under scrutiny by adult learners and may be modelled by these adult learners.

- Instructor should be up-to-date and should model ethical behaviour. Instructors may be mistrusted and may be regarded as inappropriate models for learning if, for example, they do not know the material, use unsuitable methods for adults to learn, do not respect confidentiality, or criticize adult learners destructively.

- Instructors should strive to model effective ways of learning. If an instructor is regarded as an inappropriate model for learning, then adult learners may become cynical and may lack motivation to learn, especially novice or shy adult learners who are not confident about their abilities.

2.6 Student-Centred Learning (SCL)

Recent shifts in the educational paradigm from an emphasis on teaching to one of learning have encouraged power to move from the teacher to the student (Barr and Tagg, 1995). The instructor-focused transmission of information formats, such as lecturing, have begun to be increasingly criticised and this has opened the way for a widespread growth of "student-centred learning" (SCL) as an alternative approach (O'Neill and McMahon, 2005). The term student-centred learning is becoming widely used in educational pedagogy literature; it is also described by a range of terms and this has caused confusion surrounding its implementation (O'Neill and McMahon, 2005). Many terms have been associated with student-centred learning, for example "flexible learning" (Taylor, 2000), "self-directed learning" (O'Neill and McMahon, 2005) and "experiential learning" (Burnard, 1999).

The concept of student-centred learning has been credited as early as 1905 to Dewey's work (Schugurensky, 2005). Carl Rogers, the father of client-centred counselling, is associated with expanding this approach into general theory of education (Burnard, 1999; Rogoff, 1999). The term student-centred learning was also associated with the work of Piaget and more recently with Malcolm Knowles (Burnard, 1999). Rogers (1983a), in his book "Freedom to Learn for the 80s", describes the shift in power from the expert teacher to the student learner, driven by a need for a change in the traditional environment (O'Neill and McMahon, 2005).

A student-centred teaching approach is a way of planning and teaching, and assessment is centred around the needs and abilities of students. The main idea behind the

practice is that learning is most meaningful when topics are relevant to the students' lives, needs, and interests, and when the students themselves are actively engaged in creating, understanding, and connecting to knowledge (McCombs and Whistler, 1997). Students will have a higher motivation to learn when they feel they have a real stake in their own learning. Instead of the teacher being the sole, infallible source of information, then, the teacher shares control of the classroom and students are allowed to explore, experiment, and discover on their own. The students are not just memorizing information, but they are allowed to work with and use the information alone or with peers. Their diverse thoughts and perspectives are a necessary input to every class. The students are given choices and are included in the decision-making processes of the classroom. The focus in these classrooms is on options, rather than uniformity (Papalia, 1996).

2.6.1 What is student-centred learning?

Kember (1997) defined student-centred learning as a process of learning in which knowledge is constructed by students and the instructor is a facilitator of learning rather than a presenter of information. In addition, Rogers (1983b, p. 188) described the considerable precondition for student-centred learning as the need for "...a person who is perceived as an authority portrait in the situation, is sufficiently secure within herself/himself and in her/his relationship to others that she/he experiences an essential trust in the capacity of others to think for themselves, to learn for themselves". Burnard (1999, p. 244) emphasised that "students might not only choose what to study, but how and why that topic might be an interesting one to study". Harden and Crosby (2000) points out that in student-centred learning we should focus on what the student is doing instead of what the teacher doing.

In their book, Brandes and Ginnis (1986) present the main principles of student-centred learning as follows:

- The learner has full responsibility for her/his learning.
- Involvement and participation are necessary for learning.
- The relationship between learners is more equal, promoting growth, development.
- The teacher becomes a facilitator and resource person.

- The learner experiences confluence in her/his education.
- The learner see herself/himself differently as a result of the learning experience.

2.6.2 Productivity and critiques of student-centred learning

Lea *et al.* (2003) studied the use of student-centred learning and found that it was an effective approach. After a six-year study in Helksinki, Lonka and Ahola (1995) compared traditional and activating instruction and found that the activating group developed better study skills and understanding, but were slower in their study initially. In addition, Hall and Saunders (1997) found that after student-centred learning was employed, students had increased participation, motivation and grades in a first year information technology course and 94% of the students would recommend it to others over the more conventional approach. Students in a UK university felt there was more respect for the student in this approach, that it was more interesting, exciting, and raised their confidence (Lea *et al.*, 2003).

Some disadvantages in student-centred learning have also been raised. Simon (1999, p. 42) highlights the point of focusing on individual learner, saying that "if each child is unique, and each requires a specific pedagogical approach appropriate to him or her and to no other, the construction of an all embracing pedagogy or general principles of teaching become an impossibility". Also, Edwards (1999) states that isolation from other learners may take place. The importance of the social context of learning and the value of interaction with peers is emphasised in the socio-cultural view of learning (Bredo, 1999).

2.6.3 Comparison of teacher-centred and student-centred models

Hirumi (2002) provides a useful guide to the creation and evaluation of a student-centred learning environment by comparing instructional variables associated with teacher-centred and student-centred approaches to teaching and learning, as summarised in Table 2.2.

Table 2.2: A comparison of teacher-centred and student-centred models (University of Bath, 2005).

Instructional variable	Teacher-centered	Student-centered
Learning outcomes	• Discipline-specific verbal information • Lower order thinking skills, e.g. recall, identify, define abstract and isolated facts, figures and formulas.	• Interdisciplinary information and knowledge. • Higher order thinking skills, e.g. problem-solving. • Information processing interpret, communicate information.
Goals and objectives	• Teacher prescribes learning goals and objectives based on prior experiences, past practices, and state and/or locally mandated standards.	• Students work with teachers to select learning goals and objectives based on authentic problems and students' prior knowledge, interests and experience.

Continued on next page

Table 2.2 – continued from previous page

Instructional variable	Teacher-centered	Student-centered
Instructional Strategy	• Instructional Strategy prescribed by teacher. • Group-paced, designed for 'average' student. • Information organised and presented primarily by teacher, e.g. lectures, with some supplemental reading assignments.	•Teacher works with students to determine learning strategy. •Self-paced, designed to meet needs of individual student. •Student given direct access to multiple sources of information, e.g. books, online databases, community members.
Assessment	• Assessment used to sort students. • Paper and pencil exams used to assess students' acquisition of information. • Teacher sets performance criteria for students. • Students left to find out what teacher wants.	• Assessment is integral part of learning. Performance based, used to assess students' ability to apply knowledge. • Students work with teacher to define performance criteria. • Students develop self-assessment and peer assessment skills.

Continued on next page

Table 2.2 – continued from previous page

Instructional variable	Teacher-centered	Student-centered
Teacher's role	• Teacher organises and presents information to groups of students. • Teacher acts as gatekeeper of knowledge, controlling students' access to information. • Teacher directs learning.	• Teacher provides multiple means of accessing information. • Teacher acts as facilitator, helps students access and process information. • Teacher facilitates learning.
Student's role	• Students expect teachers to teach them what's required to pass the test. • Passive recipients of information. • Reconstructs knowledge and instruction.	• Students take responsibility for learning. • Active knowledge seekers. • Construct knowledge and meaning.
Learning environment	• Students sit in rows. • Information presented via lectures, books and films.	• Students work at stations with access to multiple resources. • Students work individually at times but also need to collaborate in small groups.

2.7 What is CAI?

According to Finnegan and Sinatra (1991), CAI provides pragmatic learning and allows adult learners to have control over their level and pace of learning. CAI for adults has been proven to empower the learner, with learners accepting responsibility for educating themselves and controlling the pace and level of program accomplishment. This empowerment and success in learning computer skills brings adults into the world of the future.

Woodruff and Brown (1998) notes that CAI has long been used for supplementary instruction. In music education, for instance, CAI has found its greatest success in the development of skills in the areas of theory, sight-singing and ear-training. One means of incorporating CAI is in the presentation of modules which students may complete at their own rates and away from the traditional classroom. Becker and Dwyer (1994), who studied the impact of increased learning control on students' intrinsic motivation for a learning task, found that students who learn at their own pace gained more in self-determination, and their intrinsic motivation was higher than those students who used paper-based resources to study. Prasad *et al.* (1994) and his team in the Department of Civil Engineering at the University of British Columbia, developed CAI for their students. They found that CAI modules offer several distinct advantages which make them useful additions to classroom instruction: they allow hands-on activity, self-paced learning, and flexible exploration of topics; they are also good tools for increasing student interest in a topic and presenting information in different ways. Fletcher-Flinn and Gravatt (1995), who examined studies on CAI from 1987 to 1992, found that there is an overall favourable effective size at all grade levels for CAI versus traditional classroom settings.

With the development of the microcomputer in the late 1970s, we have seen the rapid spread of computing in businesses, schools, homes (Allessi and Trollip, 1991), with rapid expansion during the 1980s. Between 1981 and the end of the decade, American schools acquired over two million microcomputers. The number of schools owning computers increased from approximately 25 percent to virtually 100 percent. More than half the states began requiring or at least recommending pre-service technology programs for all prospective teachers (Kinnaman, 1990).

It has been about thirty years since educators began using computers for instructional purposes. A great deal of research was conducted during the 1970s, 80s and early 90s on the effects of computer use on student achievement, attitudes, and other variables, such as

learning rate (Cotton, 2001). Many names were used to describe the use of microcomputers in teaching, some of these being (Allessi and Trollip, 1991) CAI (computer-assisted instruction), CBI (computer-based instruction), CBE (computer-based education), CAL (computer-assisted learning), and IAC (instructional applications of a computers).

The term CAI will be used in this thesis as an inclusive term. Steinberg (1991) defines the term Conputer-Assisted Instruction (CAI) as a computer-presented instruction that is individualized, interactive, and guided. These terms are used in the following sense:

Individualized The computer serves as a tutor for one individual rather than as an instructor for a group. CAI need not be confined to individual users and can be effective for students working in pairs or small groups.

Interactive It involves two-way communication between a learner and a computer system. In some lessons the computer poses questions, the learner responds, and the computer presents feedback. In other lessons the user initiates the interaction and the computer responds.

Guided Because CAI is a method of instruction, some element of guidance is implied. Consider a physics lesson in which a student observes how the path of projectile varies with the angle of projection. The student specifies the angle at which the projectile should be fired and then watches as the computer traces the path of the projectile on the display screen. By entering the different values for the angle, the student can observe how changes in the angle of elevation affect the height and horizontal distance of the projectile. Such a program provides interaction and offers an opportunity for self-instruction. To be CAI as defined here, the lesson should guide the student by suggesting an appropriate range of values to select if the range he/she selected is too narrow or otherwise inadequate.

Allessi and Trollip (1991) preferred to define instructional computer programs as a computer-based instruction (CBI) because their emphasis is on instruction rather than education in general. According to this model, for instruction to be effective the following four phases are provided:

1. **Presenting Information** To teach something new, the instructor must first present information. This may take a number of forms. For verbal or pictorial information,

an instructor may present rules and examples, show pictures, or provide other non-verbal information. To teach skills, the instructor will probably model the skills to be learned. That is, the instructor will perform the skills so that students can imitate them.

2. **Guiding the student** Having observed the presentation, the student must now perform under instructor guidance. When the student performs a skill incorrectly, the instructor may model the procedure or part of it. If the student demonstrates misunderstanding of concepts or principles, the instructor will try to understand the student's confusion and dispel it. Guidance is important in instruction because no student learns all that is taught on a single exposure. Students will make errors and frequently be unaware that they have made them. It is necessary that the student be made aware of these and can correct them. The interactive process of the student attempting to apply new knowledge, the instructor correcting and guiding, and the student making further attempts is frequently omitted in instruction and yet is probably its most important component.

3. **Practice** Practice is student-centred, although the instructor often observes the student and makes corrections when errors are observed, the emphasis being on the student practising and the instructor making only short corrective statements. Practising a skill once or answering a single question will not guarantee retention. Repeated practice is often required for a student to retain information and to become fluent with it.

4. **Assessing Student Learning** It cannot be assumed that instruction will be successful for all students. Rather, student learning should be assessed, usually with tests, which are the important part of the instructional process. Tests provide information about the level of learning, the quality of teaching, and future instructional needs.

The Association for Educational Communications and Technology[1] in 1977 defined computer-assisted instruction (CAI) as a method of instruction in which the computer is used to instruct the student and where the computer contains the instruction which is

[1]AECT, http://www.aect.org/default.asp

designed to teach, guide, and test the student until a desired level of proficiency is attained (Jenks and Springer, 2002).

2.8 Differences between CAI and other modes of instruction

Steinberg (1991) notes that understanding the differences between CAI and other modes of instruction will enable us to draw appropriately from past experience. Learning in group-paced situations such as listening to lectures, participating in discussions, and viewing films is different to learning from CAI lessons. Even learning with individually-paced print media such as books and programmed instruction is significantly different to CAI. Some differences between CAI and other modes of modes of instruction are listed below.

Classroom Instruction and CAI There are three main areas of difference here:

1. **Modes of communication** In traditional classrooms, instructors may use verbal/non-verbal means, physical actions or even body language to communicate (e.g. smile to reward or to encourage correct responses, shake head, and so on). At present, communication between CAI and students is rather limited compared with human instructors. In the classroom, students communicate by speaking or by writing. In CAI, they type, touch a display screen, or click a mouse. Students know how to speak and they know how to write, but some do not know how to type.

2. **Instructor-learner interaction** (an important issue). An instructor tries to monitor students' understanding by asking questions. Usually only one student at a time responds overtly. The others respond covertly, if at all. All students except one are supposed to "think" the answer. Instructors can also judge progress in learning by observing students' behaviour. It is not so in CAI, however. A computer cannot see a learner. The only way a computer can monitor understanding is by asking questions and evaluating responses. To accomplish this, a computer lesson must require overt responses. Judging learners' responses can be flexible for a human-instructor; in CAI answer-judging can be very flexible, but it is not an innate part of computer systems.

Furthermore, a computer cannot answer arbitrary questions posed by a learner. Instructors generally can; if not, they can suggest resources for finding the answers.

Teacher-learner interaction is basically teacher-controlled, and, for the most part, group-paced in a traditional classroom. In contrast, CAI can be individually-paced and can allow multiple instructional paths.

3. **Environment factors** In the classroom the quality of students' performance is often self-evident, as is the status of students' knowledge and performance relative to the performance of others. In CAI, information about students' performance is self-evident only in some lessons. Students learn by observing and interacting with others in a classroom. A student who is unable to answer a question posed by the teacher can learn by listening to another student's response. A student who does not understand a concept can learn from a teacher's responses to other students' questions. This give-and-take of classroom learning is not present in CAI. Because CAI is individualized instruction, lessons can allow each learner to progress at a self-determined pace, moving quickly through topics that are easily understood and slowly through more difficult ones. A concept missed, or those not thoroughly understood, can be repeated. In contrast, students in a classroom move along more or less at the same pace. Faster students have to wait for slower ones and slower ones may be unable to keep up with the group.

Programmed instruction and CAI In programmed instruction, a student's response may be correct, but not the same as the one provided by the program. She/he must decide if the answers are equivalent, but may lack the background to make such a judgement. In contrast, a CAI lesson can be programmed to judge answers flexibly, accept all correct responses, and provide informative feedback specific to the nature of the learner's misconception. A CAI lesson can branch a student around material that she/he has mastered, or provide further instruction if remediation is needed.

Branching is theoretically possible in programmed instruction, but is generally not provided because implementation is cumbersome. In physical differences, with programmed instruction a student can peek at the correct answer before formulating a response, while in CAI the author has the option of allowing a student to do so or

of requiring a response to be entered before displaying the correct one.

Books While providing self-instruction, books are also different from CAI in many aspects, such as:

1. **Individualization** A book presents identical information to every reader. In this sense, books are not individualized instruction. However, all learners reads at their own pace and learns what they are capable of and motivated to learn. In this sense, books are individualized self-instruction.
2. **Interaction** Clearly there is no interaction between a reader and a book. Questions may be inserted in the text, answers provided, and helpful learning hints presented. Nevertheless, it is one-way instruction. A book does not respond to a reader's activities.
3. **Physical differences** All textual information illustrated in books are "still" on printed pages, whereas they may be either still or animated on computer displays. In CAI it is possible to focus on a specific concept by physically isolating it and presenting it on a separate display. It is also possible to do this in books, but it is not a common practice.

Film and Television Like books, film and television can be a form of self-instruction. Differences include:

- **Interaction** Films and television constitute one-way instruction. They present, but do not interact with learners.
- **Realism** Realism between films/television and CAI need not be much different today, but it instructors should be mindful that realism may even interfere with learning in some situations.

Web-Based Instruction and CAI WBI representd a further evolution of computer-assisted instruction, as described, for example, by Chumley-Jones *et al.* (2002). Technical advantages of WBI include universal accessibility, ease of updating content, and hyperlink functions that permit cross-referencing to other resources. These technical advances, particularly the hyperlink and search capabilities, fit the constructivist learning theory, where learners search out and create their own knowledge bases. Practical reasons for the decision to use CAI instead of E-learning or

web-based instruction in this research have been discussed in §1.4.1, essentially reducing to the current under-developed and unreliable state of the network infrastructure in Thailand posing too great a risk of students not being able to obtain access to their lessons at all times.

2.9 Types of CAI

Steinberg (1984, p. 144) classified CAI into games, drills and simulation, while Cotton (2001) asserted that CAI most often refers to drill-and-practice, tutorial, or simulation activities offered either by themselves or as supplements to traditional, teacher directed instruction. Perhaps the most inclusive categorisation is that of Allessi and Trollip (1991), who classify CAI into five major types as described below.

1. **Tutorials**:— Relevant to almost every subject area, from the humanities to the social and physical sciences. They are appropriate for presenting factual information, for learning rules and principles, or for learning problem-solving strategies. A good tutorial should include both presentation and guidance (Gagne *et al.*, 1981).

2. **Drills**:— The function of drills is to provide practice. They are applicable to all types of learning, assuming presentation and guidance has already occurred. Drills may be applied to simple paired-associate learning, such as spelling or foreign language word translation; to verbal information, such as definitions, historical facts, or scientific concepts and principles; to simple problem solving, such as arithmetic facts; and to complex problem solving, such as problems in the physical and social sciences.

3. **Simulations**:— Simulations differ from interactive tutorials, which help the student learn by providing information and using appropriate question-answer techniques. In a simulation the student learns by actually performing the activities to be learned in a context that is similar to the real world. In an educational context, a simulation is a powerful technique that teaches about some aspect of the world by imitating or replicating it. Students are not only motivated by simulations, but learn by interacting with them in a manner similar to the way they would react in real situations. In almost every instance, a simulation also simplifies reality by omitting or changing

details. In this simplified world, the student solves problems, learns procedures, comes to understand the characteristics of phenomena and how to control them, or learns what actions to take in different situations. In each case, the purpose is to help the student build a useful mental model of part of the world and to provide an opportunity to test it safely and efficiently.

4. **Games**:— Games are a powerful instructional tool. They have become extremely prevalent with the proliferation of computers in schools. Simulations attempt to mimic reality, but while many simulations are also quite entertaining, entertainment is not one of their distinguishing features. Conversely, games may or may not simulate reality, but they are nearly always characterized by providing the student with entertaining challenges (Allessi and Trollip, 1991). Maidment and Bronstein (1973) and Nesbitt (1971) state that the overriding purpose of instructional games is to teach, and they can be successfully used to convey a variety of information, such as:

    - Facts and principles.
    - Processes, such as titration or real estate acquisition.
    - The structure and dynamics of systems.
    - Skills, such as problem solving, decision making, or the formulation of strategies.
    - Social skills, such as communication.
    - Attitudes.

5. **Tests**:— Tests are an essential aspect of all instruction, used for a variety of purposes. There are two major ways to incorporate computers in the testing process: using the computer as an aid to construct the test, and using the computer to administer the test. Computerized test construction utilizes the computer to generate, print, and score tests that students write on paper (or, increasingly, online). Both techniques offer advantages and both have limitations. Wisely used, however, both can save a substantial amount of time without sacrificing quality, and can frequently improve the quality of testing. Assessment of learning is a crucial part of the instructional process. Tests are the primary means we have for assessment. Because

they can have such a strong influence on a student's future, test need to be constructed with great care.

2.10 Research on CAI

There have been numerous studies in recent years on the effectiveness of CAI compared with traditional teaching. In many cases, the use of multimedia instruction has proven to be effective (Kulick *et al.*, 1980; Morrell, 1992). Mclssac and Blocher (1998, p. 3) note that in the late 1990s, the use of technology was most apparent in classroom teaching; not surprisingly, research studies focusing on this area grew to major importance. There have been a variety of research studies comparing CAI with traditional teaching, with a mixture of outcomes. Following is a brief mention of some of them.

Brothen (1998) refers to Lepper and Gurtner (1989), who studied a group of 100 students on computer-assisted instruction effectiveness, finding that there was an overall positive gain in learning. In post-secondary students, Jenks and Springer (2002) state that research from the 1980s found a positive effect of CAI on students of various ages in the formal education environment. According to the study of Leeds *et al.* (1991) on mathematics student performance, the developmental students' achievement levels for the CAI group were equal to or statistically significantly better than their non-CAI counterparts. Vogler *et al.* (1991) studied the effectiveness of CAI as a supplement to a Sociology 100 course, finding that students in the CAI group gained more knowledge and got better grades than the non-CAI group. In a study of traditional lectures compared with CAI in pharmacy students, Delafuente *et al.* (1998) found that students in the CAI group spent less time learning the material but performed better than their traditional learning counterparts. Mars and Mclean (1996), in a study at a Medical school in South Africa, came to a similar conclusion. Grimes *et al.* (1997) studied economics students at Mississippi State University and found that those in the CAI group did significantly better in the final exam. Worthington *et al.* (1996) indicated that students using CAI as a supplement to a lecture course in an introductory psychology class obtained higher scores than students in the lecture-only group. Research from Dunn (2002) found that freshmen in high school in a CAI group scored significantly higher than the control group on reading comprehension measurements. Tseng (1999) found that CAI was useful in mathematics teaching with

first grade students; results indicated that most students gained more knowledge than with traditional classes. In a similar study involving elementary students, Chang (2000) found a significant increase in scores after learning addition and subtraction in arithmetic with CAI courseware. Clariana and Smith (1988) studied learning styles using CAI, finding that a change in student learning style preference, particularly for high-ability students, occurs in CAI environments. Faircloth and et al. (1986) found that greater learning gains in the experimental group in a study using CAI teaching to Consumer Credit students. Okolo (1992) performed a study using CAI on students with learning disabilities, and found a significantly improved arithmetic proficiency after four sessions of computer-based practice. Schuman (1991) found that single-step problem solving can be taught in a relatively short period of time using CAI in numerical problem solving in elementary school Students. Shiah and et al. (1994) studied the effects of CAI on the mathematical problem solving skills of students with learning disabilities and found that students performed significantly better on mathematics tests given using a computer than by paper and pencil.

Some studies have found no difference between CAI and traditional learning (Cotton, 2001). Jenks and Springer (2002) reported on some meta-analysis studies in which the same teacher taught both the CAI and traditional versions of a course; the researchers isolated the results of these studies and found no significant differences between CAI and traditional teaching. Fletcher-Flinn and Gravatt (1995) found that for those studies using paper and pencil equivalents of the CAI, there were no significant achievement differences between experimental groups and control groups. The results of Milne *et al.* (1990) indicated an overall lack of motivation among the students for mathematics and no difference in performance between the lecture/tutorial group and the CAI group; students felt that the CAI program was better for reviewing old material than for learning new topics. Huxford (1999), in a study comparing a traditional instruction format group with a CAI format group, found that CAI is not as useful for instruction as previously claimed, with college students from the different groups showing no significant difference on measures of cognitive and affective learning. Puangsuwan (1997), in his study comparing two groups of first year students in an integral calculus course at Burapa University, Thailand, found no significant difference in the final exam mean scores achieved by students in the CAI group and those in the traditional method of teaching group. Gay *et al.* (1988,

p. 31) stated that "In most studies of interactive learning programs students have actually *learned less* when they have been provided choices that would allow them more control over their own instructional strategies and forms of presentation".

2.11 Development of CAI

Allessi and Trollip (1991, p. 11–13) believe that cognitive theory is the most important to CAI design relating to perception and attention, memory, comprehension, active learning, motivation, locus of control, transfer of learning and individual differences. The most important of these issues in evaluation and design of CAI are described briefly below.

Perception and Attention Learning processes are dependent on the learner correctly perceiving stimuli and attending to them. Perception is constantly strained by many competing stimuli, so attention may falter during instruction or be attracted by stimuli other than the desired ones. Thus, effective instruction depends on presentations designed for easy and accurate perception; this may be facilitated by many presentation design factors:— detail and realism, the use of sound versus visuals, colour, characteristics of text such as its size, font, animations, and so on. For perception of proper lesson elements to occur, the attention of the student must not only be initially attracted but maintained throughout the lesson. In addition to the factors just mentioned, attention is affected by many other considerations, including the level of student involvement, personal interests and prior knowledge of the student, lesson difficulty, novelty and familiarity, pacing, and variety.

Memory Much of what we perceive we must store and be able to retrieve later. While the information storage and retrieval capacity of human intelligence is immense, assuring that the important things are not only perceived but properly stored is not trivial. This is particularly true when faced with new and large bodies of information, such as the vocabulary of a new language. Two principles underlie almost all methods of enhancing memory— the principle of organization and the principle of repetition (Fleming and Levie, 1978). In general, organization is easier and more powerful. For instance, showing a student the organization of new information, or imposing organization upon it, aids recall. When the use of organization is inappropriate or impossible, repetition is often used.

Comprehension Our current knowledge comes from interpretation and integration of what we have perceived in the past (Anderson, 1977). We should be able to classify, apply, evaluate, and manipulate stored information, and so on. Principles of concept acquisition and rule application, for example, guide much CAI design. These principles include the use of prior knowledge, defining and exemplifying concepts, rule application, and information paraphrasing. The type of learning desired must determine the type of presentations and activities of a lesson.

Active Learning Interaction not only maintains attention, but creates and stores new knowledge and skills. One of the essential features of CAI in contrast to some other media is its capacity to require and act upon student interactions. Most authors stress this important aspect of CAI.

Motivation Proper motivation is essential to learning. Several theories of motivation suggest CAI techniques that will enhance motivation. Some unique aspects of CAI, which permit methodologies like simulation and gaming, are very valuable for motivation enhancement. Motivation theories particularly relevant to CAI are those of Lepper (Lepper and Chabay, 1985), Malone (Malone, 1981; Malone and Lepper, 1987), and Keller (Keller and Suzuki, 1987). Lepper maintains that motivation should be used which is intrinsic to the instruction rather than externally applied. Malone hypothesizes that the four elements which foster motivation are challenge, curiosity, control, and fantasy. Keller also suggests that four factors (some similar to Malone's) are essential to motivation: maintenance of attention, relevance of the material, student confidence, and student satisfaction.

Locus of Control A crucial design variable in all CAI is instructional locus of control, which refers to whether control of sequence, content, methodology and other instructional factors is determined by the student, the lesson (actually, the lesson author), or some combination of the two. While the potential for flexible student control is an often-claimed advantage of CAI (Laurillard, 1987), its effects on motivation and learning are complex (Hannafin, 1984; Steinberg, 1989). In reality, all lessons have a mixture of student and lesson control. Whether the lesson is successful depends on which aspects of instruction are controlled by the student and which by the lesson.

Transfer of Learning Learning in a CAI lesson is usually just a precursor to applying or using that knowledge in the real world. Transfer refers to the extent to which improved performance in the lesson is reflected in the real world (Clark and Voogle, 1985; Cormier and Hagman, 1987). Transfer is affected by type, amount, and variety of interaction, by realism of the instruction, and by the methodologies used. In training situations, transfer is ultimately the most important instructional outcome.

Individual Differences Students do not all learn the same way or at the same rate, some instructional methods being better for some students than others. Another often-praised advantage of CAI is its capability to individualize, but, just like interactivity, this supposed advantage is not often exercised. Good software will adapt to the learner, capitalizing upon his or her talents, giving extra help where the student is weak, and providing motivators to which each student responds.

Steinberg (1991) stated that "...we need a learning theory that is general enough to encompass many categories of learning (e.g., verbal learning, learning strategies) and a theory that translates reasonably well to procedures for designing instruction. These criteria can be fulfilled by a synthesis of the theories of Bransford and Gagne". An overview of their theories relevant to a CAI framework is presented below.

2.11.1 Gagne's Theory

Gagne described learning in terms of five categories of skills and capabilities and the conditions under which they are learned in concept (Gagne, 1977).

1. **Intellectual skills**:— the rules and concepts that constitute a considerable proportion of school learning. These skills are a sequentially ordered hierarchy of capabilities. For learning to occur, each capability must be mastered as a pre-requisite to learning skills at the next higher level. The most complex level of intellectual skills is learning higher order rules, which are a combination of other rules. This requires as a pre-requisite learning other rules. A rule, in turn, is a relationship of two or more concepts, which must be learned in order to learn the rule.

2. **Verbal information**:— the capability of verbalizing information, such as stating facts or presenting information in the form of sentences. Summarizing a body of

text and paraphrasing a rule are examples. To learn verbal information, a person needs to comprehend verbal text and to have previously stored in memory well-structured knowledge that is meaningfully related to the to-be-learned information.

3. **Cognitive strategies**:— employing personal strategies to guide learning, thinking, acting, and feeling.

4. **Motor skills**:— executing tasks involving the use muscles e.g. manipulating a computer mouse.

5. **Attitude**:— choosing personal actions based on internal states of understanding and feeling e.g. deciding to study daily to achieve a high enough grade for entry into an honours programme.

In summary, the most important ideas of Gagne's theory are that (1) both attributes of a learner and events in the environment contribute to learning, and (2) each type of learning outcome has its own set of internal and external conditions.

2.11.2 Bransford's Theory

Bransford (1979) studied learning, remembering, and understanding from a process perspective. He presents a framework of four components:

1. **Learner characteristics**:— attributes that are intrinsic to each individual, including a person's prior knowledge, the structure of that knowledge in memory, beliefs and expectations, knowledge about one's own knowledge, developmental maturity, and experience.

2. **Criterial tasks**:— used to test learning outcomes. A student's task may be to memorize or to solve a problem. For effective learning, different activities are needed for different criterial tasks.

3. **Nature of materials**:— material to be learned varies along many dimensions. They may be visual or verbal, written or aural, simple or complex, hierarchical in nature or not. Gathering information from maps, for instance, involves different skills to learning from verbal discourse.

4. **Nature of learning activities**:— include attention, analysis, elaboration, and rehearsal.

Bransford emphasizes that the most significant idea underlining this framework is the interaction among components. Each of Bransford's components interacts with the others to affect learning. Even for a single criterial task, such as a memory task, the learning activities differ according to the nature of the materials and characteristics of the learners. Immature learners, unlike mature learners, are apt to use a single memory strategy for every task, repetition. Appropriate or not, they try to remember by repeating the material to be learned again and again. The task of condensing a body of text requires different activities than memorization. The activities in which learners spontaneously engage vary with the characteristics of the learners. Mature learners reorganize text and state the significance of it in their own words. Children from ages 11 to 15 years, however, do not manipulate text. They tend to delete relatively unimportant information, and then copy the rest almost verbatim from the text (Brown *et al.*, 1982).

2.11.3 Instructional design for CAI

Steinberg (1984) proposed a two-level, three-phase of CAI designation, with a broad range of goals, learners, subject matter domains, tasks and instructional techniques. The core of the Three-Phase plan is:

1. Laying the groundwork for the lesson as a whole by making an initial plan.
2. Using this plan as a guide to produce the instruction, one unit at a time.
3. Integrating the parts and completing the lesson.

Lesson design occurs in three phases, as follows:

1. **Initial Planning**:— made for the lesson as a whole, before production begins, including components of the systems approach:
    - Characterization of the target population. It is important to characterize the target population by more than simply age or grade level. Specify skills of the target population if the skills deviate from the anticipated norm.

- Formulation of overall goals. The reason for writing goals is to clarify, in the instructors' mind, what the learners are supposed to accomplish. Goals provide a framework for designing the lesson, as well as for evaluating it. In CAI there are three aspects to goal formulation: goals for the learner, the role of the computer in helping the learner achieve those goals, and the role of the lesson in the curriculum.

  Learner goals The overall goal for the learner is a statement of the skills, knowledge, processes or attitudes the learner will attain.

  Role of the computer The diverse roles of the computer can be grouped into five categories:

  (a) Providing individualization.

  (b) Providing experience not otherwise possible.

  (c) Separating practice in interdependent skills.

  (d) Enabling curriculum revision.

  (e) Providing group interaction.

  Role of the lesson in the curriculum CAI lesson must be fitted in the curriculum, and the author should specify the intended use of the lesson. For example CAI may be the only medium of instruction for certain parts of a course, it may follow classroom instruction to review principles, apply concepts, or perfect a skill.

- Task analysis. Not only the content must be analysed, but also the learning strategies, appropriate organization of the content, and analysis of novice learners' misconceptions. Task analysis is a prototype, which the author should adapt and modify according to the target population, goals and content of the lesson. A general procedure for task analysis is presented as follows:

  (a) Generate a prototype item, or more than one if the goal is stated as more than one task.

  (b) Be systematic. Write down your work as a succession of numbered steps. Show all of your work.

  (c) Review each of the steps. On another sheet of paper, for each step, write the step number, the subject matter knowledge, and the skills or strategies

you employed.

(d) Summarize the analysis of knowledge and skills that you have just completed into a list of topics.

After generating the list of topics, the author will need to ascertain how much additional instruction to provide for each. At this stage a detailed task analysis is required, to enable the author to specify pre-requisite skills and to decide how to organize the knowledge for instructional presentation. In addition, the detailed analysis provides a basis for generating specific goals later when the units of instruction are developed.

- Designation of pre-requisite skills. It cannot be assumed that all students of the target population already have the pre-requisite skills. A short pre-test can be presented at the beginning of the lesson to determine this.
- Development of an initial set of evaluation measures. An important aspect of developing a lesson is evaluating it to determine if learners have achieved the specified goals. Although the actual evaluation of students' performance takes place at a later time in lesson development, measures should be planned and generated as much as possible at this time.

2. **Ripple Plan**:— design and production of the instruction per se occurs in this phase. Design begins at the heart of instruction, by generating the presentation, including audio, visuals, question-response feedback sequences, etc. The units of instruction are designed and programmed and also tested with students. Based on the results of such early trials, a designer evaluates and modifies the presentation, adds informative feedback for commonly occurring errors, and designs supplementary instruction if needed. Management decisions about advancing the student through the lesson are also made. Essential aspects include the following:

(a) Rationale. Creation entailed in CAI lessons is much more than just writing text. It includes, planning interaction, posing questions, judging responses, and commenting on those responses.

Equally important is the planning for smooth human-machine interaction and for managing the instruction. There is no need to make extensive plans and expend considerable time programming an entire lesson only to discover later

that the instructional design is faulty. Interacting with others as each unit is produced is helpful. Authors are less reluctant to incorporate comments and suggestions of colleagues if only part, rather than the entire lesson, requires revision.

(b) Components. A systematic and efficient procedure is required; such a procedure is the function of the Ripple Plan and is in two parts. The first part consists of planning, creation, and revision of materials off-line. Each unit developed is composed of a presentation, responses and feedback, and human factors and management. The second part is implementation and evaluation: programming the computer to produce the actual product, and testing it. The basic idea is to plan, program, and evaluate one component before expanding the unit to include additional components.

(c) Procedure. First, start with the presentation, producing and writing the computer program; evaluate the program by doing it yourself as a student, as well as asking a colleague or some students to do so. Use this try-out to improve the presentation.

Secondly, based on the evaluation just completed, generate feedback for incorrect responses, decide how to help students who had difficulty understanding the instruction, then try-out the lesson and get others to do so, too.

Thirdly, decide such matters as the conditions under which the student is allowed to advance in the instruction, and whether to allow the student to ask for help or to provide it automatically. This is a management and human factors decision. Make revisions as shown necessary. Again, program, evaluate and revise.

3. **Completing the Lesson**:— this requires integrating the parts of the CAI and includes the following steps:

- Complete management and human factors decisions. At this step, consideration of human-machine interaction is taken into account. The author should think about communicating to the learners what the computer will expect of them and what they can expect from the computer. Decide also who will manage the learners' path of instruction through the lesson: the computer, the

learner, the classroom instructor, or some combination of these. For those aspects of instruction under computer control, plan rules for advancing through the lesson.

- Generate the introductory display. A title page is provided in every lesson, with an index or "menu" often contained in most lessons. Some other introductory displays are (1) an explanation of the function and use of special-purpose keys, (2) the purpose of the lesson, and (3) special information or rules if the lesson is a game or simulation.
- Generate concluding displays. Learners have to be told what they can do, and what options are available to them. For example, when the lesson has ended, when to start again from the beginning or what learners should do when they want to quit the lesson.
- Complete initial set of evaluation measures.
- Evaluate and revise. We cannot know if the lesson as a whole has accomplished its goals until students from the target population have tried it. These trials enable the lesson to evaluated and revised.
- Document the lesson. This documentation provides decision-making information to potential users of the lesson. It should include the topics covered in the lesson, the goals, prerequisites, target population, instructional techniques used, special features, number of students who tested the completed lesson, and results of student trials.
- Plan maintenance. Sometimes programming errors do not occur until after hundreds of users have studied a lesson. In addition, if the content of the lesson is subject to change (e.g., census data), plans must be made for updating it.

2.11.4 Gagne's Nine Events of Instruction

According to Robert Gagne, there are nine events that activate processes needed for effective learning (Carr and Carr, 2000; Kruse, 2005), and all lessons should includes this sequence of events. These were based on the information processing model of mental events that occur when adults are presented with various stimuli. Gagne's nine events of

instruction correlate to and address the conditions of learning; they are listed below and also illustrated schematically in Figure 2.3.

1. **Gain attention** In order for any learning to take place, students must first be motivated. A multimedia program that begins with an animated title screen sequence accompanied by sound effects or music startles the senses with auditory or visual stimuli. An even better way to capture students' attention is to start each lesson with a thought-provoking question or interesting fact. Curiosity motivates students to learn.

2. **Inform learners of objectives** Early in each lesson, students should encounter a list of learning objectives. This initiates the internal process of expectancy and helps motivate the learner to complete the lesson. These objectives should form the basis for assessment and possible certification as well. Typically, learning objectives are presented in the form of "After completing this lesson you will be able to...".

3. **Stimulate recall of prior learning** Associating new information with prior knowledge can facilitate the learning process. It is easier for learners to encode and store information in long-term memory when there are links to personal experience and knowledge. A simple way to stimulate recall is to ask questions about previous experiences, an understanding of previous concepts, or a body of content.

4. **Present the content** This event of instruction is where the new content is actually presented to the learner. Content should be chunked and organized meaningfully, and typically is explained and then demonstrated. To appeal to different learning modalities, a variety of media should be used if possible, including text, graphics, audio narration, and video.

5. **Provide "learning guidance"** To help learners encode information for long-term storage, additional guidance should be provided along with the presentation of new content. Guidance strategies include the use of examples, case studies, graphical representations, mnemonics, and analogies.

6. **Elicit performance (practice)** In this event of instruction, the learner is required to practice the new skill or behaviour. Eliciting performance provides an opportu-

nity for learners to confirm their correct understanding, and the repetition further increases the likelihood of retention.

7. **Provide feedback** As learners practice new behaviour it is important to provide specific and immediate feedback of their performance. Unlike questions in a post-test, exercises within tutorials should be used for comprehension and encoding purposes, not for formal scoring. Additional guidance and answers provided at this stage are called formative feedback.

8. **Assess performance** Upon completing instructional modules, students should be given the opportunity to take (or be required to take) a post-test or final assessment. This assessment should be completed without the ability to receive additional coaching, feedback, or hints. Mastery of material, or certification, is typically granted after achieving a certain score or percent correct. A commonly accepted level of mastery is 80% to 90% correct.

9. **Enhance retention and transfer to the job** Determining whether or not the skills learned from a training program are ever applied back on the job often remains a mystery to training managers— and a source of consternation for senior executives. Effective training programs have a "performance" focus, incorporating design and media that facilitate retention and transfer to the job. The repetition of learned concepts is a tried and true means of aiding retention, although often disliked by students.

Some useful suggestions from Gagne to prospective CAI authors for producing effective lessons included (Gagne *et al.*, 1981):

- Leave the pace of the lesson under the control of the user.
- Avoid the placement of too much text on a screen display.
- Provide the learner with instructions on what to do next.

2.11.5 Ten steps for developing effective CAI

Allessi and Trollip (1991) provided an interesting model for developing CAI, the crucial ten steps of which are listed below.

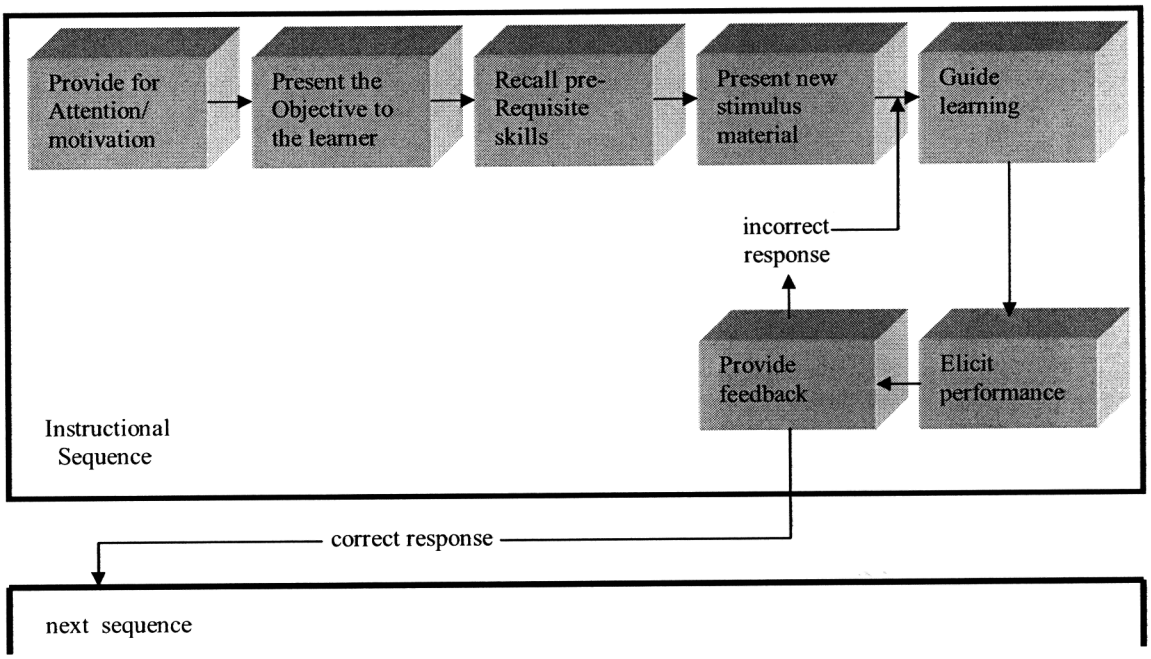

Figure 2.3: Illustration of Gagne's "Nine Events of Instruction", following Gagne *et al.* (1981).

1. **Determine needs and goals** The goal of a lesson includes what the student should know or be able to do after completing the lesson. Determining goals therefore includes assessing the characteristics and instructional needs of intended students.

2. **Collect resources** Resource materials subject to collection are:

   - Subject matter, such as textbooks, reference books, original source materials, films and, most importantly, other people knowledgeable in the area.
   - Instructional development; the materials involved include text on instructional design, story-boarding design sheets, graphic arts materials, and persons who have experience in instructional design.
   - Instructional delivery systems, such as the computer itself, software reference guides, and people experienced with the computer software intended to be used during development.

3. **Learn the content** The designer must not only learn the content but also interview the experts, and read texts and other instructional materials. An author cannot develop effective instruction which challenges the student in creative ways unless she or he become thoroughly familiar with the content. Shallow understanding can only produce a shallow lesson.

4. **Generate ideas** Generating ideas via brainstorming is very important. With brainstorming, the designer, with assistance from others, pursues the goal of generating as many ideas as possible. Brainstorming is strongly recommended, because it has proved to be a method that facilitates creativity and quickly produces a list that will include some interesting and good ideas.

5. **Design instruction** The outcome of brainstorming will lead the author to eliminate the worst ideas and then begin ordering, detailing, and refining the ideas that are good. This is done by performing concept and task analyses on the learned content. Such analyses bring to bear principles of learning to assemble a plan for an effective lesson. This includes preliminary choices about instructional methodologies and factors.

6. **Flowchart the lesson** A flowchart is a series of diagrams describing the operations a computer performs. Flowcharting is important because CAI should be interactive, and interactions are best depicted as a visual representation of decisions and events. The flowchart includes information about when the computer will draw or animate pictures, what happens when the student makes mistakes, and when the lesson should end.

7. **Storyboard displays on paper** Storyboarding is the process of preparing textual and pictorial displays so they will fit within the display limitations of the computer. While the flowcharts depict the sequence and decisions of a lesson, the storyboards depict its content and presentations. This step includes drafting the actual instructional messages students will see, such as information presentations, questions, feedback, directions, prompts, pictures and animation.

8. **Program the lesson** This is the process of translating what the designer has on paper into a series of instructions understandable to the computer. In this case programming is defined as any way to produce a lesson on the computer (not only referred to writing code in a standard language such as JAVA or PASCAL). Check the program for errors, and make changes until it does exactly what designer wants.

9. **Produce supporting materials** There are at least four kinds of supporting materials required: student manuals, instructor manuals, technical manuals, and adjunct

instruction. Teachers and students have different needs, and materials for them should be quite different. Technical manuals are necessary when setting up a lesson is complicated or requires sophisticated devices. Adjunct instruction includes worksheets, diagrams, exams, photographs, and assignment sheets.

10. **Evaluate and revise** The lesson and support materials should be evaluated with emphasis on how the lesson looks and works. For instance, have other people with design experience go through it; assess the lesson by observing the results of real students studying the lesson and investigating how much they learn. This step includes both pilot testing and validation.

2.12 Evaluation of CAI

In a paper on the evaluation of technology-based learning, Alexander and Hedberg (1993) refer to the blurring of meaning between evaluation and assessment in the context of the effectiveness of such learning. In their view, assessment refers to the "collection and use of data based on student learning outcomes", while evaluation encompasses "assessment as well as the range of other methods of data collection" (such as: questionnaires on attitudes to computers, reactions to the program, ease of use, learner control, content, etc.; observations of class behaviour; interviews with open-ended questions; summative and formative evaluations).

The four main evaluation models for CAI (and technology-based learning in general) are:

1. Objectives based model (Tyler, 1949). This uses evaluation as a means for determining the extent to which educational objectives are achieved and is therefore essentially summative in nature. Based on the rationale of pre-post design, this model is easy to apply but students are seen as all the same, with no allowances for those with different abilities, backgrounds and interests.

2. Decisions-based or Context, Inputs, Processes and Products (CIPP) model (Stufflebeam, 1975). This focuses on the decisions made during development of the lessons, with a view to improving them. While useful for evaluating complex programs, this model is difficult to implement and maintain.

3. Values-based model (Payne, 1994; Scriven, 1972). This model considers that evaluation should show not only whether learning goals have been achieved, but also whether the goals are worth achieving. It allows a program to be evaluated without the need to know about the objectives. Criticisms of this model include that it does not always measure outcomes and does not answer questions about how to make judgements and what the learner needs to assess.

4. Naturalistic model (Guba and Lincoln, 1981). This model bases evaluation around participants' key concerns and issues, using qualitative data collection such as journals, observations and interviews. The results are then used to benefit the subjects of the study. A criticism of this type of evaluation is that participants may identify criteria which have little educational worth.

2.13 Novelty effect in CAI

There have been numerous studies attempting to resolve the question of whether multimedia and CAI improve learning. On the one hand, researchers have said that compared with traditional instruction, CAI improved student scores and attitudes toward learning, and decreased learning time (Fletcher-Flinn and Gravatt, 1995). Okolo *et al.* (1993) concluded that computer technology may improve academic achievement, motivation, and time on task, as a well designed program will motivate students to spend time learning and their scores should improve. However, not all researchers agree that CAI is an effective teaching medium. For example Clark (1983, 1994) claims that media do not influence learning. He feels that any perceived advantage of CAI can be explained by other hypotheses, e.g. content differences between instructional methods with different media are not controlled and therefore the medium is not necessarily the cause of any significant effect; because the learning method is new, students automatically find it more exciting and this novelty effect will only temporarily improve learning; and, it is the method of instruction that fosters learning, not the medium.

Anecdotal evidence warns against drawing conclusions when new forms of instruction are introduced, particularly if it is technology-based, as the novelty of the instruments may, in the short-term, stimulate students to "try harder" (Alexander and Hedberg, 1993). This "novelty effect" is sometimes called the Hawthorne effect, described by Mouton and

Marais (1993) as follows: "The mere fact that human beings are studied leads to atypical behaviour" (p.86). That is, the subjects of a research project may feel flattered to be part of the investigation and may respond in ways that they feel are "desirable, admirable and rational".

2.14 Student attitudes to CAI

Cotton (2001, p. 8) has reviewed articles by a number of different authors, and summarises various reasons given for liking CAI activities and/or favouring them over traditional learning. Students say they like working with computers because computers:

- Are infinitely patient.
- Never get tired.
- Never get frustrated or angry.
- Allow students to work privately.
- Are fun and entertaining.
- Individualize learning.
- Are self-paced.
- Do not embarrass students who make mistakes.
- Make it possible to experiment with different options.
- Give immediate feedback.
- Are more objective than teachers.
- Free teachers for more meaningful contact with students.
- Are impartial to race or ethnicity.
- Are great motivators.
- Give a sense of control over learning.

- Are excellent for drill and practice.
- Call for using sight, hearing, and touch.
- Teach in small increments.
- Help students improve their spelling.
- Build proficiency in computer use, which will be valuable later in life.
- Eliminate the drudgery of doing certain activities by hand (e.g. drawing graphs).
- Work rapidly— closer to the rate of human thought.

2.15 Evaluation of student attitudes

An important tool in evaluating CAI is determining students attitudes, feelings, beliefs and experiences, often using the technique of focus group interviews (Gibbs, 1997). Focus groups take the form of a small-group discussion, typically with 6–8 respondents directed by a researcher or an associate; the number of participants can be as few as 4 or up to 15. Focus groups can be useful to obtain certain types of information, or when circumstances would make if difficult to collect information using other methods. They have been widely used in the private sector over the past few decades, and are being increasingly used in this area. Krueger and Casey (2000) suggest that the key to successful focus groups is to have an interactive setting, where participants can draw each other out, sparking new ideas. The reaction of each person sparks ideas in others, and one person might fill in a gap left by others; one may even find a form of collaborative mental work, as participants built on each other to come to a consensus that no one individual would have articulated on their own. Group interviews can be used when (Mathers *et al.*, 1998):

- Limited resources prevent more than a small number of interviews being undertaken.
- It is possible to identify a number of individuals who share a common factor and it is desirable to collect the views of several people within that population sub-group.
- Group interaction among participants has the potential for greater insights to be developed.

2.16 Hypothesis evaluation

The idea of a null hypothesis was developed by the famous statistician, Sir Ronald Fisher (1890-1962). The object is to set up a hypothesis to be "knocked down" or rejected, the convention being to assume no effect or no difference from the hypothesized null value until sufficient evidence to the contrary is provided (Johnson and Christensen, 2000). Ary *et al.* (1996) explain that "it is called null because it states that there is 'no difference' or 'no effect' or that there is 'no relationship'. The null hypothesis is represented by the symbol H_0.

In some cases, the null hypothesis can be rejected when the empirical data indicates that the difference between the sample groups is large enough that it is not likely to be due to chance. The researcher then adopts an "alternative hypothesis", represented by the symbol H_1 (Ary *et al.*, 1996). Johnson and Christensen (2000) state that the alternative hypothesis typically asserts the opposite of H_0, and usually represents a statement of a difference or a relationship that is consistent with what the researcher actually believes is true. When engaged in hypothesis testing, researchers should follow the two rules (Johnson and Christensen, 2000, pp. 401, 406):

Rule 1 If the probability value is less than or equal to the significance level, then the researcher rejects the null hypothesis and tentatively accepts the alternative hypothesis (H_1), which is some value other than the value stated by H_0. The researcher also concludes that the observed relationship is statistically significant.

Rule 2 If the probability value is greater than the significance level, then the researcher cannot reject the null hypothesis. The researcher can only claim to fail to reject the null hypothesis and conclude that the relationship is not statistically significant.

2.17 Conclusion

This chapter has presented an overview of the literature relevant to Computer Assisted Instruction and related topics. Some theories of learning, such as behaviourism, cognitivism and constructivism have been discussed, including an assessment of their relative strengths and weaknesses. Essential differences in philosophy between teacher-centred and student-centred learning have been highlighted, as these are the focus of Thailand's

present moves towards educational reform. Finally, strategies for developing effective CAI have been reviewed, together with previous research on attitudes students have shown towards CAI. In the following chapter the above findings are used to develop the research methodology and analysis techniques for this project.

Chapter 3

Methodology

The use of Information and Communication Technology (ICT), as the literature review of the previous chapter has shown, offers great potential for enhancing education at every level from primary to the university courses. Toomey (2002) defined ICT for teaching and learning as a technology that is used for accessing, gathering, manipulating and presenting or communicating information. Bassi *et al.* (1996) predicted that advanced technology will revolutionize teaching and training. In recent years, the emphasis of educational values has shifted from teaching to learning (Djojonegoro, 2005). There has been a move from how the information is transferred, to how learning is encouraged in the classroom. The changing demographics of today's classroom environment justify reassessing how and why students learn.

This chapter describes the methods and procedures used in the present study. It begins with the identification of the subjects and students who participated in the study. This is followed by a description of the choice of the three CAI topics. How the CAI lessons were developed as an instrument in the study is described, followed by the attitude surveys, and pre-tests and post-tests. Finally, the procedures for collecting data, the statistical analysis, and the hypotheses tested are explained.

3.1 Population

The target population for this study was a group of first year students in the first semester of academic year 2005 at the Nakhon Pathom Rajabhat University (NPRU). Students were enrolled in the course *Information Technology for Life* (subject code 4 000 107), which is

taken by all first year students as a general education course. The entire course is usually traditional instructor-based.

3.2 Sample

The sample for the study was drawn from the students in the Faculty of Management Science. Using a stratified random sampling technique, 122 students in the General Management program were selected as the control group, which was taught entirely by the traditional (lecture) method, and 93 Accounting Program students formed the experimental group which was partly taught using CAI lessons. The composition of the two groups is shown in Table 3.1.

Table 3.1: Sample sizes and their gender composition.

Sample	Male	Female	N
Control group	23	99	122
Experimental group	6	87	93

The participants in the experiment were chosen according to their Grade Point Average (GPA) and overall pre-test scores, in such a way that the two groups were close to identical in their learning abilities and background knowledge. The instructors participating in the teaching volunteered to do so. The same instructor taught all three topics in the control group, while the experimental group undertook CAI lessons with the researcher.

3.3 Research Design

The purpose of this study was to investigate differences in student achievement when using CAI and traditional learning, and to compare student satisfaction based on their attitude toward CAI. A field experiment was set up to investigate the hypotheses expressed in this research. A desirable characteristics of CAI is to give students a chance to control the lesson flow; Allessi and Trollip (1991) (p. 12) refer to this as "instructional locus of control", where students have control of sequence, content, methodology, and other instructional factors.

The CAI in this study was designed (see §3.5) in accordance with the guidelines proposed in the previous chapter (see §2.11, particularly §2.11.5, p. 62). A flexible menu

was provided, students only having to click their mouse to select the topic they wished to study. They could skip familiar topics and repeat other topics at any time. Interaction between students and the lesson was also provided, as immediate feedback was given. The study utilized half-hour pre-tests and post-tests for each topic.

In collecting data, the pre-tests, consisting of 30 questions on each of the three topics, were applied to all students participating in the experiment. The intention in using pre-tests was to discover the students' base-level of knowledge. After the lesson on each topic, a post-test (consisting of the same 30 questions) was administrated to detect changes in knowledge.

Following each CAI session, participants completed a 35-item questionnaire in which they attempted to express their feelings about the lesson. Finally, a 7-participant random sampling was carried out for a focus group interview in each topic.

Data analysis consisted of calculating normalised gains from each student's scores. Student attitude surveys used a 5-point Likert scale (Gliem and Gliem, 2003; McIver and Carmines, 1981), consisting of equal numbers of favourable and unfavourable statements. F-test and t-test analyses were used in comparing the two sample means in the study.

Table 3.2 lists the dependent and independent variables in this research.

Table 3.2: Independent and dependent variables in this research.

Independent variables	Dependent variables
Traditional learning	Student performance
CAI learning	Student satisfaction

3.4 Syllabus

NPRU's syllabus for the *Information Technology for Life* course is outlined in §1.3.3. This is a "3/4" credit points course, meaning that the weight of the course is 3 credits and it entails 4 periods per week of teaching. Each period is 50 minutes, and the 4 teaching periods are divided into 2 periods for lectures and 2 periods for computer laboratory work. The semester consists of 15 weeks. The topics taught in the 15 weeks are summarised in Table 3.3, while the complete syllabus is given in Appendix A (page 123).

Table 3.3: Summary of *Information Technology for Life* syllabus, Nakhon Pathom Rajabhat University.

Week(s)	Topics
1–2	Getting started
3–5	Hardware
6–8	Storage
9–11	Software
12–14	Networks
15	Security and copyright

3.5 Development of CAI lessons

The 3 subtopics selected from this syllabus for CAI presentation in this project were:

1. Computer components and functions.
2. The Internet.
3. Data communication.

The lessons developed are presented in full in Appendix B (on pages 129–166) as computer screen images. Programming of the lessons on the Microsoft Windows platform was undertaken after an outline had been developed in "storyboard" form by the researcher. Two of the lessons were then fully programmed by the researcher himself, using the `ToolBook`™ software (see footnotes in §1.4.3, p. 18). The third lesson was programmed by an expert programmer from Burapa University, Thailand, using the `AuthorWare`™ software under the direction of the researcher. These followed the 10 steps for creating computer-based instruction (see §2.11.5) suggested by Allessi and Trollip (1991), implemented as follows:

1. Determine needs and goals:— the knowledge content of the 3 topics was analysed, and it was observed that most of the material contained in these topics is actual information. Following the suggestions of Gagne *et al.* (1981) (see §2.9), the tutorial format was considered most appropriate. As Gagne stated, tutorials are used in almost every subject area from the humanities to the social and physical sciences; they are appropriate for presenting factual information, for learning rules and principles, or for learning problem-solving strategies.

2. Collect resources:— some Thai textbooks and the other resources were borrowed from the university's' library, and experts in education, instructional design and Computer Assisted Instruction from another university were invited to guide and offer useful suggestions. Storyboarding sheets were prepared, all graphics relating to the 3 topics were classified and selected from books and others references, or downloaded from educational websites. The sound tracks for the CAI lessons were recorded.

3. Learn the content:— the researcher is an instructor with teaching experience in excess of 30 years, and has been teaching this course for 5 years. Thus, the researcher/course designer had a thorough understanding of the 3 topics.

4. Generate ideas:— discussions and brainstorming about the contents with a colleague within NPRU and instructors at other Universities (Burapa University and Sripratum University (Chonburi Campus), Thailand) were very helpful. Valuable advice and excellent comments from those experts assisted the researcher to formulate his ideas. It was decided to spend one period (50 minutes) on each topic, for both the control group and the experimental group, following the comments of Allessi and Trollip (1991), namely that a lesson should be composed of a segment of instruction that deals with one or at most a few concepts that require fifteen to sixty minutes for students to complete. The contents of the three lessons are shown in Tables 3.4–3.6.

Table 3.4: Topic 1— Computer components and functions.

Topic	Contents
1. Types of computers	1. Super computer 2. Mainframe computer 3. Mini computer 4. Micro computer 5. Notebook and laptop computer 6. Embedded computer
2. Main parts of a computer and their functions	1. Input unit 2. Central processing unit (CPU) 3. Memory unit 4. Output unit 5. Secondary storage

Table 3.5: Topic 2— The Internet.

Topic	Contents
The Internet	1. Meaning 2. Brief history 3. Internet applications 4. URL 5. Internet connection 6. World Wide Web (WWW) 7. Web browsers 8. Services and e-mail 9. Search engines 10. Intranet and extranet

Table 3.6: Topic 3— Data Communication.

Topic	Contents
1. Connection types	1. Meaning 2. Point-to-point. 3. Multipoint 4. Switching network
2. Communication types	1. Wired system 2. Microwave system 3. Satellite system. 4. Radiowave

After the contents for each topic had been analysed, behavioural objectives were set up and reviewed in collaboration with external experts in IT and instructional design. Included were 15 multiple-choice questions (4 alternatives for each) at the end of each topic, as revision material. On completing their lessons, students could practice and evaluate their understanding by answering these questions. If a student's answer was incorrect, immediate audio feedback would be given, along with a text message, and the screen would then automatically display the page corresponding to the content of the question. Correct answers were accompanied by a distinctive tune/animation and a complimentary text message. There were no time limits set for studying each topic. Various navigation buttons were provided on each page, allowing students to move to previous or new content. Revision questions could be attempted as many times as desired. This lesson flow is illustrated in Figure 3.1.

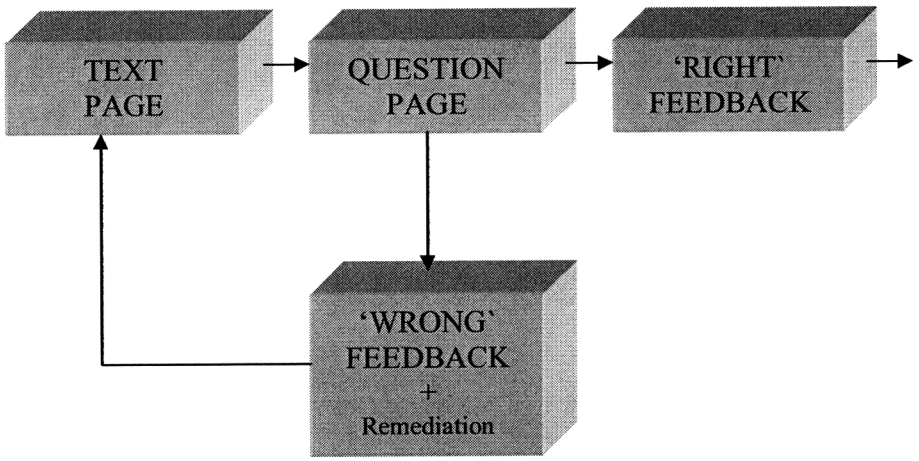

Figure 3.1: Programmed branching model of instruction, used in the CAI lessons developed for *Information Technology for Life* at NPRU (Merrill, 1994).

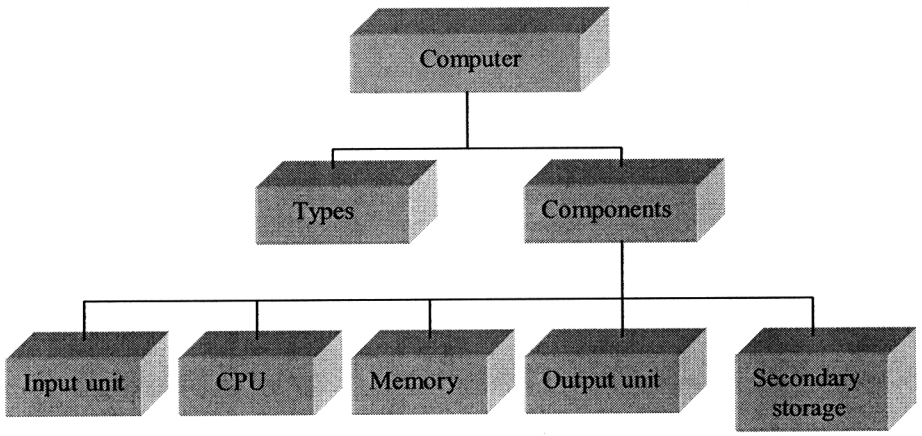

Figure 3.2: Flowchart of topics covered in the "Computer Components" CAI lesson developed at NPRU.

5. Design instruction:— many ideas were generated during the brainstorming sessions between the researcher, instructional designer, and contents experts. Details of appropriate activities in each topic were set up, and structures such as titles, table of contents, objectives, navigation, multimedia, and informative feed-back were developed.

6. Flowchart the lesson:— Flowcharting of the lesson topics (as listed in Tables 3.4–3.6) is illustrated in Figures 3.2–3.4. A blue-print flowchart was set up for developing the CAI lessons, following the guidelines of Allessi and Trollip (1991) (see §2.11.5, item 6, p. 64).

7. Storyboard displays on paper:— textual, pictorial, and graphical material to be dis-

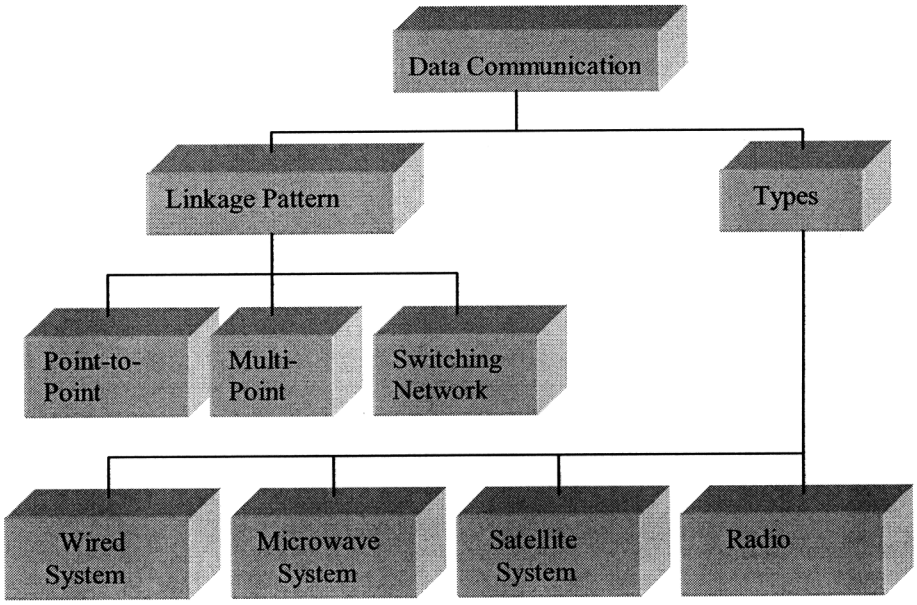

Figure 3.3: Flowchart of topics covered in the "Data communication" CAI lesson developed at NPRU.

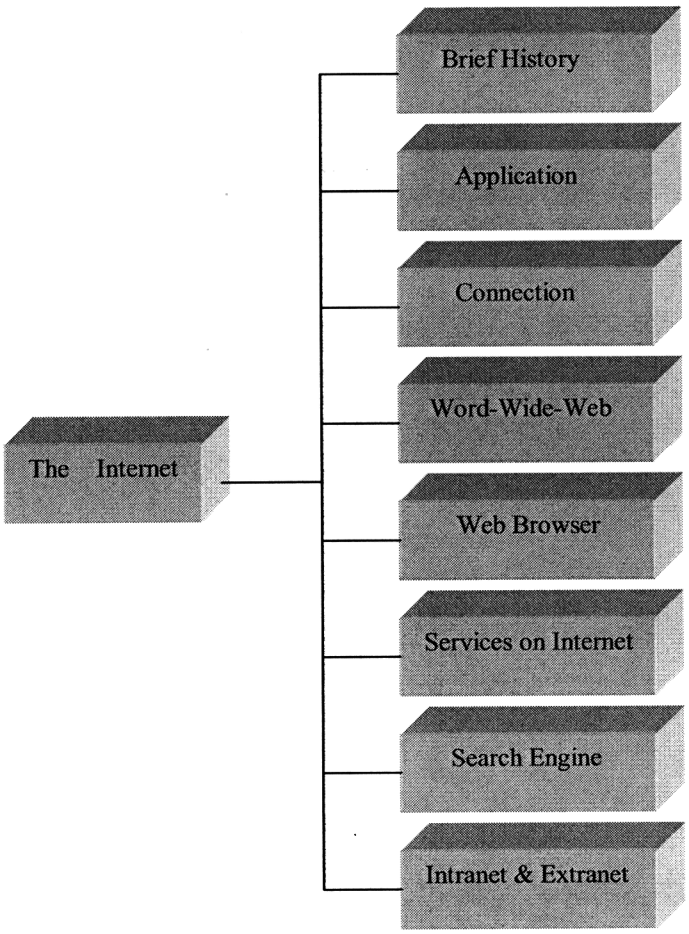

Figure 3.4: Flowchart of topics covered in the "Internet" CAI lesson developed at NPRU.

played in the CAI lessons was recorded, followed by careful evaluation and revision in consultation with content experts and instructional designers.

8. Program the lesson:— ToolBook™ Instructor 2004 and Authorware V. 8.0 (see footnotes in §1.4.3, p. 18) were used to develop the CAI lessons. Once programming of the 3 CAI lessons was complete, they were converted into executable files and written onto a CD-ROM for evaluation and revision.

9. Produce supporting materials:— student aids were prepared, including notes on the 3 CAI programs, how to run them, computer system requirements, and how to operate and control peripheral devices while accessing the courseware.

10. Evaluate and revise:— in order to test the operation of the CAI lessons, 3 of the junior computer education program students at NPRU were asked to act as pilot testers. The purpose of the project was explained to them, and their assistance was requested as a vital part of the production phase. These pilot students were encouraged to be very critical and to made notes about the lessons whenever they had a comment to make. It was also explained that they would be observed while taking the lessons, and that they would be asked a variety of questions about the material on completion of their testing. Finally, the CAI lessons were revised after careful consideration of the students' suggestions, and the new versions were written to CD-ROM. Figure 3.5 shows the computer laboratory at NPRU where the CAI lessons were implemented.

3.6 Attitude surveys

Gay (1996, p. 155) states that attitude scales attempt to determine what an individual believes, perceives, or feels. Attitude can be measured toward self, and a variety of other activities. The Likert technique was employed in this study to survey student attitudes toward both the CAI and traditional lessons. Both the experimental and control groups were investigated.

Students were requested to select one of five responses: strongly agree (SA), agree (A), undecided (U), disagree (D), or strongly disagree (SD). Each response was associated with a point value: SA = 5, A = 4, U = 3, D = 2, SD = 1. For negative statements, the

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Figure 3.5: The computer laboratory at Nakhon Pathom Rajabhat University, where the CAI lessons were taught.

point values were reversed, that is SA = 1, A = 2, and so on. An individual's score was determined by summing the point values for the statements (Gay, 1996). Thirty attitude questions were selected from Bureau of Evaluation Services and Testing (BEST), Indiana University Bloomington (Jacobs, 2005). These were translated into Thai and used as the attitude survey questionnaire in this study. After the students in the experimental group finished their lesson, they were all asked to anonymously complete the attitude survey questionnaire. At the end of the multiple-choice questions there was space for open ended student's comments or suggestions.

3.7 Interviews

The interview is an important data gathering technique in evaluation, involving verbal communication between the researcher and the participants. Interviews are commonly used in survey designs and in exploratory and descriptive studies. There are a range of approaches to interviewing, from completely unstructured, in which the participants are allowed to talk freely about whatever they wish, to highly structured, in which the participants are limited to answering direct questions.

According to Songer and Mintzes (1994), many researchers have come to the conclusion that the most complete view of a student's conceptual understanding is probably obtained by using a combination of both a qualitative method (such as interviewing) and a traditional quantitative method (such as multiple choice exams) where the choice of the particular form(s) of each is tailored to fit the research question. Furthermore, studies that employ multiple research probes have a high model validity and are more likely to fully and adequately represent a learner's understanding.

3.7.1 Focus Groups

Focus group interviews, described in §2.15 were used as another qualitative survey method in this research. Seven randomly selected participants from the CAI group were interviewed for each topic. They were requested to participate in the interviews after completing each lesson, with 7 set questions being asked in the course of each interview (see Appendix C.1, page 167).

3.8 Instrumentation

The experiments were conducted in the computer laboratory/self-study room of NPRU's central library. The equipment used is shown in Figure 3.6, and more specific details are listed below.

1. Hardware:— 100 sets of hardware and other peripheral devices, consisting of:
    - Micro-computers with processor speeds of 800 Mz, 20 Gb hard disks, and on-board sound systems.
    - Colour monitors with 15 inch screens.
    - Mouses, mouse pads, and keyboards.
    - Earphones.
2. Operating system:— Microsoft Windows (XP) was used.
3. Courseware:— one week before the experimentation was due to take place, the CAI CD-ROM was installed onto each computer's hard disk by the library technician, and tested for correct functionality.

Figure 3.6: Typical workstation used by CAI students in the computer laboratory of NPRU's central library.

4. Student's handbooks:— these provided information on how to start the lesson, how to use the peripheral devices (e.g. headsets), and how to adjust them.

5. CAI courseware:— consisting of the 3 CAI topics described previously.

6. Test items:— both the control and experimental groups had to take a pre-test before each lesson. One week later, when they had finished their lesson, the students were asked to take a post-test in order to measure their knowledge gain. In developing the post-test, 60 multiple-choice questions (with 4 alternatives) were developed, corresponding to the behavioural and content objectives of the lessons. The test items were subjected to examination by experts in educational measurement and evaluation theory, then revised according to their suggestions. Nine students who had previously completed the subject *Information Technology for Life* were asked to do the tests. These students' answer sheets were corrected and the test items examined to determine the item discrimination, item difficulty, and reliability using the Kuder-Richardson KR-20 formula. In general, a value of reliability ≥ 0.60 is excepted, and the preferable range of difficulty is in the range 0.20–0.80. Some test items falling outside these criteria were deleted, replaced or modified, depending

on the pilot group findings. By way of a field trial, a class of 29 second year NPRU computer education program students were asked to do the modified tests. Their answer sheets were corrected, and again the scores and test items were analysed. Only thirty items met the desirable criteria described above, so these were selected (see Appendix D, pages 181–189).

3.9 Experimentation

3.9.1 Control Group

Students in the control group normally attended classes with other students as directed in their timetable, on Thursdays 2:50–4:30 pm. Topics were taught in the order shown in the syllabus (see Table A.1). However, for the 3 topics chosen for CAI study, the control group was separated from the rest of the class and taught by a volunteer instructor in a traditional (lecture) style, using a white board and overhead/data projector. The volunteer instructor was a lecturer from another university in Thailand; he has 36 years of teaching experience to tertiary students of the same standard as the control group students. The same exercises offered to the experimental group were provided at the end of the control group. No extra content sheets were given to any students, as they could find any necessary material in the library.

Figure 3.7 shows the control group attending a traditional (lecture) class being taught by a volunteer instructor.

3.9.2 Experimental Group

Students in the experimental group attended classes on Fridays 8:30–10:10 am. For the 3 topics chosen for study by CAI, they went to the self-study room (computer laboratory) in the NPRU central library where the CAI lessons took place. Here there were over 100 sets of microcomputers on which the CAI lessons had previously been installed. Students worked one-per-computer on the lessons. They were asked to read the instruction notes (see Appendix E) to understand how to use the lessons, and further assistance could be requested at any time if problems were encountered. Figure 3.8 shows some students working on a CAI lesson.

Figure 3.7: Photograph showing the control group attending a traditional lecture, delivered by a volunteer instructor.

Figure 3.8: Photograph showing some students from the experimental group working on a CAI lesson.

After participants had finished each lesson, they were requested to anonymously complete the attitude survey questionnaire for that lesson, and focus group interviewing took place within a week. Students were permitted to come and repeat their study with the CAI lesson at any time before the post-test took place.

3.9.3 Measurement

Post-tests were taken in the week after both groups had finished their lessons. Students were required to answer 30 questions on each lesson; the test duration was 25 minutes. Their answer sheet were corrected and the scores were recorded.

3.10 Pre-tests and Post-tests

As already stated (see §3.8, p. 82, item 6), both the control and experimental groups completed a pre-test before starting each lesson. The tests consisted of 30 multiple-choice questions and lasted 25 minutes. On completing each of the 3 lessons they did a post-test consisting of the same questions. The answer sheets were corrected and the scores saved in a computer database; confidentiality was maintained at all times. Figure 3.9 shows some CAI students doing a post-test.

3.11 Final exam

The 90 questions in the final examination for the course *Information Technology for Life* were based on the material taught in the classroom only, including 30 questions on the three CAI topics. Although there was no computer laboratory examination, the computer laboratory scores obtained during the semester were taken into account in compiling the final result for the subject. The total score for the subject consisted of 70% from work done during the semester and 30% from the final examination.

3.12 Statistical analysis

Microsoft Excel™ 2003 was used to carry out the numerical analysis in this research. A matched-pairs t-test was used to look for any significant differences between the two

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Figure 3.9: Students taking a post-test after finishing a CAI lesson.

groups (see §3.12.1). Examples of related (paired) groups are (Burns, 2000, p. 198):

- When the same subjects are tested twice in a "before and after" situation with an intervention.
- When subjects in two groups are paired by selecting individuals who are as similar as possible with respect to other external variables which may influence the outcome of the research.

Improvements in students' knowledge were determined using average normalised gains, as discussed in §4.4 (Hake, 1998).

First, basic descriptive statistics, including frequencies, standard deviations, analysis of variance, and t-tests of significance, were determined. The level of significance, p, set for this study was $p \leq 0.05$. Babbie (2001) notes that this value is frequently used in research studies and is adequate to show statistical significance; its physical interpretations is that the probability that a relationship as strong as the one observed can be attributed to a sampling error alone is no more than 5 in 100. The lower the number, the greater the significance when comparing quantitative data.

Pearson Correlation was applied to investigate the relationship between student performance using CAI and their attitudes. Burns (2000, p. 231) describes correlation as "the

act or process of showing the existence of a relationship between things".

Student attitude survey results were analysed by looking at the means of students satisfaction levels for each item. Focus group interview results were also analysed and the main ideas arising from students' comments were classified.

3.12.1 Hypothesis testing

In statistical terminology, a non-directional test is often referred to as a two-tailed test of significant (Ary *et al.*, 1996). Gay (1996) notes that tests of significance are almost always two-tailed, which corresponds to the possibility that a difference may occur in either direction e.g. if the null hypothesis states that there is no difference between the groups. On the other hand, a directional test is referred to as a one-tailed test (Ary *et al.*, 1996). Gay (1996) notes that a one-tailed test assumes that a difference can only occur in one direction e.g. if the null hypothesis states that one group is not better than the other. Croucher and Oliver (1990, p. 181) advise: "use a one-tailed procedure if and only if the researcher has some genuine prior reason for anticipating that a result will tend in a particular direction". Hays (1988, p. 272) suggests that a one-tailed hypothesis test is implied when the basic question involves terms like 'more than', 'better than', 'increased', or 'declined'.

The *t*-test is used to determine whether two means are significantly different at a selected probability level (Gay, 1996, p. 477). In this study, the *t*-test was used to investigated the level of significance between two sample means e.g. to compare for similarity students' learning ability and background knowledge.

3.13 Hypotheses tested in this study

$H_0$1 There is no significant difference in student performance based on CAI learning versus traditional learning.

The purpose of this hypothesis was to compare the effectiveness of CAI learning versus traditional learning. Previous studies have indicated that the learning method affects performance.

$H_0$2 There is no significant difference in CAI student performance when comparing

weak, average and strong students.

The purpose of this hypothesis was to find out whether CAI lessons are more beneficial for weaker students than stronger students.

$H_0 3$ There is no significant difference in student performance on the final examination based on CAI learning versus traditional learning.

The purpose of this hypothesis was to compare the effectiveness of CAI students knowledge retention versus that of traditional students, based on performance in the final examination.

$H_0 4$ There is no significant difference in attitude towards the method of teaching between CAI students and traditional ones.

The purpose of this hypothesis was to discover the degree of student satisfaction between the two teaching methods.

$H_0 5$ There is no significant correlation between CAI students' performance and their attitude toward CAI utilization.

The purpose of this hypothesis was to discover the degree of the correlation, if it exists.

$H_0 6$ There is no significant correlation between traditional students' performance and their attitude toward the method of teaching.

The purpose of this hypothesis (as for $H_0 5$) was to discover the degree of correlation, if it is exists.

3.14 Limitations of study

In using high school GPA scores for matching students, it is assumed that the GPA ranking is consistent from school to school in the secondary system.

The target population of this study was limited to first year students in the faculty of Management Science at Nakhon Pathom Rajabhat University, Thailand. The sample was limited to 5 classes of students with a major in Accounting and General Management. The conclusions drawn from this study are therefore not necessarily applicable to all universities in Thailand, or to all courses.

3.15 Ethical issues

The subjects in this study were not exposed to any unreasonable discomforts, risks, or violations of their human rights. Their rights to justice, dignity and privacy were recognised. All participating students were volunteers; no additional credit was granted for participation.

This study was conducted following the guidelines set out by the Australian Human Research Ethics Committee (HREC). In accordance with the HRECs' requirements, all participants signed an Informed Consent Form (see Appendix F, Figures. F.1–F.3, pages 200–202), after the purpose of the study and other details in the Informed Consent Form were clearly explained. Also, a brief introduction about the experiment and privacy matters was provided, and an opportunity made for answering participants's questions.

The participants' names and their student identification numbers were not known by anyone except the instructors and the researcher; this information was not published.

3.16 Conclusion

In this study two sample groups of first year students majoring in General Management and Accounting at NPRU Thailand were investigated. Three topics from a general education course (4 000 107) were selected with a view to comparing learning performance using either traditional teaching or CAI. Three CAI lessons were developed following the guidelines of Allessi and Trollip (1991). Both the control and experimental groups were given a pre-test before the experimentation took place. One week after they completed the lessons on each topic, they were given the same test as a post-test. The differences in scores between pre-tests and corresponding post-tests were statistically analysed and used to support or refute the null hypotheses of the research. Finally, student attitudes to their teaching methods were investigated, including surveys and focus group interviews.

Chapter 4

Results

This chapter contains the analysis of data and an interpretation of the tested hypotheses examining the impact of the learning method. First, an overview of the study is given. Next, the results are presented and discussed, together with statistical analyses for each hypothesis, as developed in Chapter 3. Finally, all the experimental results are combined in a summary.

Throughout this chapter, the experimental group is referred to as the CAI group, and the control group is referred to as the lecture group.

4.1 Quality of tests

To ensure that each test item in this study was appropriate, an assessment of the test items was carried out with respect to their difficulty, P, and discrimination, D (see Appendix G, Tables G.1–G.3 on pages 203–205). Office of Educational Assessment (2005) gives the definitions of difficulty and discrimination as follows,

Item difficulty is simply the percentage of students who answer an item correctly. The item difficulty index ranges from 0 to 1; the higher the value, the easier the question. Item difficulty is relevant for determining whether students have learned the concept being tested.

The difficulty means, $\overline{P}$, and standard deviations, SD, of the test items for the three topics taught in this study are shown in Table 4.1.

Table 4.1: Mean difficulty, $\overline{P}$, and its standard deviation, SD, for the test items in the three topics taught to the CAI and lecture groups.

Topic	$\overline{P}$	SD
Computer components and their function	0.46	0.172
The Internet	0.43	0.161
Data communication	0.52	0.148

Item discrimination refers to the ability of an item to differentiate among students on the basis of how well they know the material being tested. It provides an estimate of the degree to which an individual item is measuring the same thing as the rest of the items. The item discrimination is "good" if the index is above 0.30; "fair" if it is in the range 0.10–0.30 and 'poor" if it is below 0.10.

The discrimination means, $\overline{D}$, and standard deviations, SD, of the test items for the three topics taught in this study are shown in Table 4.2.

Table 4.2: Mean discrimination, $\overline{D}$, and its standard deviation, SD, for the test items in the three topics taught to the CAI and lecture groups.

Topic	$\overline{D}$	SD
Computer components and their function	0.40	0.150
The Internet	0.41	0.181
Data communication	0.51	0.143

4.2 Results for Lecture and CAI groups

In the first week of the experiment all participants were requested to take a pre-test on each of the 3 topics to be taught. The number of students who took these tests, classified by gender, is shown in Table 4.3.

Table 4.3: Number of participants, by gender, taking the pre-tests.

Group	Male	Female	N
Lecture	23	99	122
CAI	6	87	93

To ensure that there were no differences in the learning abilities and background knowledge between the two groups, each student's Grade Point Average (GPA) was con-

sidered (see listing given in Appendix H on page 207) and it was necessary to remove some of the students shown in Table 4.3 from each group to maintain balanced groups. A t-test analysis was performed to confirm that the mean GPAs for the two groups were not significantly different (see following section). Table 4.4 shows the final composition of the two groups; all subsequent data analysis was carried out only on these students. The gender imbalance in the two groups is a natural outcome of the enrolment pattern in *Information Technology for Life*, which is predominantly female; consequently, no gender-based interpretations were possible in this study, due to the small male sample size.

Table 4.4: Number of participants, by gender, considered in the final analysis.

Group	Male	Female	N
Lecture	14	66	80
CAI	6	74	80

4.2.1 Students' learning ability

In testing for equivalence of learning ability between the two groups, based on their GPA scores (plotted in Figure 4.1), the following null hypothesis was used:

H_0: There is no difference in students' learning ability between the groups.

To test this hypothesis, an f-test was first used to test for equivalence between the GPA standard deviations of the two groups (Snedecor and Cochran, 1989). Based on the result, a t-test for two samples with unequal variances was applied. The t-test statistic was evaluated as $t = 0.394$ (see Table 4.5); hence, the null hypothesis was accepted.

Table 4.5: Results of GPA t-test analysis, used to compare learning abilities of CAI and lecture groups. $\overline{X}$ is the mean GPA.

Group	$\overline{X}$	SD	Std. error	n	df	t-critical	t-stat.	p-value
Lecture	2.64	0.333	0.037	80	79	1.977	0.394	0.694
CAI	2.67	0.495	0.055	80				

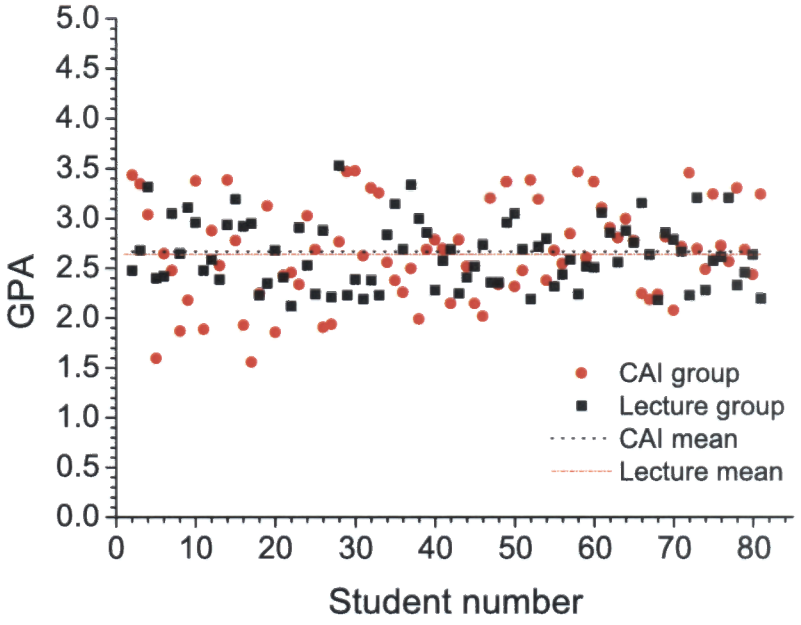

Figure 4.1: Comparison of GPA scores for students in the CAI and lecture groups.

4.2.2 Students' background knowledge

To ensure the validity of this study, it was necessary for the two groups of participants to have the same background knowledge. The null hypothesis tested for this condition was:

H_0: There is no difference in students' background knowledge between the two groups.

All 3 pre-tests, each with a maximum possible score of 30, were taken into account in testing the hypothesis. The pre-test total scores are shown for all students in the two groups in Figure 4.2. A t-test analysis, similar to that described in the preceding section, was carried out on the pre-test scores. The results are summarised in Table 4.6, which shows a t-statistic of 0.794, meaning that the null hypothesis must be accepted. That is, the GPA and pre-test scores show that the two groups are identical in their background knowledge and learning abilities.

Table 4.6: Results of t-test analysis on total pre-test scores, used to compare background knowledge of CAI and lecture groups. $\overline{X}$ is the mean score by group, out of a possible 90.

Group	n	$\overline{X}$	SD	df	t-critical	t-stat.	p-value	SE_{diff}
Lecture	80	26.93	4.046	79	0.794	1.975	0.428	0.693
CAI	80	27.48	4.690	0.524				

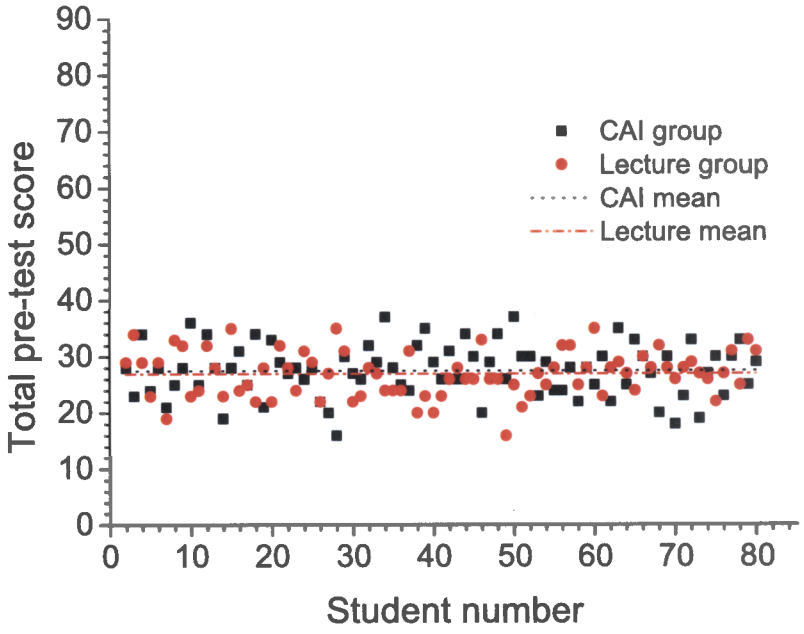

Figure 4.2: Comparison of total pre-test scores for students in the CAI and lecture groups.

4.3 Analysis of Pre-test/Post-test results

Pre- and post-test results for the two groups are listed in full in Appendix I (Tables I.1–I.4, on pages 209–218).

4.3.1 Lecture group

The scores obtained from the pre-tests and post-tests in the three topics for the Lecture group, as shown in Figures 4.3–4.5, were investigated using paired-sample t-test analysis. The null hypothesis for this test was:

H_0: There is no difference between pre-test and post-test results for the lecture group.

The t-test analysis results for the individual lessons, as well as the combined result for all 3 topics, are summarised in Table 4.7. The t-statistics obtained show that there was a significant difference between pre-test and post-test results for all 3 topics, individually and collectively. Thus, the null hypothesis was rejected, with the lecture group showing a significant gain in knowledge in all three topics after attending their corresponding classes.

Table 4.7: Results of t-test analysis, comparing pre-test and post-test scores for the Lecture group. The maximum possible score for each test is 30.

Topic	pre-$\overline{X}$	SD	post-$\overline{X}$	SD	t	p-value
1. Computer components and functions	9.05	2.349	10.64	2.711	4.315	< 0.001
2. The Internet	7.40	2.21	10.99	3.00	8.555	< 0.001
3. Data communication	10.48	2.256	11.80	2.346	4.172	< 0.001
TOTAL	26.93	4.046	33.43	4.983	9.126	< 0.001

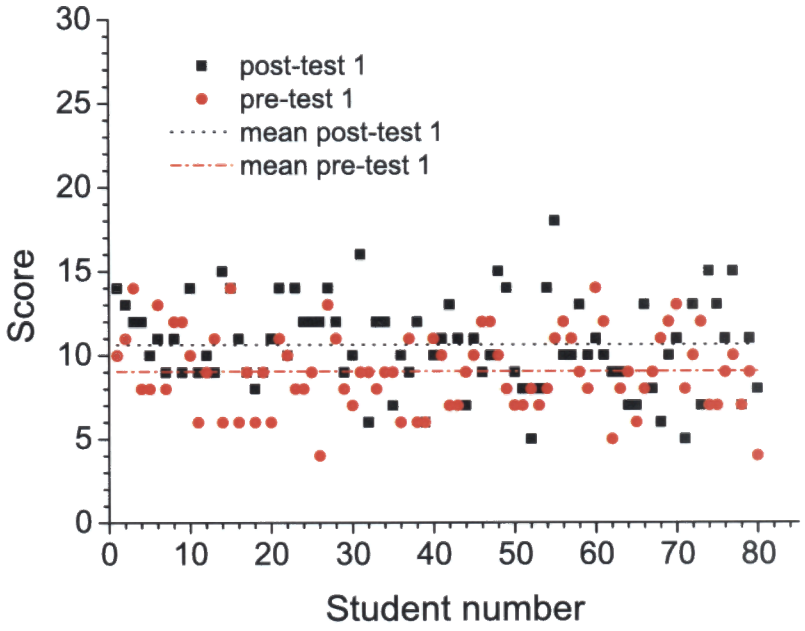

Figure 4.3: Lecture group pre- and post-test results for Topic 1.

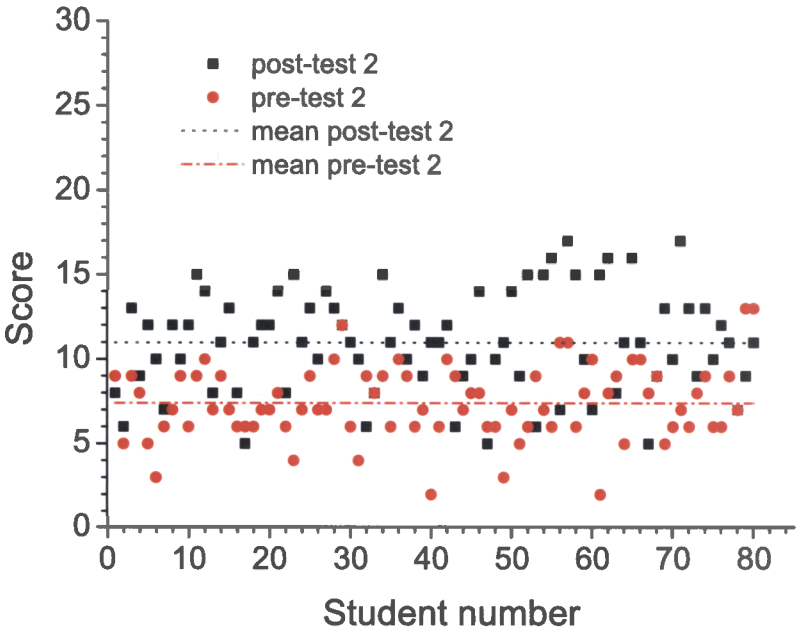

Figure 4.4: Lecture group pre- and post-test results for Topic 2.

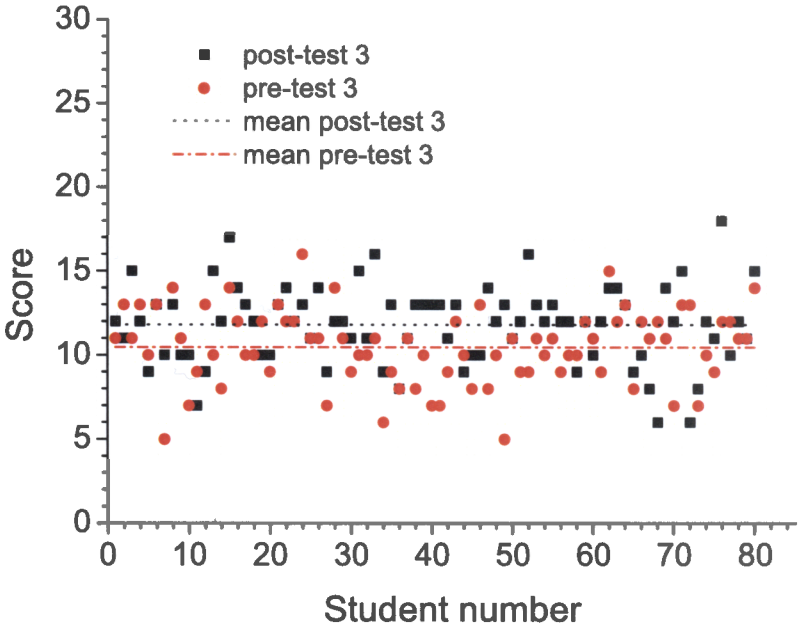

Figure 4.5: Lecture group pre- and post-test results for Topic 3.

4.3.2 CAI group

A similar analysis to the one described in the previous section was performed on the CAI group. The scores obtained from the pre-tests and post-tests in the three topics for the CAI group, as shown in Figures 4.6–4.8, were investigated using paired-sample t-test analysis.

The null hypothesis for this test was:

H_0: There is no difference between pre-test and post-test results for the CAI group.

The t-test analysis results for the individual lessons, as well as the combined result for all 3 topics, are summarised in Table 4.8. As with the lecture group, the t-statistics obtained show that there was a significant difference between pre-test and post-test results for all 3 topics, individually and collectively. Therefore, the null hypothesis was rejected and it was concluded that the CAI group also increased their knowledge of the three topics after attending their respective lectures.

Table 4.8: Results of t-test analysis, comparing pre-test and post-test scores for the CAI group. The maximum possible score for each test is 30.

Topic	pre-$\overline{X}$	SD	post-$\overline{X}$	SD	t	p-value
1. Computer components and functions	8.43	2.666	12.83	3.145	10.882	< 0.001
2. The Internet	8.26	2.337	14.28	4.438	11.482	< 0.001
3. Data communication	10.79	2.708	13.84	3.227	6.659	< 0.001
TOTAL	27.48	4.690	40.94	8.484	13.420	< 0.001

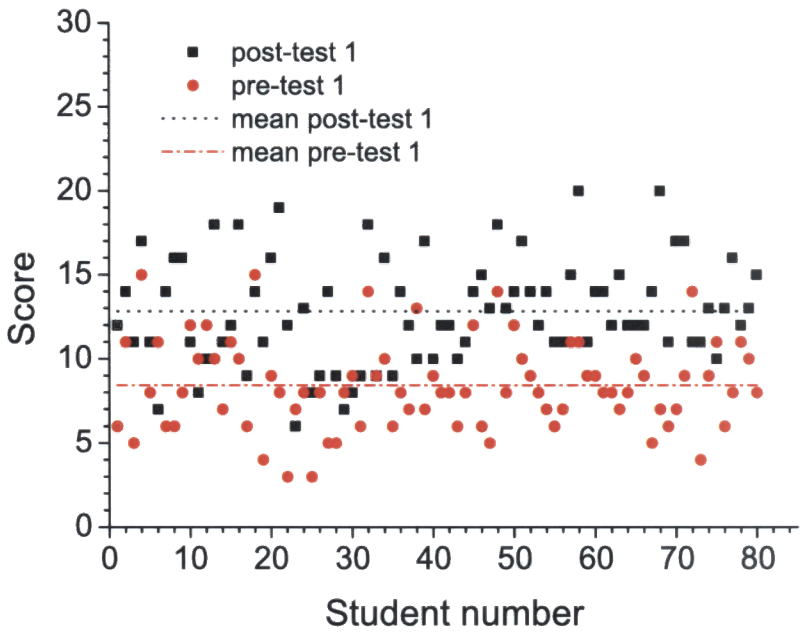

Figure 4.6: CAI group pre- and post-test results for Topic 1.

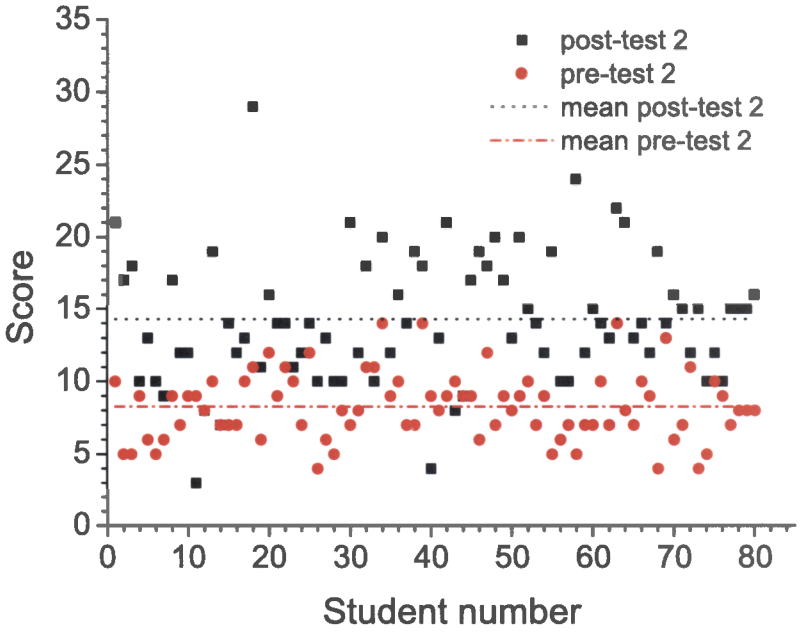

Figure 4.7: CAI group pre- and post-test results for Topic 2.

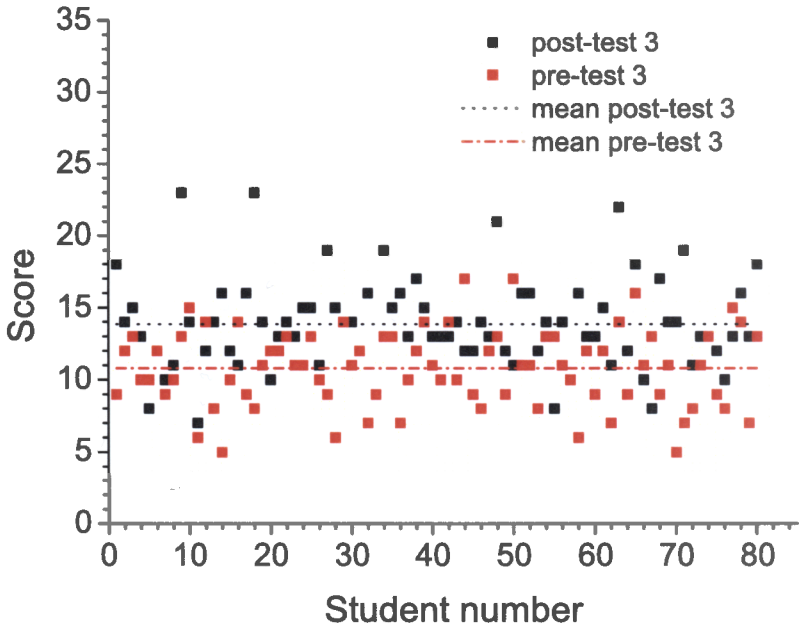

Figure 4.8: CAI group pre- and post-test results for Topic 3.

4.4 Analysis of post-test results

As explained earlier, one week after each lesson the students were required to take a post-test. "Average normalized gains", $\langle g \rangle$, were used to quantify improvements in students'

knowledge (Hake, 1998). Physically, the average normalised gain can be thought of as the ratio of the actual gain to the maximum possible gain, expressed as a percentage:

$$\begin{aligned}\langle g \rangle &= \frac{\langle G \rangle}{\langle G \rangle_{\max}} \times 100\% \\ &= \frac{\langle S_{\text{post}} \rangle - \langle S_{\text{pre}} \rangle}{100 - \langle S_{\text{pre}} \rangle} \times 100\% \end{aligned} \tag{4.1}$$

where $\langle G \rangle$ and $\langle G \rangle_{\max}$ are the actual and maximum-possible average class gains, respectively; $\langle S_{\text{post}} \rangle$ and $\langle S_{\text{pre}} \rangle$ are the average class scores (expressed as percentages) in the post- and pre-tests, respectively.

"High-g" courses have $\langle g \rangle \geq 70$; "medium-$g$" courses have $70 > \langle g \rangle \geq 30$; and "low-$g$" courses have $\langle g \rangle < 30$.

Normalised gains achieved by the CAI and Lecture groups for the three topics are plotted in Figures 4.9–4.11, while the overall gains for the two groups are plotted in Figure 4.12.

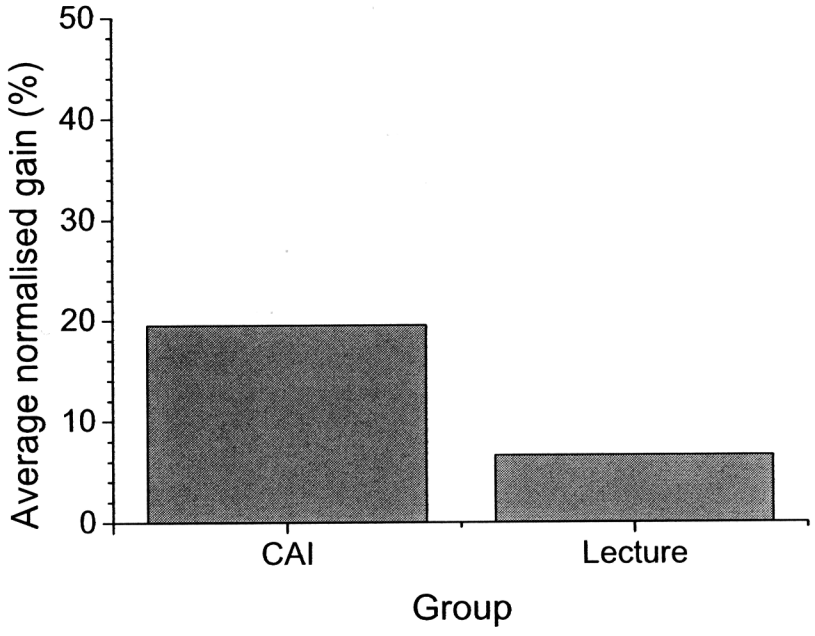

Figure 4.9: Average normalised gains for CAI and Lecture groups in Topic 1.

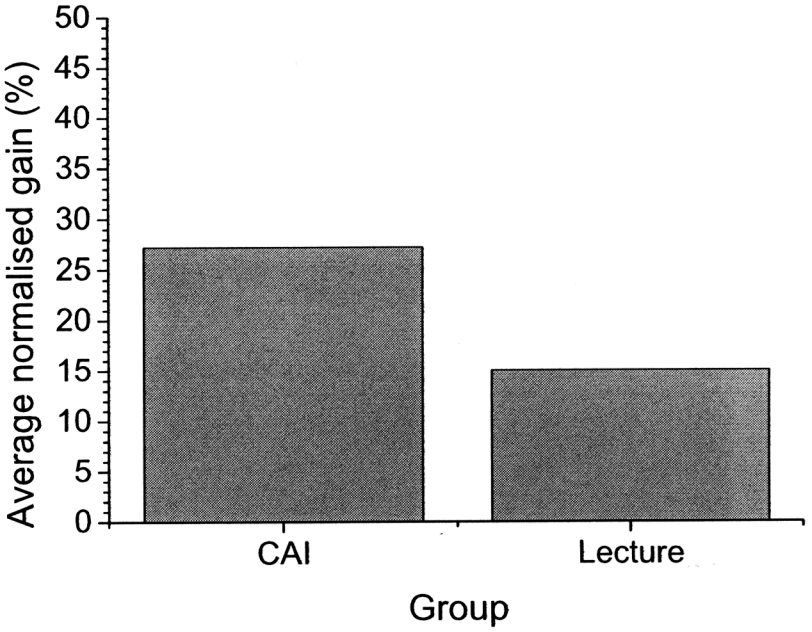

Figure 4.10: Average normalised gains for CAI and Lecture groups in Topic 2.

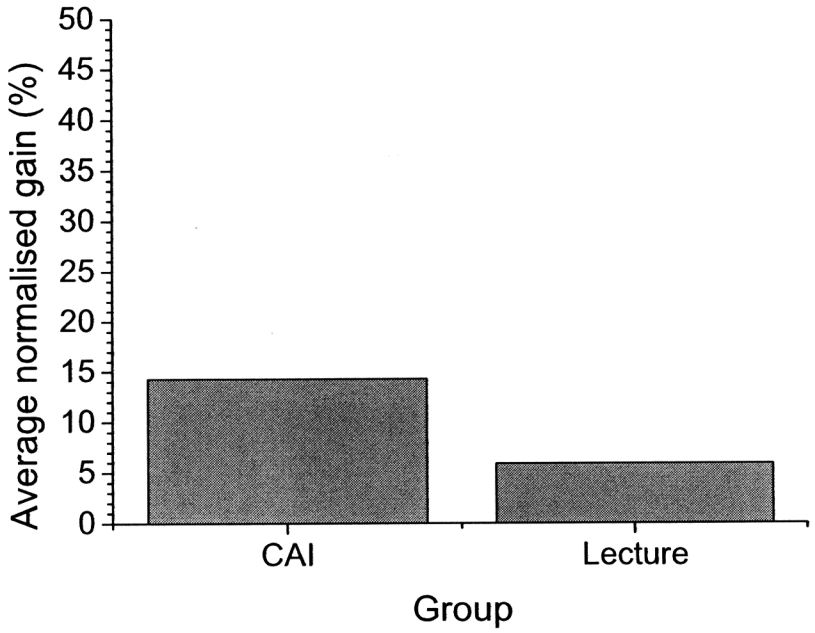

Figure 4.11: Average normalised gains for CAI and Lecture groups in Topic 3.

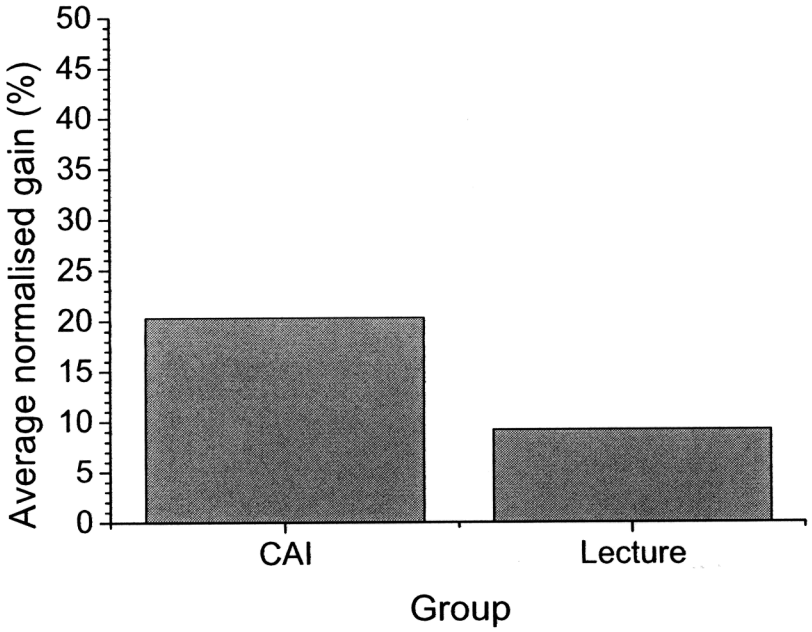

Figure 4.12: Combined average normalised gains for CAI and Lecture groups in the three topics.

The first research question posed in §1.6 was "Do students learn more in a CAI class than in a traditional (lecture) class?" The null hypothesis for testing in this analysis is therefore:

H_0: The average normalised gains for the CAI and Lecture groups are the same.

Independent-sample t-tests were carried out on the average normalised gains to test this hypothesis. Gay (1996, p. 477) defines independent samples as being "... randomly formed, that is, formed without any type of matching. The members of one group are not related to members of the other group in any systematic way other than that they are selected from the same population".

The t-test results are shown in Tables 4.9–4.11, from which it can be seen that the respective t-values for Topics 1–3 are 5.103, 4.138 and 2.953. Also, analysis of the 3 topics considered together is shown in Table 4.12, with a t-value of 5.787. As all calculated t-values were greater than the corresponding critical values, the differences in average normalised gains between the CAI and Lecture groups in each case were concluded to be significant at the $p = 0.05$ level; therefore, the null hypothesis was rejected and the differences in gains were accepted as a significant difference in performance between the groups. Therefore, it was concluded that the CAI group students scored significantly greater average normalised gains in each of the three topics, and for the combined topics,

than did the lecture group students.

It is interesting to note that the average normalised gains for both the CAI and lecture groups are largest for test 2, smaller for test 1, and smallest for test 3. This could be explained by the content of lesson 2 (about the Internet) being more familiar as general knowledge to both groups than the other two topics and therefore better captivating their interest to learn than did the other topics (computer components and data communication). It is also possible that the greater gains achieved in each test by the CAI group over the lecture group may, at least in part, be due to the novelty effect discussed in §2.13. However, the persistence of the gains of the CAI group into the final examination shows that this learning advantage is real. It is not possible to say from this short study whether the gain advantage would remain over a much longer CAI teaching period.

Table 4.9: Topic 1 (Computer components and functions) t-test analysis for significance in difference between average normalised gains, $\langle g \rangle$, comparing CAI and Lecture groups (t-critical = 1.975).

Group	$\langle g \rangle$%	SD	t-value	p-value	SE in difference
Lecture	6.61	15.570	5.103	< 0.001	2.530
CAI	19.52	16.420			

Table 4.10: Topic 2 (The Internet) t-test analysis for significance in difference between average normalised gains, $\langle g \rangle$, comparing CAI and Lecture groups (t-critical = 1.976).

Group	$\langle g \rangle$%	SD	t-value	p-value	SE in difference
Lecture	15.04	16.068	4.138	< 0.001	2.944
CAI	27.22	20.866			

Table 4.11: Topic 3 (Data communication) t-test analysis for significance in difference between average normalised gains, $\langle g \rangle$, comparing CAI and Lecture groups (t-critical = 1.977).

Group	$\langle g \rangle$%	SD	t-value	p-value	SE in difference
Lecture	5.88	14.486	2.953	0.004	2.846
CAI	14.29	20.933			

Table 4.12: Combined topic 1–3 t-test analysis for significance in difference between average normalised gains, $\langle g \rangle$, comparing CAI and Lecture groups (t-critical= 1.977).

Group	$\langle g \rangle$%	SD	t-value	p-value	SE in difference
Lecture	9.18	9.78	5.787	< 0.001	1.930
CAI	20.34	14.22			

4.4.1 Comparison between weak, average and strong students within groups

A further analysis of the average normalised gains presented in the previous section was carried out to see whether the different forms of teaching benefited weaker students more than stronger ones within a group. To this end, the CAI and Lecture groups were each subdivided into 3 smaller groups based on the range of their GPA scores. The composition of the sub-groups within the CAI and Lecture groups are shown in Table 4.13.

Table 4.13: Composition of CAI and Lecture sub-groups, determined according to GPA.

sub-group	GPA range	$N(CAI)$	N (Lecture)
Weak	1.56–2.22	15	6
Average	2.23–2.88	41	55
Strong	2.89–3.53	24	19

The sub-groups were then tested for differences in $\langle g \rangle$ in each mode of teaching. The null hypothesis tested was:

H_0: H_0: There is no difference in learning gains between weak-average, average-strong, and strong-weak groups.

The t-test analyses for the various CAI sub-groups are shown in Table 4.14, from which it can be concluded that the null hypothesis is valid when comparing the performance of weak students with that of average students. In contrast, comparing the average sub-group with the strong one and the strong with the weak students, the hypothesis is not supported.

Table 4.14: Results of t-test comparison of average normalised gains, $\langle g \rangle$, between the three sub-groups (weak, average and strong) within the CAI cohort.

Sub-group compared	t	t-critical	p-value	SE in $\Delta \langle g \rangle$
Weak-Average	1.349	2.020	0.185	3.227
Average-Strong	2.580	2.009	0.013	3.625
Strong-Weak	3.747	2.026	0.001	3.658

The corresponding t-test analyses for the various Lecture sub-groups are shown in Table 4.15, from which it can be concluded that the null hypothesis is valid in all cases.

Table 4.15: Results of t-test comparison of average normalised gains, $\langle g \rangle$, between the three sub-groups (weak, average and strong) within the CAI cohort.

Sub-group compared	t	t-critical	p-value	SE in $\Delta \langle g \rangle$
Weak-Average	0.066	2.447	0.949	4.765
Average-Strong	0.318	1.993	0.751	2.727
Strong-Weak	0.221	2.306	0.830	5.178

4.4.2 Comparison of weak, average and strong students between groups

The analysis described in the previous section was extended to test whether the average normalised gains were significantly different when comparing weak, average and strong students between the CAI and Lecture groups. A t-test analysis was carried out, as shown in Table 4.16. It was concluded that there was no significant difference in performance when comparing the weak students; however, the average normalised gains of the average and strong students in the CAI group were significantly higher than those of the corrresponding Lecture group students.

Table 4.16: Results of t-test comparison of difference in average normalised gains, $\Delta \langle g \rangle = \langle g \rangle_{\text{CAI}} - \langle g \rangle_{\text{Lecture}}$, for weak, average and strong students between groups.

Sub-groups compared	$\langle g \rangle_{\text{CAI}}$	$\langle g \rangle_{\text{Lecture}}$	t	t-critical	p-value	SE in $\Delta \langle g \rangle$
Weak	14.00	8.69	1.035	2.306	0.331	5.135
Average	18.35	9.00	3.599	1.997	0.0006	2.598
Strong	27.71	9.83	4.651	2.020	0.00003	3.719

4.4.3 Final examination performance

The final examination in *Information Technology for Life* took place during the last week of semester, three months after the experimentation was completed. The examination was of 1 hour duration and consisted of 90 multiple-choice questions covering the whole syllabus, including 30 questions on the three topics taught by CAI (10 questions per topic). In considering the total score for the 3 special topics, the following null hypothesis was postulated:

H_0: There is no difference in the final examination scores for the CAI and Lecture groups in the three topics.

A t-test analysis was carried out to test this hypothesis. The results are shown in Table 4.17, supporting the rejection of this hypothesis. The implication of this result is that there was a significant difference in final examination scores between the two groups, with the CAI group performing better than the Lecture group.

Table 4.17: Results of t-test analysis comparing combined final examination scores, $\overline{X}$, for the three topics (t-critical = 1.975).

Group	$\overline{X}$	SD	t-value	p-value	SE in difference
Lecture	12.70	3.156	2.434	0.016	0.524
CAI	13.98	3.464			

4.5 Analysis of student attitudes

Students were requested to complete an attitude-survey questionnaire (see Figs. J.1–J.13 on pages 221–233 for both the English and Thai versions) after each of the lessons. Each questionnaire was composed of thirty questions, based on a 5-point Likert scale. Students were asked to respond to each statement in terms of their degree of agreement or disagreement. The difference between the two surveys was that in the control group survey certain questions referred to instructor characteristics, while in the experiment group survey the corresponding questions referred to CAI characteristics.

The number of questionnaires collected varied from experiment to experiment, as students were at liberty to participate or not. Unchecked responses were not taken into account in the final analysis. The number of students responding to the attitude surveys is shown in Table 4.18. All students were also asked a general question, "Do you have

access to a computer at home or in your dormitory?". Approximately 30% responded in the affirmative, in each group, as shown in Table 4.19.

Table 4.18: Numbers of students responding to attitude survey questionnaires.

Group	Composition		Number of responses	*N*
	Male	Female		
CAI	6	79	11	96
Lecture	29	82	9	120

Table 4.19: Response of CAI and Lecture group students to general attitude survey question on access to a home computer.

Do you have access to a computer at home or at your dormitory	Group							
	CAI				Lecture			
	Yes	No	N/A	*N*	Yes	No	N/A	*N*
	25	57	14	96	35	70	15	120
	30%	70%			33%	67%		

4.5.1 CAI student attitudes

CAI students' responses to the attitude surveys are summarised in Appendix J.1, on pages 234–240. 88.4% of the students agreed or strongly agreed that the CAI content and lessons were excellent (items 1 & 2); 84.3% agreed or strongly agreed that the lesson objectives were stated clearly, that the expectations of the students were made clear to them, and that the topic objectives were achieved in the lessons. A summary of the average responses for all items, by category, is given in Table 4.20.

Table 4.20: Summary of average CAI group student responses to attitude survey items.

Category	Average Likert response	% (A + SA)
Global items (1–2)	3.96	88.4
CAI characteristics (3–9)	3.96	83.6
Objectives (10–12)	3.93	84.3
Difficulty (13–15)	3.26	51.8
Student development (16–30)	3.70	73.4

4.5.2 Lecture student attitudes

Lecture group students' responses to the attitude surveys are summarised in Appendix J.1 on pages 243–249. The results for the Lecture group students were very similar to those of the CAI group, with 88.3% of the students either agreeing or strongly agreeing that the lecture presentations and content were excellent (items 1 & 2); 78.1% agreed or strongly agreed that the lesson objectives were stated clearly, that the expectations of the students were made clear to them, and that the topic objectives were achieved in the lessons. A summary of the average responses for all items, by category, is given in Table 4.21.

Table 4.21: Summary of average Lecture group student responses to attitude survey items.

Category	Average Likert response	% (A + SA)
Global items (1–2)	4.02	88.3
Instructor characteristics (3–9)	3.84	73.5
Objectives (10–12)	3.88	78.1
Difficulty (13–15)	3.24	36.9
Student development (16–30)	3.59	62.4

4.5.3 Comparison of CAI and Lecture group attitudes to their respective teaching methods

The scores for every item in the attitude surveys were averaged for each group and tested for any significant differences in the means. The null hypothesis tested was:

H_0: There is no difference between the attitudes of the CAI and Lecture groups to their respective teaching methods.

The t-test analysis is summarised in Table 4.22.

Obtained t = 0.789 as shown in the table 4.22

Table 4.22: Results of t-test analysis comparing average of all attitude-survey items, $\overline{X}$, between CAI and Lecture groups (t-critical = 2.002).

Group	$\overline{X}$	SD	t-value	p-value	SE in diff.
Lecture	3.677	0.364	0.286	0.776	0.084
CAI	3.643	0.280			

Although the t-value obtained justified accepting the null hypothesis, there were some interesting observations to be made in a number of the specific items, as enumerated

below.

1. On the item that the lessons held their attention, CAI group students agreed more strongly (3.93) than Lecture group students (3.61).

2. On the item that the CAI/Lecture lessons made difficult topics more easily understandable, the CAI group agreed more strongly (3.89) than the Lecture group (3.59).

3. On the item that they can learn more from reading books than using CAI or attending lectures, the Lecture group (3.13) agreed more strongly than the CAI group (2.82).

4. On the item that the particular lesson motivated students to learn more, the CAI group (3.88) agreed more strongly than the Lecture group (3.57).

5. On the item that they enjoyed learning the subject matter, the CAI group (3.98) agreed more strongly than the Lecture group (3.68).

6. On the item that students felt they had to put in more effort with CAI/Lecture teaching, the CAI group (2.57) agreed more strongly than the Lecture group (2.37).

7. On the item that they prepared before coming to the CAI or Lecture class, the CAI group (3.52) agreed more strongly than the Lecture group (3.27).

8. On the item that the CAI/Lecture teaching made the subject more interesting, the CAI group (4.09) agreed more strongly than the Lecture group (3.84).

9. On the item that the CAI/Lecture teaching improved their understanding of concepts in the topic studied, the CAI group (4.04) agreed more strongly than the Lecture group (3.80).

4.5.4 Correlation between attitude to teaching method and performance

The purpose of this study was to investigate, using the Pearson product-moment correlation method, whether there exists a relationship between students' attitude toward their lesson delivery method and their performance.

This procedure was first proposed by the English statistician, Karl Pearson (Burns, 2000). According to Gay (1996, p. 646), the Pearson r coefficient is the most appropriate measure of correlation when the sets of data to be correlated represent either interval or ratio scales. Like the mean and standard deviation, the Pearson r takes into account each score in both distributions; it is also the most stable measure of correlation (Gay, 1996, p. 446). Calculated values of r range from -1 to $+1$. An r of -1 means there is a perfect inverse relationship between the two variables; an r of $+1$ means there is a perfect direct relationship; an r of 0 indicates the complete absence of a relationship; the closer r is to -1 or $+1$, the stronger the relationship.

The null hypothesis for this investigation was:

H_0: Students who gain higher scores favour the teaching method more than those who gain lower scores.

If this hypothesis is true, then students with higher scores should also exhibit higher levels of satisfaction in their attitude survey. In this study, only the first experiment (Topic 1, Computer components and their functions) was investigated. The results of the correlation analysis are shown in Table 4.23.

Table 4.23: Relationship between attitude to teaching method and performance.

Group	N	r-coefficient	SE in diff.
Lecture	80	0.333	0.304
CAI	80	0.065	0.361

These results are quite different, with the CAI students apparently showing only a slight correlation ($r < 0.20$), while for Lecture students there is a low correlation ($0.20 \leq r < 0.40$) (Burns, 2000, p. 235). To test whether there is a significant difference between the correlation values from the two groups, the following null hypothesis was examined:

H_0: The correlation coefficients shown in Table 4.23 are not significant. Equation 4.2 was used to calculate the t-test parameters for the Pearson r-coefficients, following Hays (1988).

$$t = \frac{r_{xy}\sqrt{N-2}}{\sqrt{1-r_{xy}^2}} \tag{4.2}$$

where r_{xy} = correlation coefficient between x and y

N = number of degrees of freedom

The results obtained are shown in Table 4.24. The t-values listed there justify the null hypothesis being rejected in the case of the Lecture group and accepted for the CAI group.

Table 4.24: Results of test for significance of correlation coefficients, r, between attitude to teaching method and learning outcome (t-critical = 1.990).

Group	N	r-coefficient	t-value
Lecture	80	0.333	3.119
CAI	80	0.065	0.575

4.6 Analysis of focus group results for CAI students

There were 7 questions examined during the focus group interviews, which were conducted in Thai. The same questions were for all three CAI lessons, but different students comprised each focus session. Students' responses were digitally recorded and later transcribed into English and the main points were summarised as below. A more complete summary is presented in Appendix C (see sections C.2–C.4, on pages 167–174).

What did you like most about the CAI course? The main response was that with CAI the lessons motivated students to learn, and they supported student learning. Respondents also maintained that the CAI lessons made it easier for students to understand the subject matter. Students liked the multimedia aspects of the lesson, which they said made the lessons more interesting and meaningful. Students liked that they were not bored while learning with CAI.

What did you like least about the CAI course? Nearly one third of the participants answered that there was nothing they did not like; the rest said they needed more time to complete the lessons. Five students felt there was too much material presented to be completed in the available time. One student said he or she did not like self-paced learning.

What is the most valuable thing you learned in this class? Most of the answers concerned self-paced learning and student-centred learning. Students had a chance to learn by themselves and they felt they could gain more knowledge this way, as they had freedom in learning.

Some student said that they had a good chance to practice computer skills when they took CAI lessons. Some said that the lessons were flexible, allowing them to choose any topics, and being able to go back and forth wherever and whenever they wanted.

What aspects of the lesson were most valuable? Students found this question difficult to answer. One third made no comments, while others described how the presence of colours and sound in the CAI lesssons motivated them to learn.

What aspects of the lesson were least valuable? Nearly two thirds of students had no response to this question, perhaps being reluctant to criticise. Many said no aspects of the lessons were least valuable, that all aspects were good.

Describe the strongest aspects of the CAI methodology. Students did not give direct answers to this question. Some interesting responses were that with CAI students themselves take on the responsibility for learning. Some said that CAI is better than just reading textbooks or being taught by an instructor. Others thought it was easier to learn with CAI, as the material was well structured and presented a useful summary of the contents.

Describe the weakest aspect of the CAI methodology. Diverse responses were given to this question. Some said that students may not bother with the lesson and instead do other things on the computer. The matter of insufficient time to complete the lessons was brought up again. When faced with difficulties there was no instructor available to help them out. Some students wanted handouts to go with the CAI. Students' progress was held up when computers did not work properly.

Open-ended comments. There were some interesting insights here. Many students said they liked CAI and would like to take other CAI courses. Some students said that this learning method decreased their anxiety or stress while they are learning. Some said it was not boring, whereas learning with an instructor is boring. Some explained that CAI encouraged them to learn, to know, to see, to proceed and to find out about things by themselves.

4.7 Conclusion

This investigation considered students of similar ability and prior knowledge. One group studied three topics in the subject *Information Technology for Life* by CAI while the other (control) group had traditional lessons. The level of significance in all statistical analyses was set to 0.05.

Based on pre- and post-tests, within both groups there was a significant increase in knowledge in the three topics. However, comparing between groups for the three combined topics, the CAI group performed significantly better than the Lecture group. According to the attitude surveys, there was a significant correlation between Lecture group students' attitude towards the teaching method and their performances in the examination, but this was not the case for the CAI group.

Data from the focus group interviews provided strong evidence that the CAI students liked this mode of learning.

Chapter 5

Discussion, Conclusion, Implications and Recommendations

This chapter summarises the findings of the study. In addition, conclusions and a set of recommendations for future study are addressed so that additional research can be carried out to determine the applicability of the results.

This research was conducted using a sample of Nakhon Pathom Rajabhat University students in Thailand. The findings of the present study generally support the conclusions made in prior CAI studies, such as Kulik *et al.* (1986). The CAI students performed better on the overall post-test than did the students taught by a conventional lecture method. Students in the CAI group expressed a positive attitude towards the CAI format as implemented in this study. Also, they tended to favour the major aspects of the CAI format, such as self-pacing and student-centred learning. Observations showed that students participated actively during the CAI classes and focus group interviews.

5.1 Summary

With the continuing growth of technology and the increasing pressure for schools to raise test scores, teachers are being faced with the challenge of combining traditional teaching with technology to improve content achievement (Meyer, 2002).

The purpose of this study was to compare the effects of CAI teaching with those of traditional teaching on student knowledge and satisfaction. A minor goal for the study was to investigate whether or not CAI supports weaker students more than the stronger

ones. Many studies have documented disadvantages of CAI, including those by Jenks and Springer (2002), Fletcher-Flinn and Gravatt (1995) and Milne *et al.* (1990). However, some have found CAI superior, such as Lepper and Gurtner (1989), Leeds *et al.* (1991) and Tseng (1999). This issue continues to challenge educators in their quest for a solution.

The study examined a sample of first year undergraduate students who were enrolled in the *Information Technology for Life* (4000107) course offered at the Nakhon Pathom Rajabhat University in Thailand. This general education course has a very large enrolment, from which 3 classes of General Management students were selected to be the control group, and 2 classes of Accounting students to be the experimental group. The average number of students in the control group was 122, while there were 93 students in the experimental group; there were 80 students who attended and participated in all three pre/post-test exercises, the results from these being used in the calculation of the Pearson correlation coefficients reported in §4.5.4. Attendance was not compulsory and varied from week to week. Only those students who attended each class were considered in the final analysis. Three topics were chosen for the experiments; the control group attended a lecture class, while the CAI group used CAI courseware on computers. Before the lessons took place, students in both groups took the three pre-tests. The students were divided into two equivalent groups on the basis of their GPA scores. At the end of each lesson, students were asked to complete a 30-item attitude survey questionnaire in order to investigate their feelings toward both the CAI and traditional methods. The post-tests were conducted one week after the students had finished their study of each topic. Students' performances were considered from the pre-test and the post-test score. Normalized gains were calculated to compare the levels of knowledge gained by the groups through the different teaching methods. Performances within groups were also calculated. The students' level of course satisfaction was measured through their attitude toward the two teaching methods.

5.1.1 Review of the findings

To compare the effectiveness of CAI versus traditional teaching, six null hypotheses were formulated in this study. Table 5.1 provides a summary of the results obtained in this study.

Table 5.1: Summary of hypothesis testing.

Hypothesis	t-value	Decision
$H_0 1$ There is no significant difference in student performance based on CAI learning versus traditional learning.	5.787	Rejected
$H_0 2$ There is no significant difference in CAI student performance when comparing weak, average and strong students.		
Weak-Average	1.349	Retained
Average-Strong	2.580	Rejected
Strong-Weak	3.747	Rejected
$H_0 3$ There is no significant difference in student performance on the final examination based on CAI learning versus traditional learning.	2.434	Rejected
$H_0 4$ There is no significant difference in attitude towards the method of teaching between CAI students and traditional ones.	0.286	Retained
$H_0 5$ There is no significant correlation between CAI students' performance and their attitude toward CAI utilization.	0.575	Retained
$H_0 6$ There is no significant correlation between traditional students' performance and their attitude toward the method of teaching.	3.119	Rejected

5.2 Discussion

This section discusses in more detail the interpretation of the statistical analysis of the 6 null hypotheses listed in §3.13 (p. 87). There were several results that were not statistically significant and these are therefore not addressed in the discussion.

5.2.1 $H_0 1$: No significant difference in student performance

The first hypothesis indicated that there is a significant difference in student performance based on the CAI versus traditional teaching. This hypothesis was concerned only with the learning method, its purpose being to compare the effectiveness of CAI versus traditional teaching. Previous studies have indicated that the learning method affects performance. Capper (2001) stated that on average across different levels of education and training, 233 CAI studies resulted in increased student performance from the 50^{th} percentile to about the 65^{th} percentile of the control group (Capper, 2001, p. 4). The results of the present

study show that the effect size of the CAI group was 0.92, corresponding to about the 82^{nd} percentile of the control group.

Coe (2000) defined the term effect size as a way of quantifying the effectiveness of a particular intervention, relative to some comparison. Effect sizes can also be thought of as the average percentile standing of the average experimental participant relative to the average control participant. An effect size of of 0 indicates that the mean of the experiment group is at the 50^{th} percentile of the control group; an effect size of 0.8 indicates that the mean of the experiment group is at the 79^{th} percentile of the untreated group, and a value of 1.7 corresponds the 95.5 percentile of the control group. Effect sizes can also be interpreted in terms of the percent of non-overlap of the experiment group's scores with those of the control group. An effect size of 0 indicates that the distribution of scores for the experiment group overlaps completely with the distribution of scores for the untreated group, that is, there is 0% of non-overlap. An effect size of 0.8 indicates a non-overlap of 47.4% in the two distributions, and effect size of 1.7 indicates a non-overlap of 75.4% in the two distributions.

The t-values determined for this hypothesis in each experiment were greater than their corresponding critical values at the 0.05 level of significance, for each topic, suggesting that there is a significant difference in student knowledge depending upon the learning method. The overall results provided strong evidence that students performed better when studying with CAI than with the traditional lecture approach.

5.2.2 $H_0$2: No significant difference in CAI outcomes for weak, average and strong students

Analysis of the second hypothesis indicated that there are two different outcomes when comparing the 3 sub-groups within the CAI group i.e. weak with average students, average with strong students, and weak with strong students. The calculated t-values were 1.349, 2.580 and 3.747 respectively. In comparing the weak sub-group with average students, the calculated t-values were not high enough to substantiate a significant difference in performance. Hence, it was concluded that the CAI equally benefited weak and average students. However, in the comparison between average and strong students and strong and weak students, the results indicated significant a difference in performance for both sub-groups. In particular, the calculated t-value between strong and weak students

produced about triple the value for the weak-average sub-groups. This indicated that a strong significant difference existed here. Although by definition strong students should perform better than weaker ones in nearly every case, in this study the effectiveness of the CAI lessons on the average students was approximately twice as great as the weak students; on strong students it was approximately twice as great as for average students, and approximately three times as great as the weak students.

In the lecture group it was found that the *t*-values in sub-groups weak-average, average-strong and strong-weak were 0.066, 0.318 and 0.221 respectively. None of the overall *t*-values obtained in each paired group indicated any significant difference in performance, even when comparing weak and strong students. This is perhaps not surprising, given that there are approximately 150 students in each lecture and it is physically impossible for the instructor to give each student individual attention within the 2-hour lecture period.

Comparing the Experimental and Control groups among weak, average and strong students, the calculated *t*-values were 1.035, 3.599 and 4.651 respectively. These results indicate that there is no significant difference in outcome when comparing weak students from the two groups. These results suggest that CAI and traditional learning provide less learning support for weak students. In contrast, for the CAI group student performance for the average and strong sub-groups were significantly different compared with those of the Control group. From this it may be concluded that CAI lessons better support student learning for average to strong students.

5.2.3 $H_0$3: No significant difference in final examination performance

The third hypothesis, which appears similar to the first, was included to look specifically at examination performance, rather than just week-to-week class performance. Its analysis revealed a significant difference in student performance in their final examination when comparing CAI students with Lecture students. Examination performance, measured a considerable time after the teaching was carried out, is a measure of retention of learning. These findings are in agreement with a survey of studies by Cotton (2001), who showed that the retention of content learned using CAI is superior to retention following traditional learning alone.

5.2.4 $H_0$4: No significant difference in attitude

The purpose of this hypothesis was to compare the degree of student satisfaction with their learning method. In general for the two groups there was no significant difference in student attitudes toward their method of learning. Both groups felt that overall the method of teaching was very good. In detail, there were some interesting attitude differences.

In this study, it was found that more CAI students felt that the CAI lesson held their attention. Moreover, the results also showed that more CAI students felt that the lessons were not too hard for them, compared with the traditional group. Despite this, one of the interesting results was that more students in the Lecture group felt that they could learn more from reading books than being taught by an instructor. This means that students felt the instructor's teaching method was no different to reading a textbook on their own. The study showed that more CAI students had a desire to take more classes taught this way. In addition, more CAI than Lecture students said they enjoyed learning the subject matter. In contrast, more Lecture students felt that they had to try harder when taught by an instructor, while the CAI group did not feel this obligation; nevertheless, there were more CAI students who prepared before coming to class than was the case with the Lecture group. Finally, there were more CAI students than Lecture students who felt the teaching method made the subject interesting, and more CAI students felt that the lesson improved their understanding of concepts in the field they had studied.

5.2.5 $H_0$5: No significant correlation between CAI performance and attitude to CAI

The purpose of this hypothesis was to find the extent of correlation, if any, between CAI students' attitude to CAI and their performance. The calculated correlation was very small ($r = 0.065$), indicating no relationship between student performance and their attitude toward CAI.

5.2.6 $H_0$6: No significant correlation between lecture group performance and attitude to traditional teaching

The purpose of this hypothesis was to find the extent of correlation, if any, between students' attitudes to traditional teaching and their performance. In this case the calculated

r-factor was 0.333, which is much greater than that of the CAI group. Thus, though there is a correlation between student performance and their attitude toward traditional teaching, it is very weak. The t-value calculated was 3.119, implying a statistical significance for this relationship. It appears that students who gained high scores have a tendency to favour the instructor, while those students who gained lower scores are not so favourably disposed to the instructor.

5.3 Conclusion

Based on this study, it has been shown that students learning under CAI performed better than students learning under the traditional lecture method. Within the CAI group, stronger students showed greater knowledge gains than weaker ones. The study suggests that there is a significant difference in student performance on the final examination, with CAI students gaining more knowledge than students following traditional lecture classes. It was also found that there is no significant difference in students' attitude toward their method of teaching; moreover, in CAI students there is no significant relationship between students' performance and their attitude toward the method of teaching. In contrast, there is a weak but significant relationship between attitude toward the method of teaching and their performance in students following a traditional lecture format.

5.4 Implications

The results of this study suggest that Thai university students can be taught successfully through the CAI lesson format. The students demonstrated that they are capable of taking responsibility for their own learning. Their knowledge gains from the experiments show that Thai students are not necessarily passive in their learning. If circumstances permit, the students are ready to play an active role, thereby making learning a lively and rewarding experience. In a CAI environment, it is likely that the students' learning potentials can be greatly enhanced.

For Thai instructors, this study has shown that the presentation of the content does not have to be limited to lecturing. The use of new technology in education, such as CAI allows, provided students a chance to learn at their own pace. This is the national goal for

Thai education today.

Another implication is that higher education teaching in Thailand should consider the utilisation of CAI. University administrators should consider providing funds for creating more CAI lessons, and both short and long training courses for instructors to practice CAI design and development should be promoted.

The Thai National ICT project plan is an initiative set for the years 2001–2010. In particular, the ICT for Education master plan of The Ministry of Education is focused on the use of ICT as a major tool for educational reform (Waitayangkoon, 2004). The results from this study form a small contribution to the stated goal of developing CAI at all levels of Thai education. Miller (2001b) commented about the Thai National ICT project, "is challenged to bring about Thai educational reform by demonstrating to academic staff how to use technology to enhance teaching and learning and how to develop students with creative and critical thinking skills using student-centred, problem-based, experiential learning techniques".

In the near future, the curriculum and subjects taught in the 41 Rajabhat Universities are likely to be similar to those presently taught. Therefore, it is recommended that a joint project of developing CAI courses for all Rajabhat Universities should be established. This would be a beneficial undertaking because it would distribute the costs of developing courses across the Rajabhat Universities, rather than duplicating effort with each of them working independently.

5.5 Recommendations for Further Study

The objective of this study was to investigate the short-term impact of CAI teaching versus that of traditional teaching on student knowledge and attitudes toward the method of teaching. To extend this effort, additional expanded studies should be performed to examine the long term retention of knowledge gained during the semester, for instance by looking not only at pre-test and post-test results, but also the knowledge of participants at various intervals after the semester's end. Further studies could compare different CAI and Web-based learning or other types of e-learning.

This study was limited to the general education course at NPRU. Another area for future research would be to determine whether the result of this research could also be

applied to other subject areas in the Rajabhat Universities. It could also be extended to different majors, such as Science, Electronics, Languages, and so on, perhaps using larger sample sizes to compare the effects of CAI versus traditional teaching.

Appendices

Appendix A

Information Technology for Life syllabus

Table A.1: *Information Technology for Life* syllabus, Nakhon Pathom Rajabhat University.

Category	Knowledge Area	Knowledge Item
Getting started (Weeks 1–2)	1.1 Information Technology	1.1.1 Understand the basic concepts of IT
	1.2 Types of computers	1.2.1 understand and distinguish between mainframe computer, microcomputer, personal computer, and laptop. Computer in terms of capacity, speed, cost, and typical users. Understand the terms *intelligent* and *dumb terminal.*
	1.3 Main parts of a personal computer	1.3.1 Know the main parts of a personal computer in general: The central processing unit (CPU); hard disk, common input/output devices, types of memory, removable storage devices such as diskette, zip disc, thumb drive, CD-ROM, DVD-ROM etc. Understand the term "peripheral device".
Hardware (Weeks 3–5)	2.1 Central Processing Unit	2.1.1 Understand the term "central processing unit" (CPU), know that the CPU does calculations. Logic control, immediate access memory etc. Hardware for inputting data into a computer such as mice, keyboards, trackballs, scanners, touch-pads, light pens, joysticks etc.
	2.2 Input devices	2.2.1 Know some of the main devices

Continued on next page

Table A.1 – continued from previous page

Category	Knowledge Area	Knowledge Item
	2.3 Output devices	2.3.1 Know the most common output devices for displaying the results of processing carried out by a computer, e.g. various visual display units (VDUs), screen or monitors, printers such as those commonly available, plotters, speakers, speech synthesizers etc. Know where and how these devices are used.
Storage (Weeks 6–8)	3.1 Memory storage devices	3.1.1 Compare the main types of memory storage device in terms of speed, cost and capacity e.g. internal/external hard disk, data cartridges, CD-ROM, DVD-ROM, diskette etc.
	3.2 Types of memory	3.2.1 Understand different types of computer memory: e.g. RAM (random-access memory), ROM (read only-memory). Understand when they are used.
	3.3 Measuring memory	3.3.1 Know how computer memory is measured (bit, byte, Kb, Mb, Gb, Tb). Relate computer memory measurements to characters, fields, records, files, and directories/folders.
Software (Weeks 9–11)	4.1 Types of software	4.1.1 Know the meaning of the terms "operating system software" and "applications software". Understand the distinction between them.
	4.2 Operating system software	4.2.1 Understand the main functions of an operating system. Understand the given examples. Be aware of the main advantages of using a GUI interface.

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Table A.1 – continued from previous page

Category	Knowledge Area	Knowledge Item
	4.3 Applications software	4.3.1 List some common software applications together with their use, e.g. word processing applications, spreadsheets, database, presentation tools. Desktop publishing and multimedia applications.
Networks (Weeks 12–14)	5.1 LAN and WAN	5.1.1 Know the definitions of local area networks (LAN) and wide area networks (WAN). Know about the advantages of group work and sharing resources over a network.
	5.2 Data communication	5.2.1 Know the meaning of the terms data communication, types of communications and transmission media. Understand the terms modem, digital, analog, baud bandwidth etc. Understand the terms Public Switched Data Network (PSDN), Integrated Service Digital Network (ISDN).
	5.3 Electronic mail	Understand the term electronic mail and know the use of e-mail. Understand what is needed to send and receive e-mail. Detail some of the information and communication technology (ICT) equipment needed to use e-mail.

Continued on next page

Table A.1 – continued from previous page

Category	Knowledge Area	Knowledge Item
	5.4 The Internet	Know what the Internet is. Understand the concept of the Internet and some of its main uses. Understand the economics of Internet mail systems relative to other mail delivery methods. Know what a search engine is. Understand the distinction between the Internet and the World Wide Web (WWW).
Security and copyright (Week 15)	6.1 Security	6.1.1 Know about the purpose and value of backing up computer files to removable storage devices. Know how to protect a personal computer against intrusion. Know about privacy issues associated with personal computers, e.g. protecting the computer, adopting good password policies. Know what happens to your data and files if there is a power failure.
	6.2 Computer viruses	6.2.1 Understand the term virus when used in computing. Be aware how viruses can enter a computer system. Understand the dangers of downloading files onto your computer. Know about some anti-virus measures.
	6.3 Copyright	6.3.1 Understand software copyright and some of the main security and legal issues associated with copying, sharing and lending diskettes. Understand some of the implications of transferring files across a network. Understand the terms shareware, freeware, and user licence.

Appendix B

CAI lessons

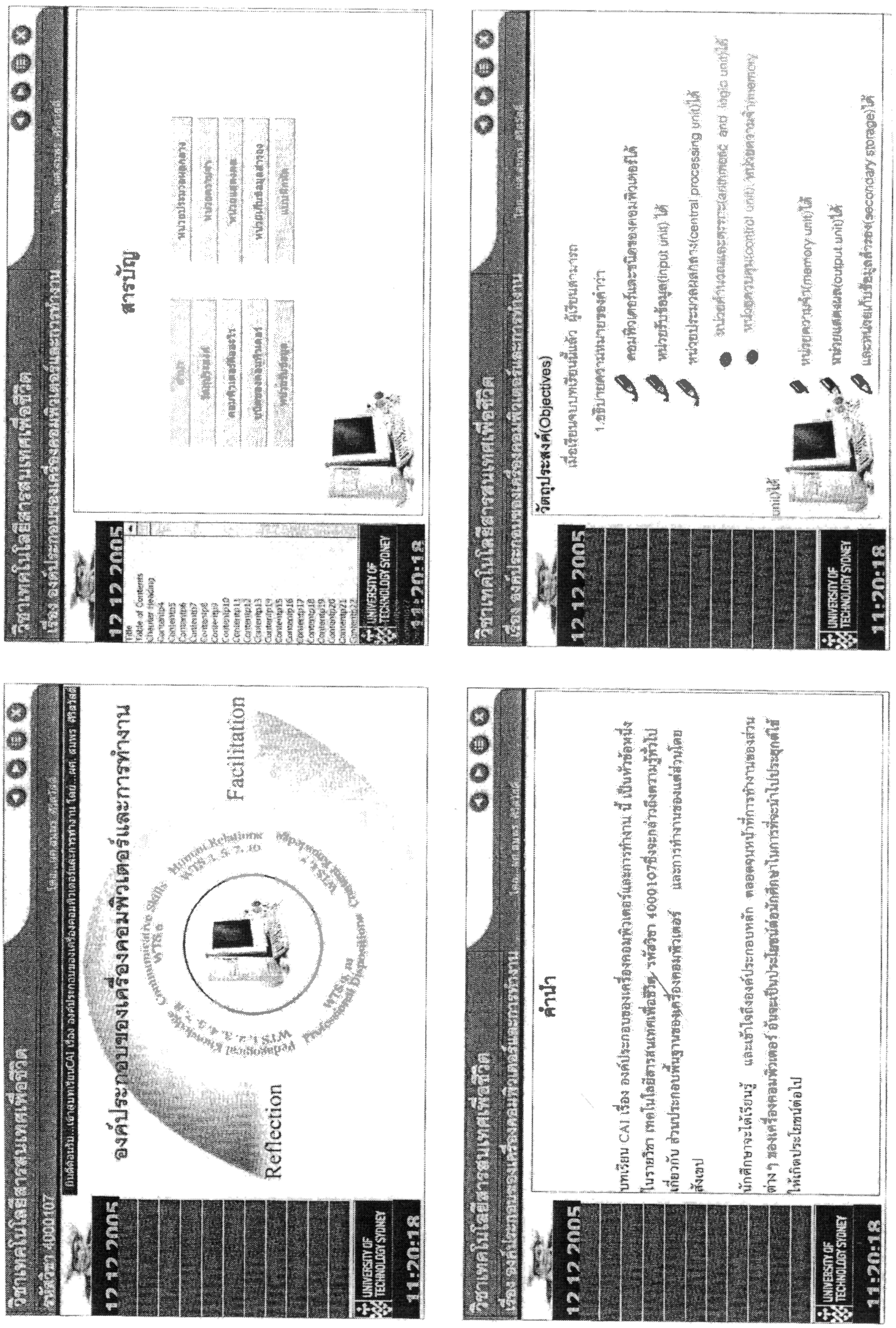


Figure B.1: Computer component and functions.

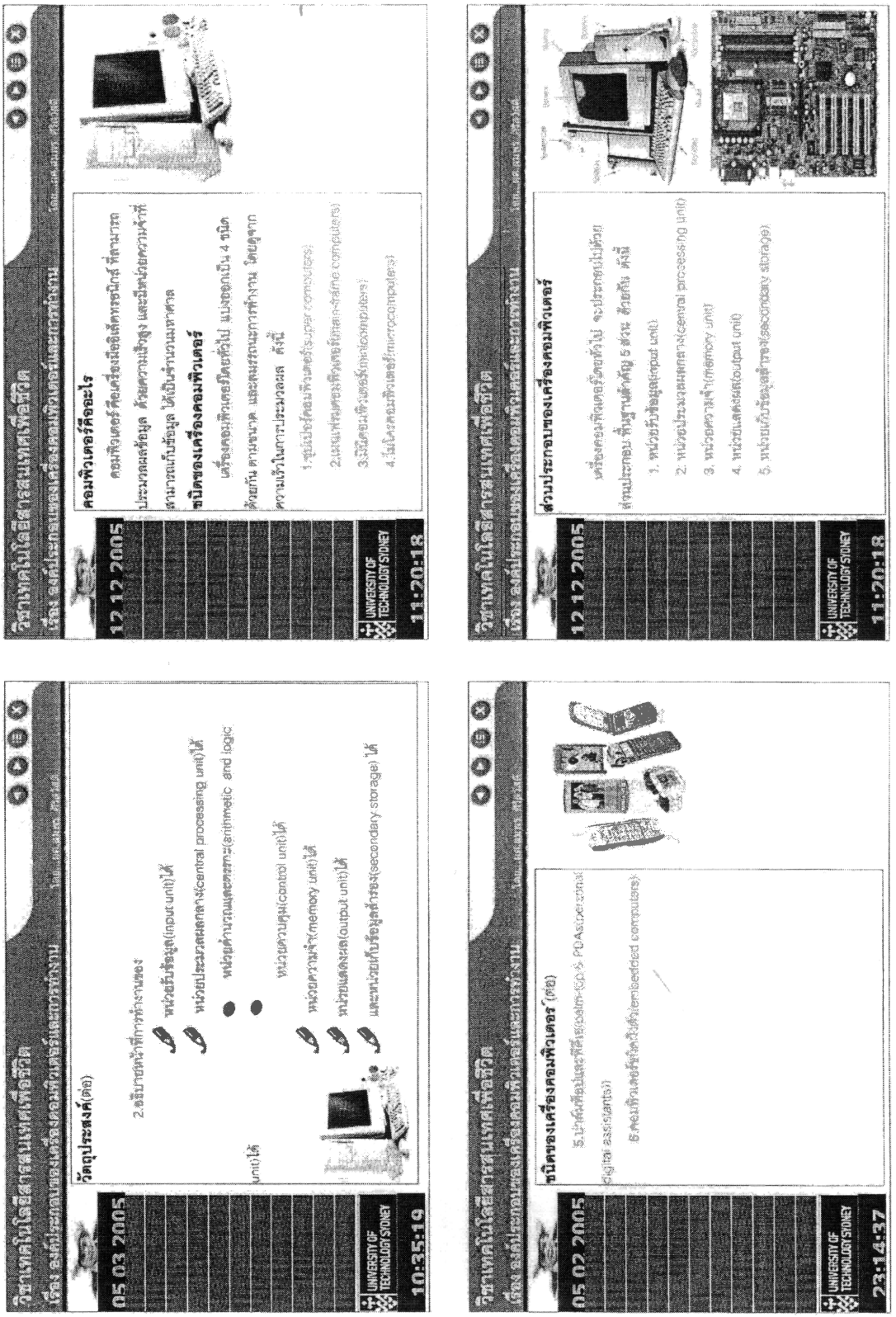
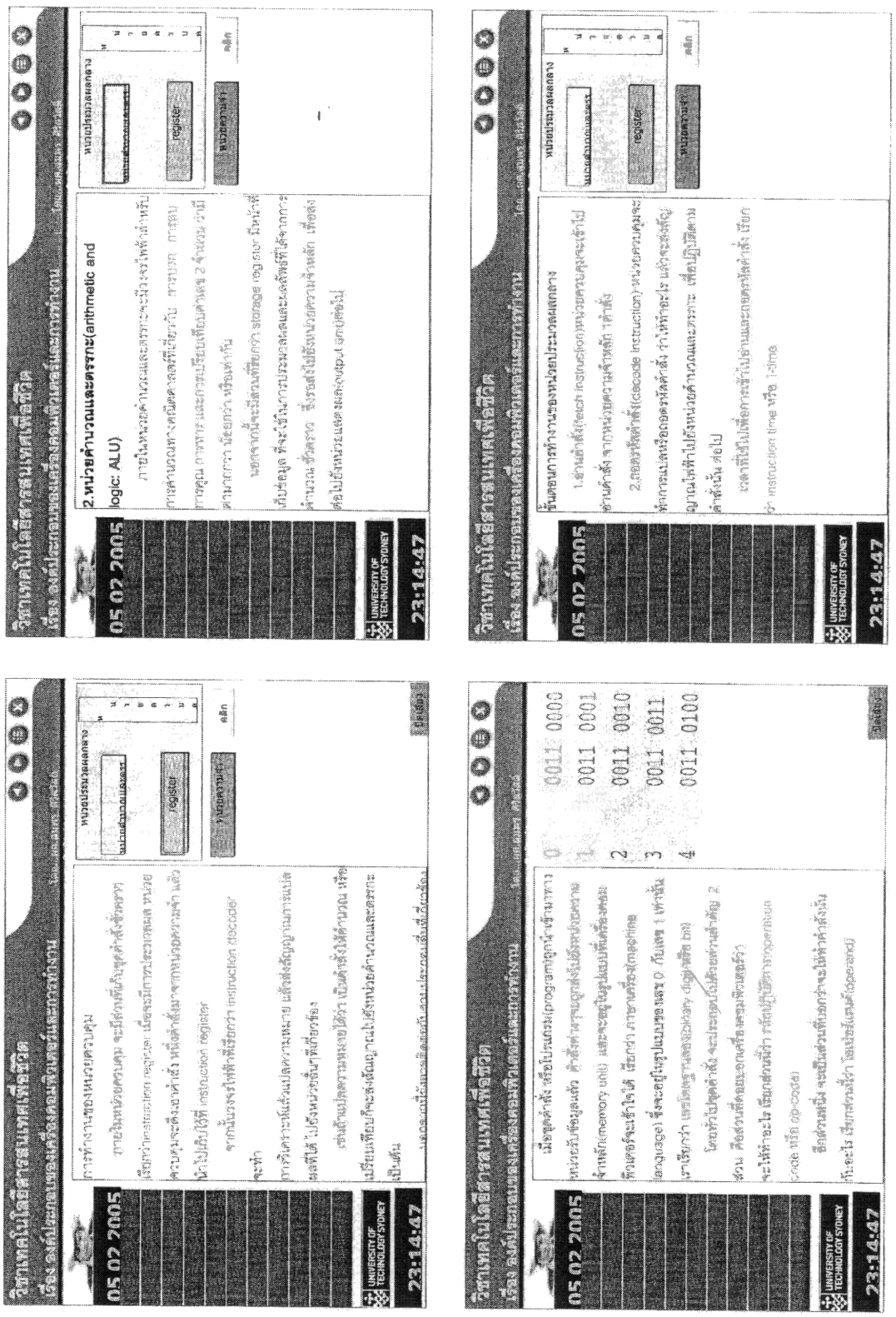


Figure B.2: Computer component and functions (cont.)

Figure B.3: Computer component and functions (cont.)



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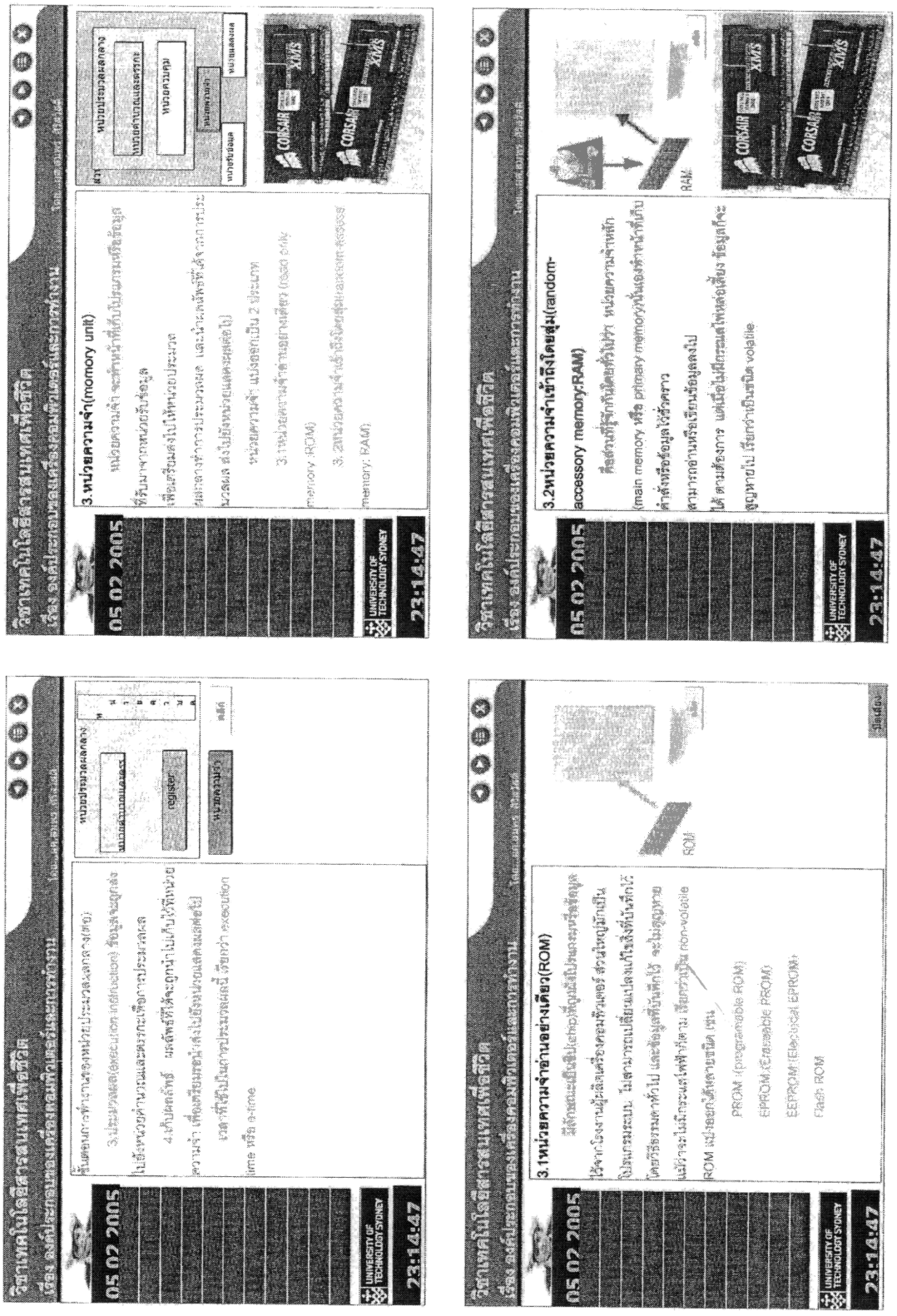

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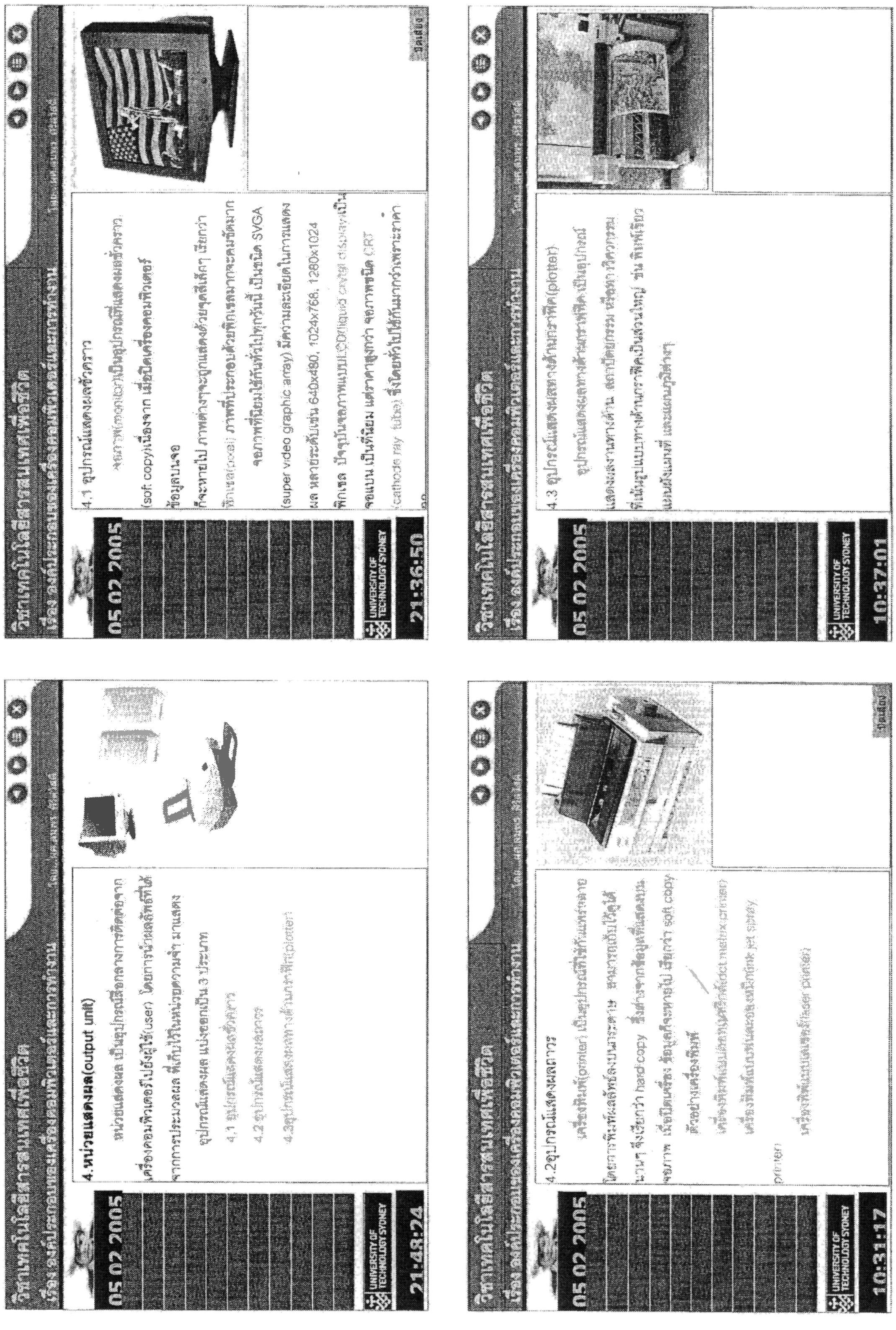

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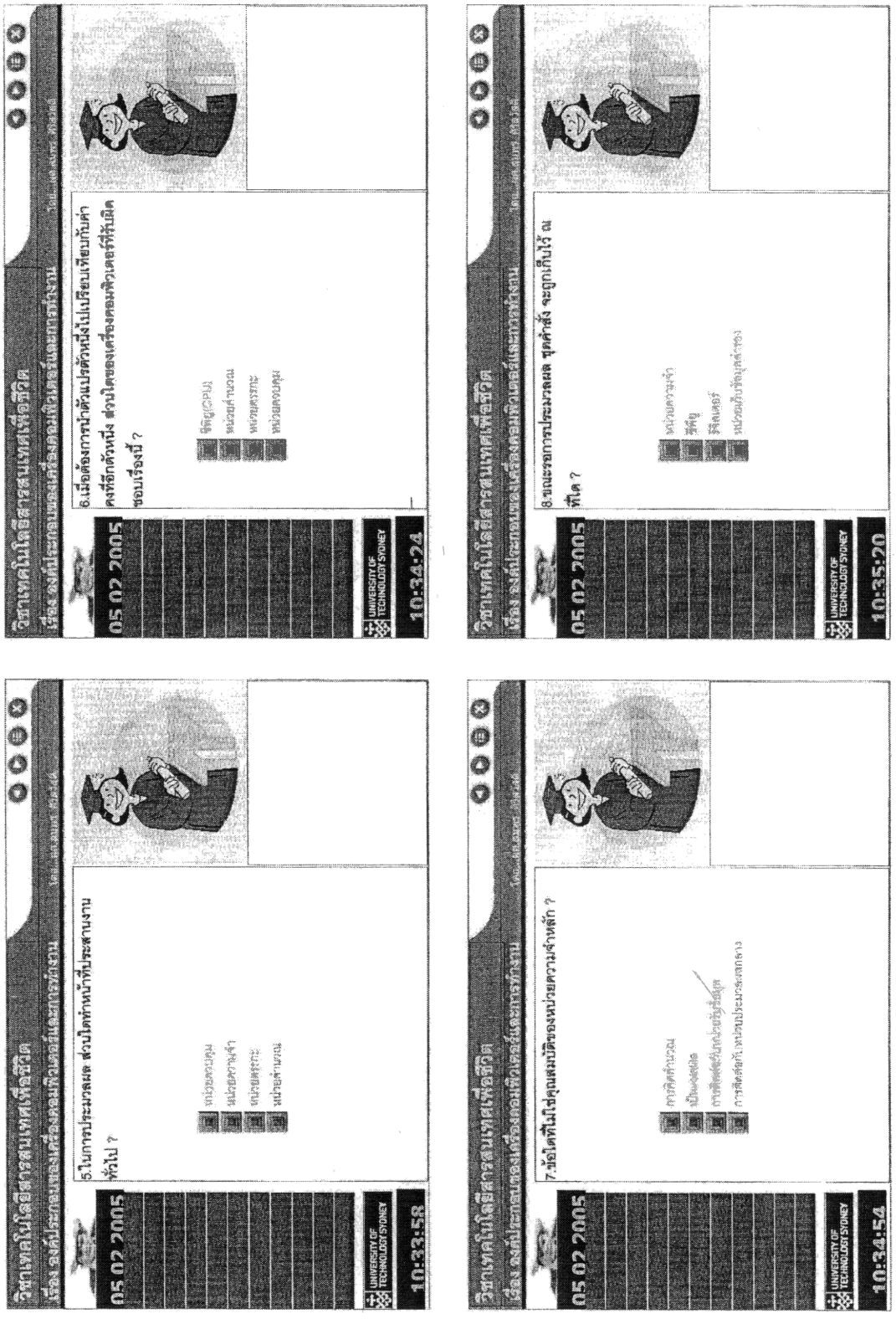
Figure B.7: Computer component and functions (cont.)

Figure B.8: Computer component and functions (cont.)



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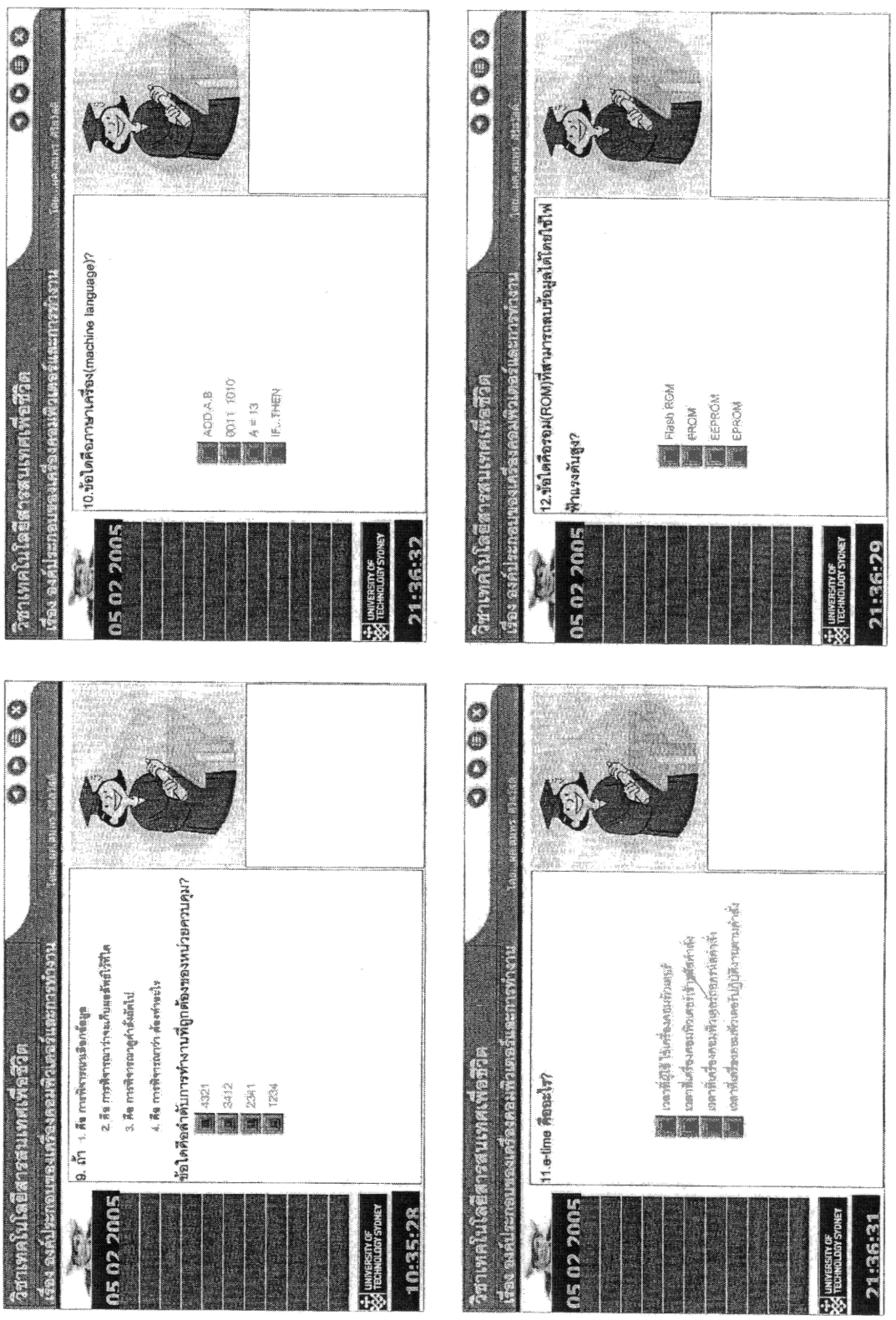

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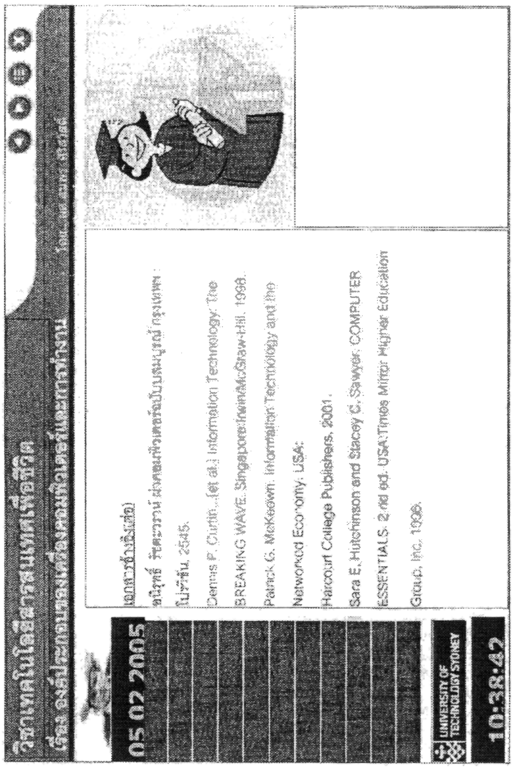
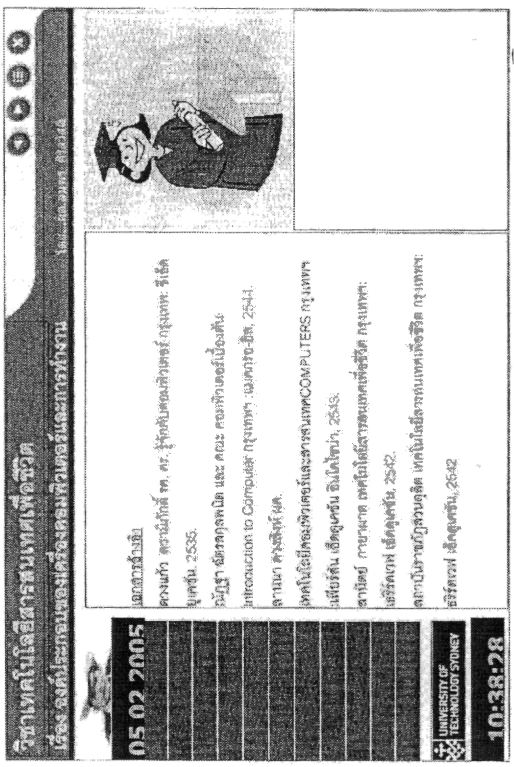
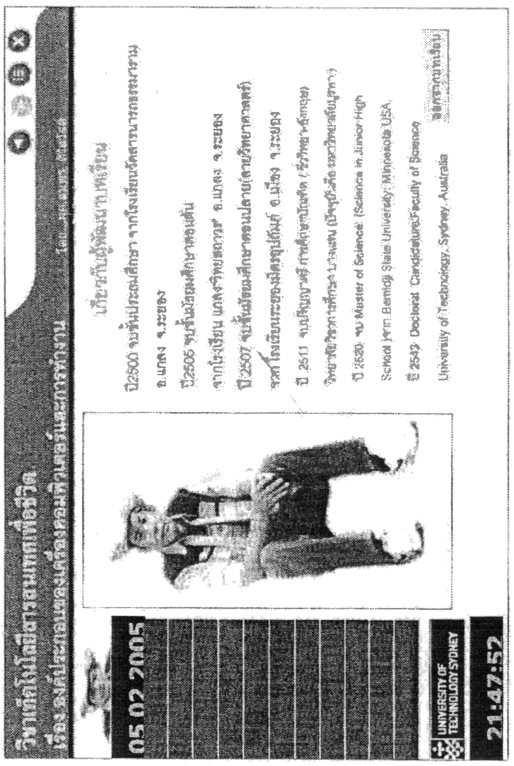
Figure B.11: Computer component and functions (cont.)







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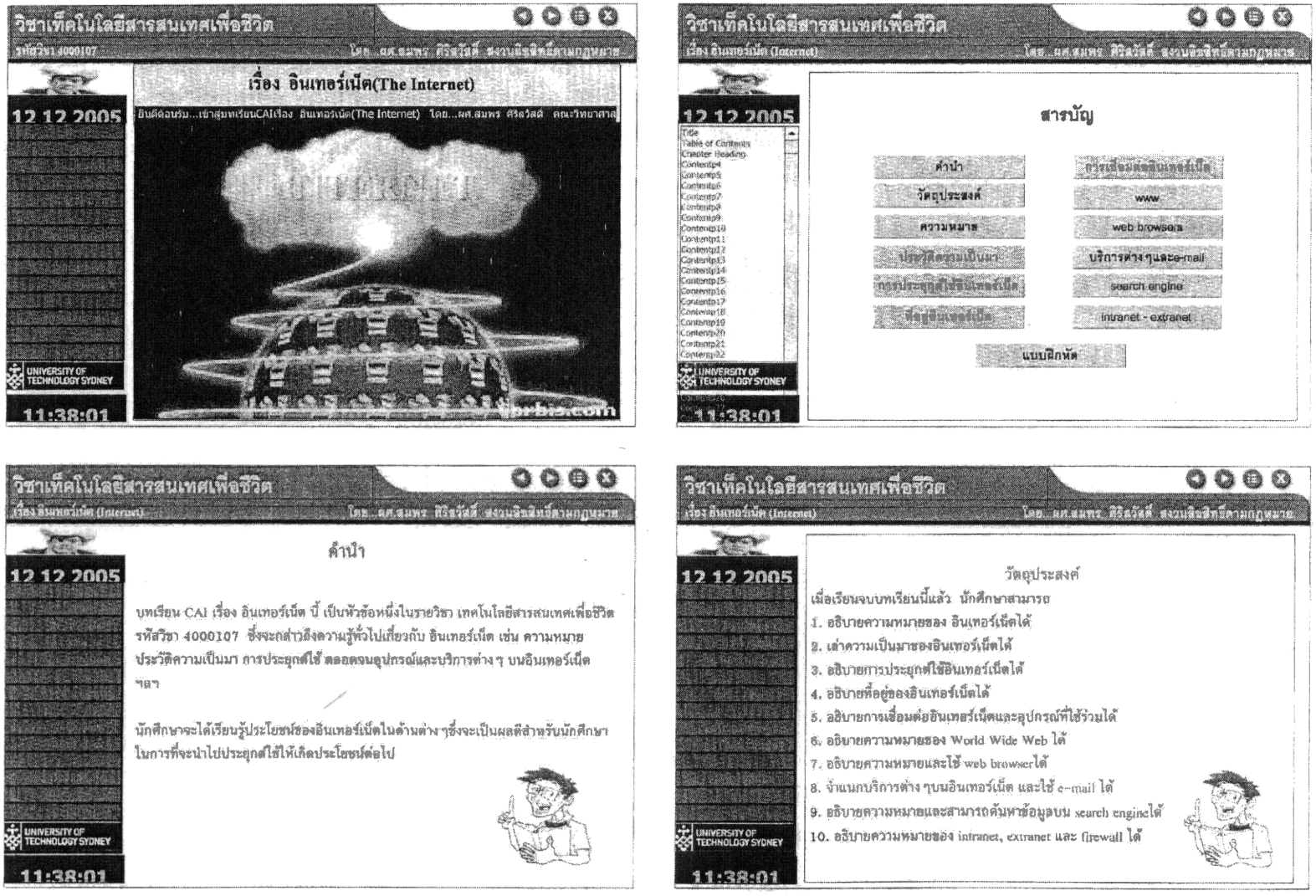

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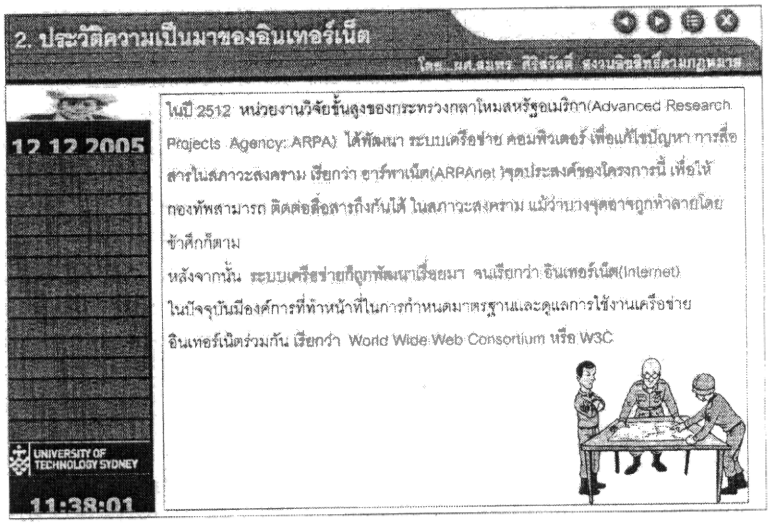

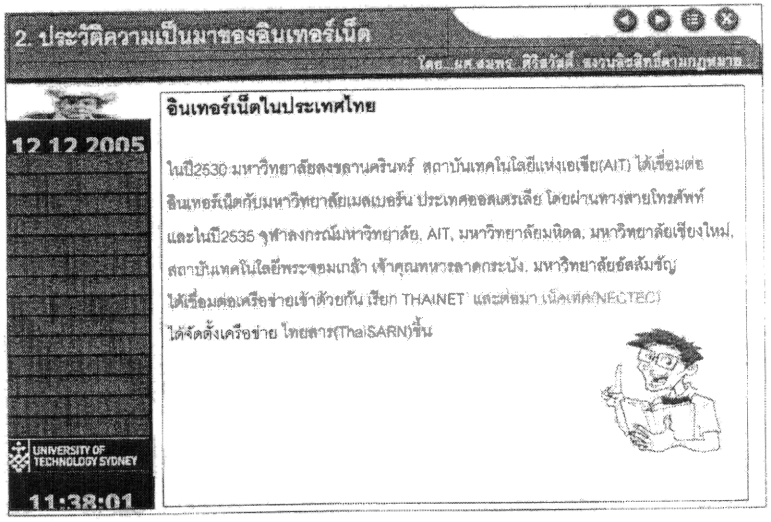

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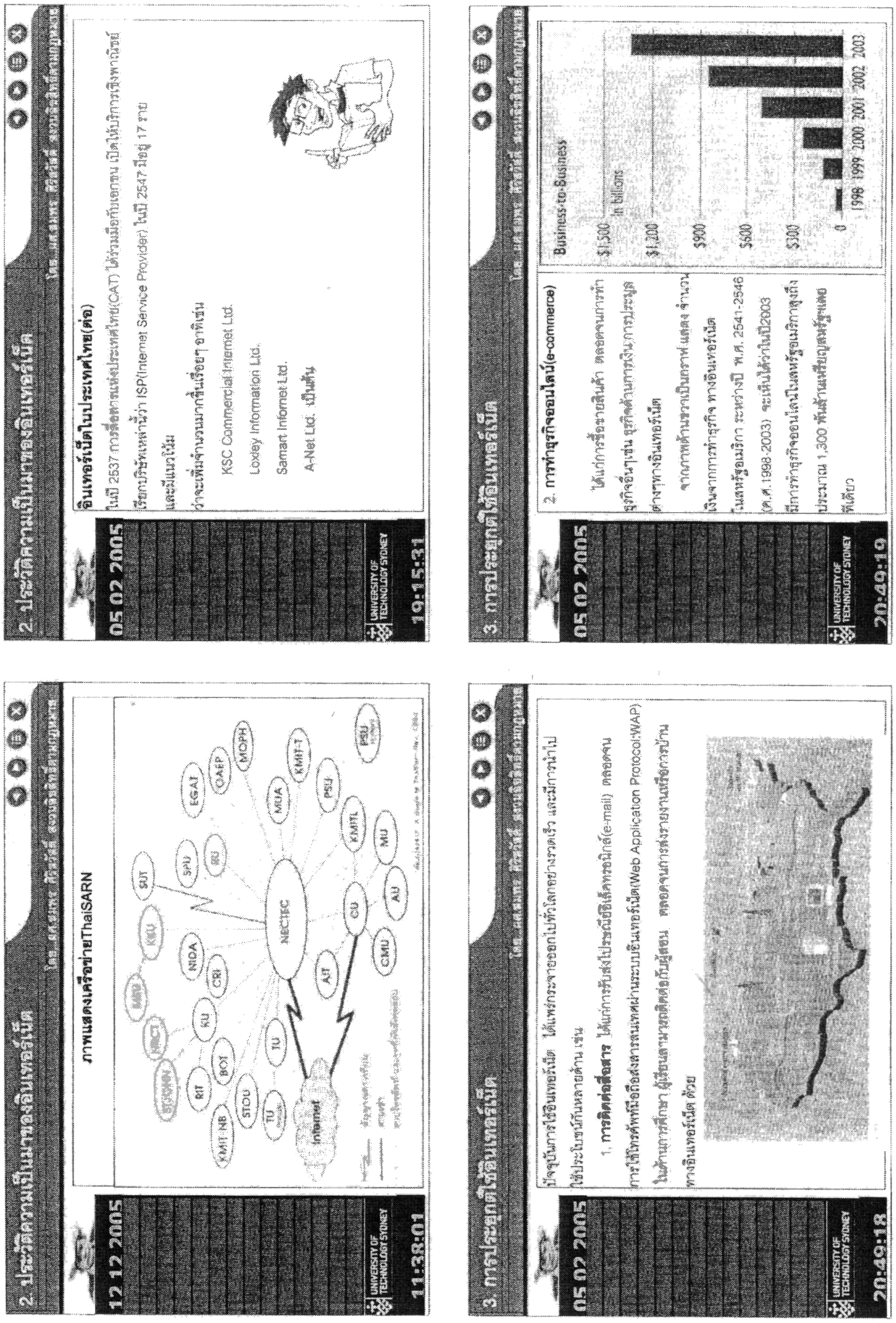

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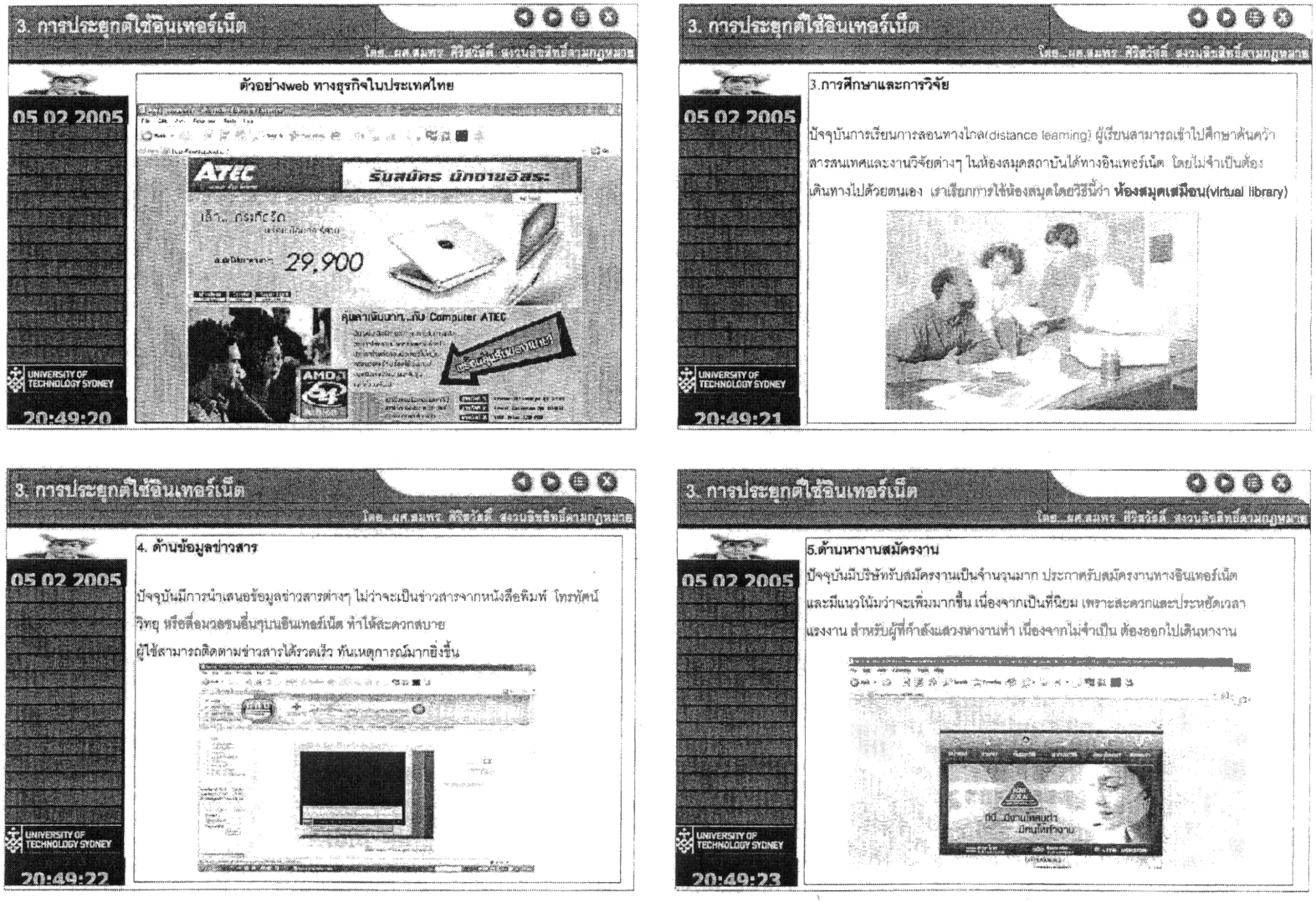

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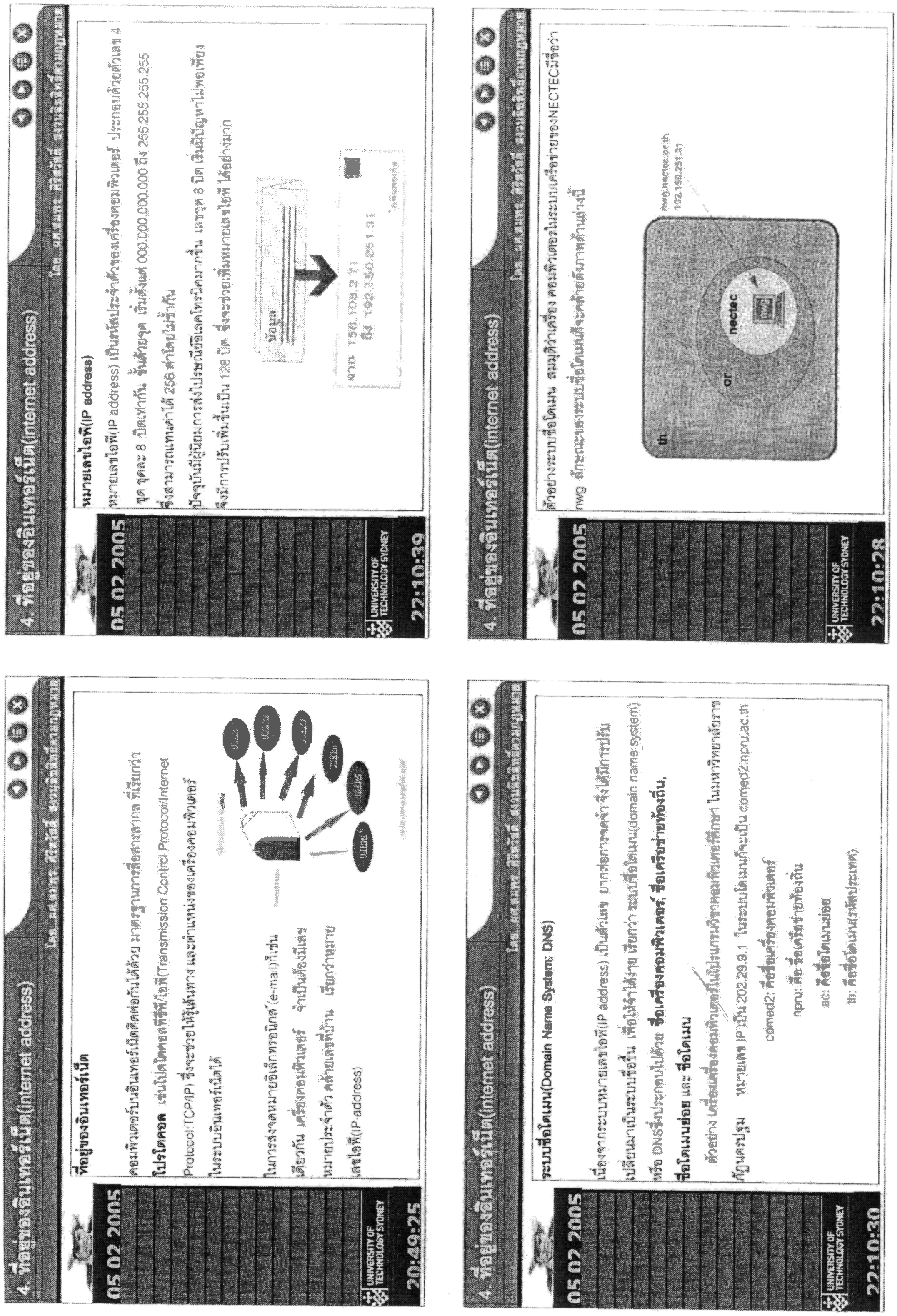

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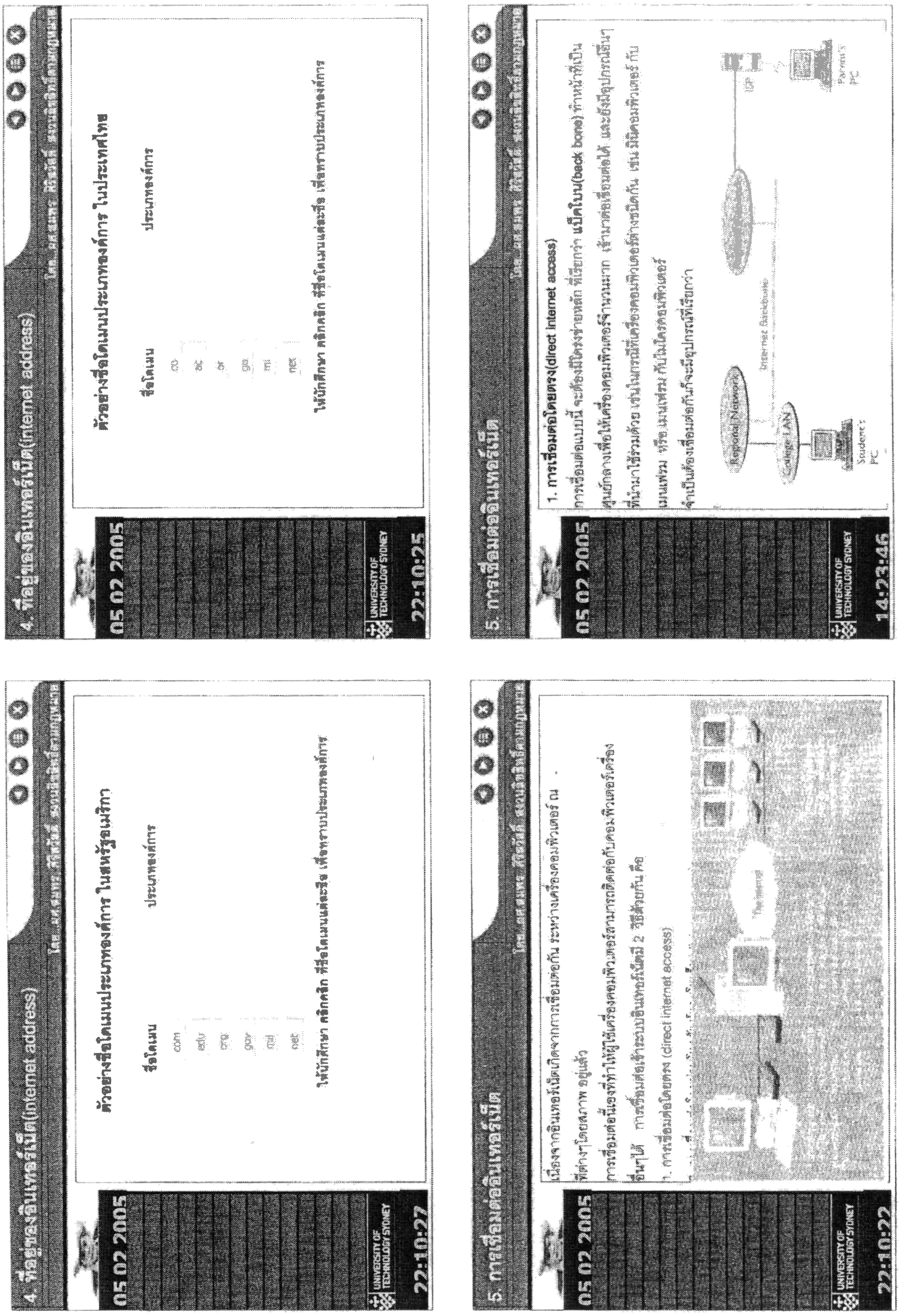

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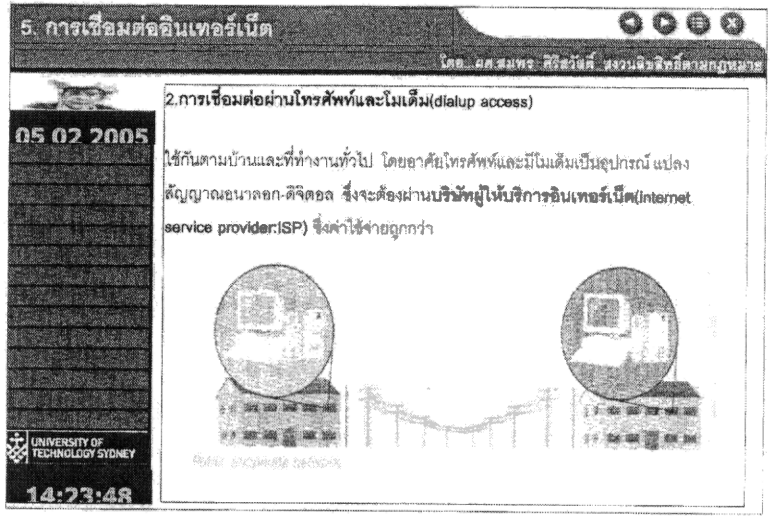

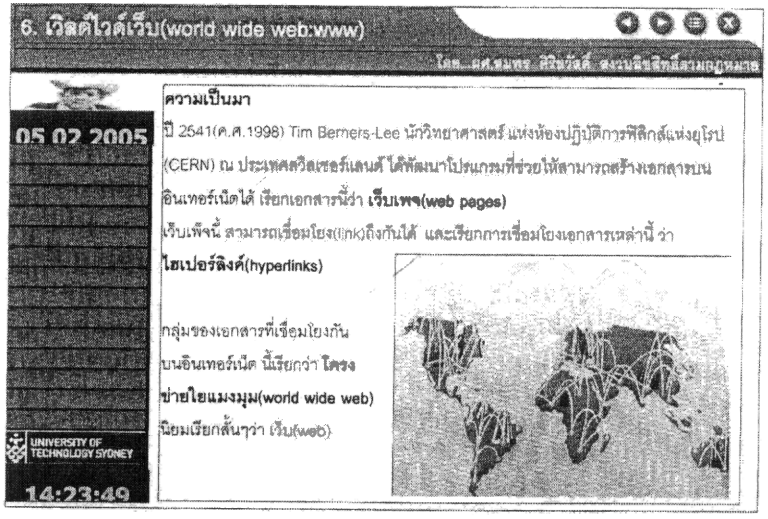

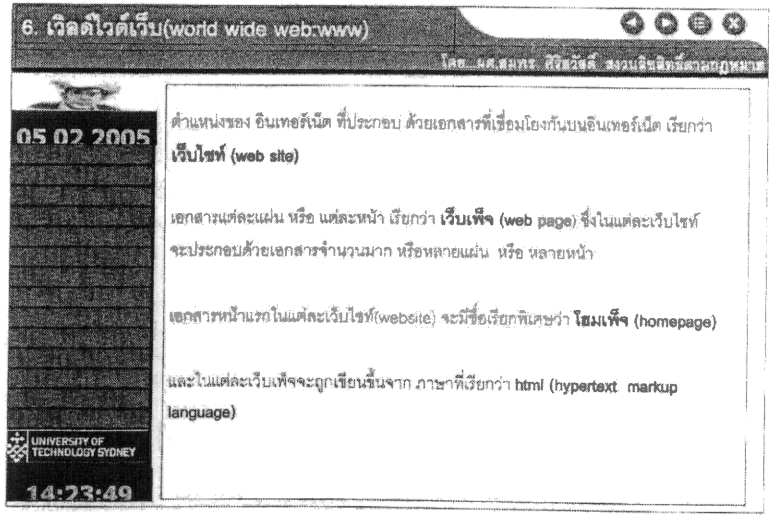

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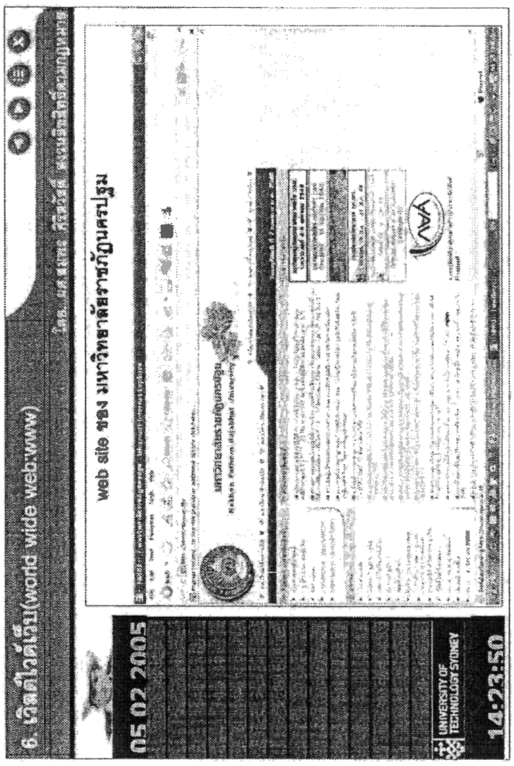

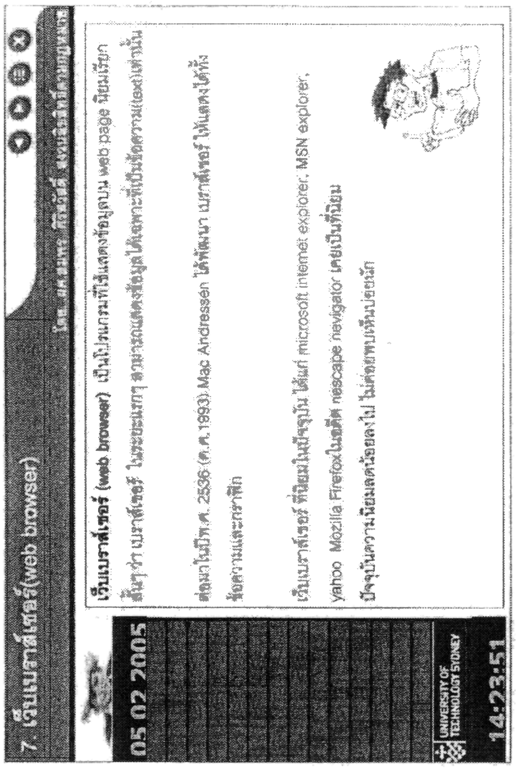

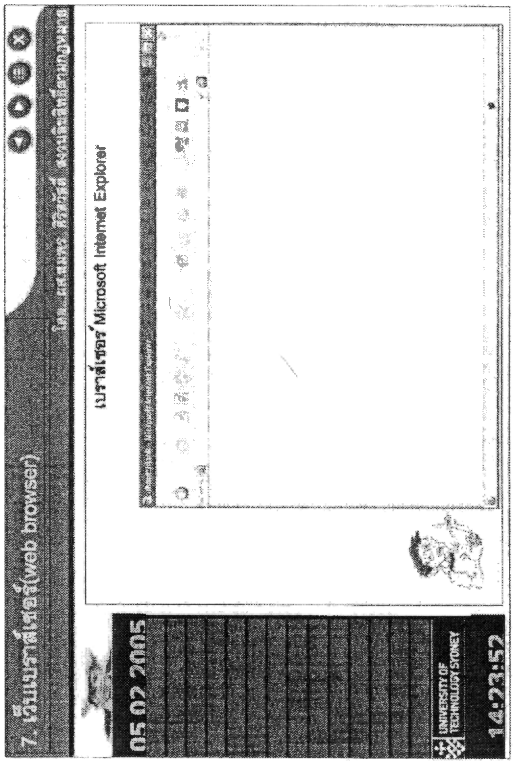

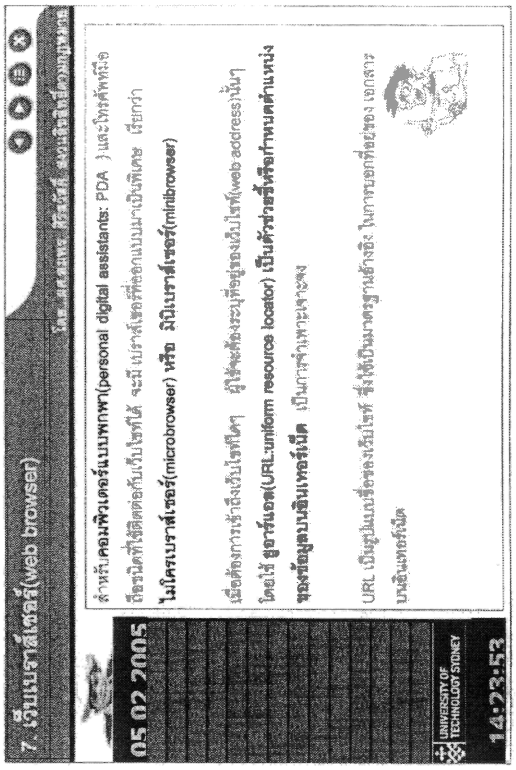

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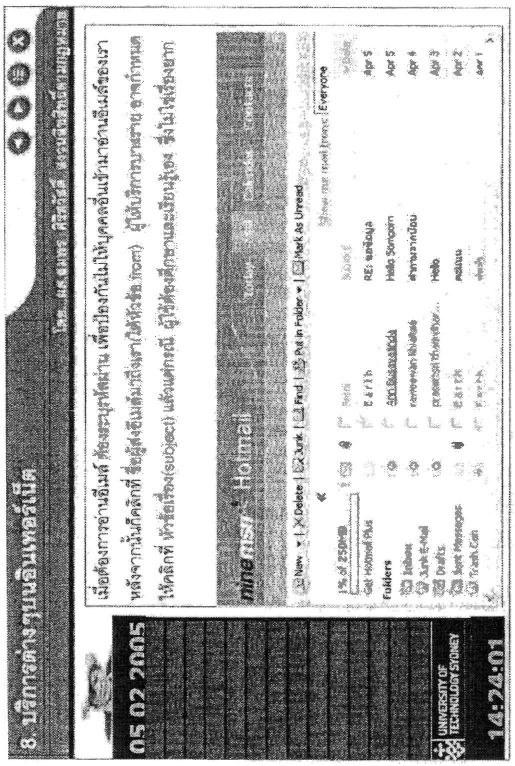
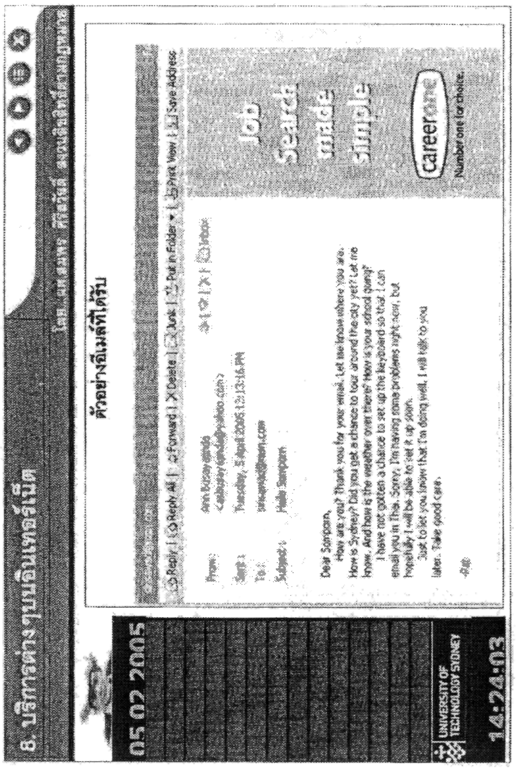
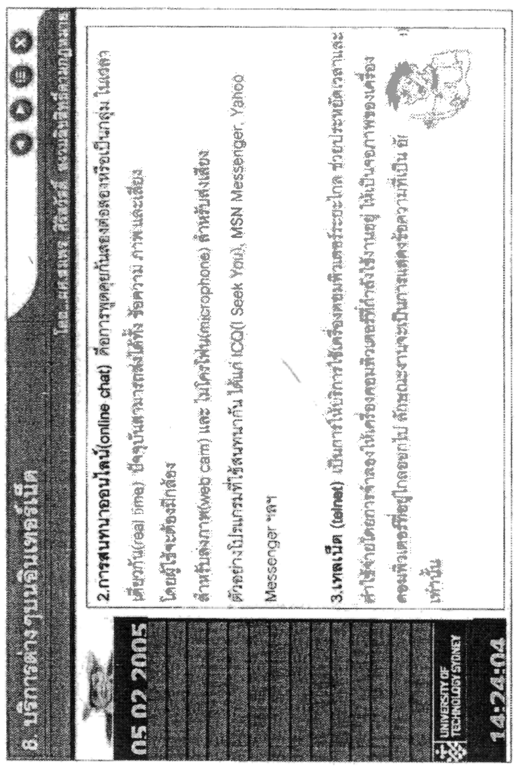
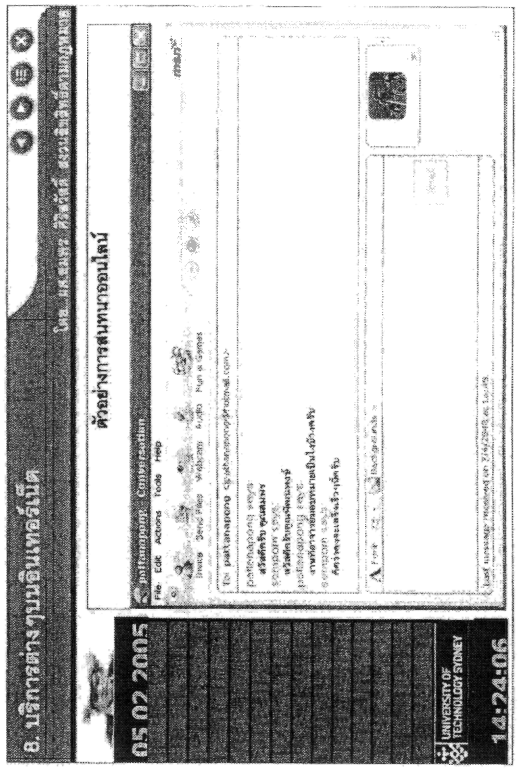
Figure B.21: The Internet (cont.)

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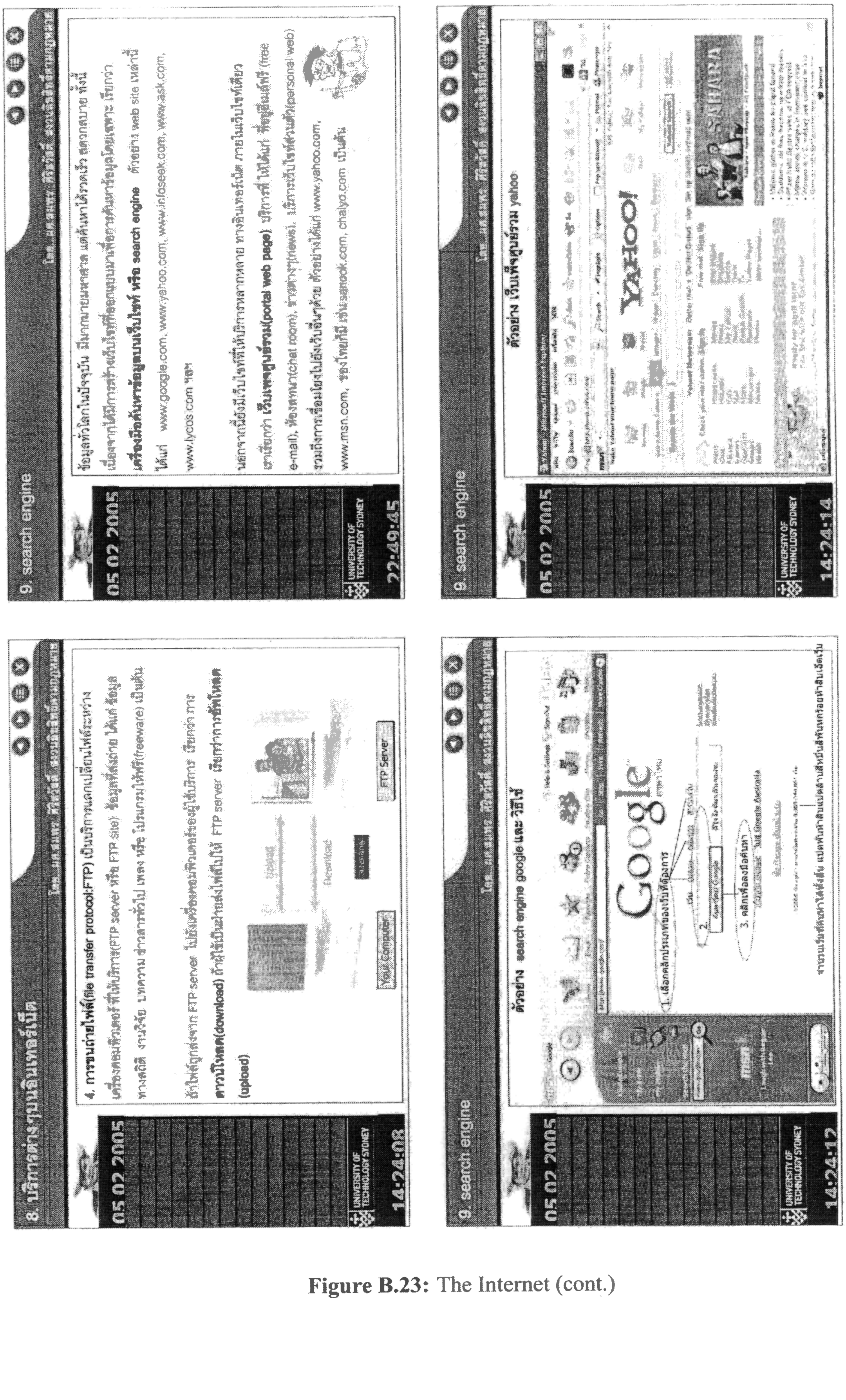

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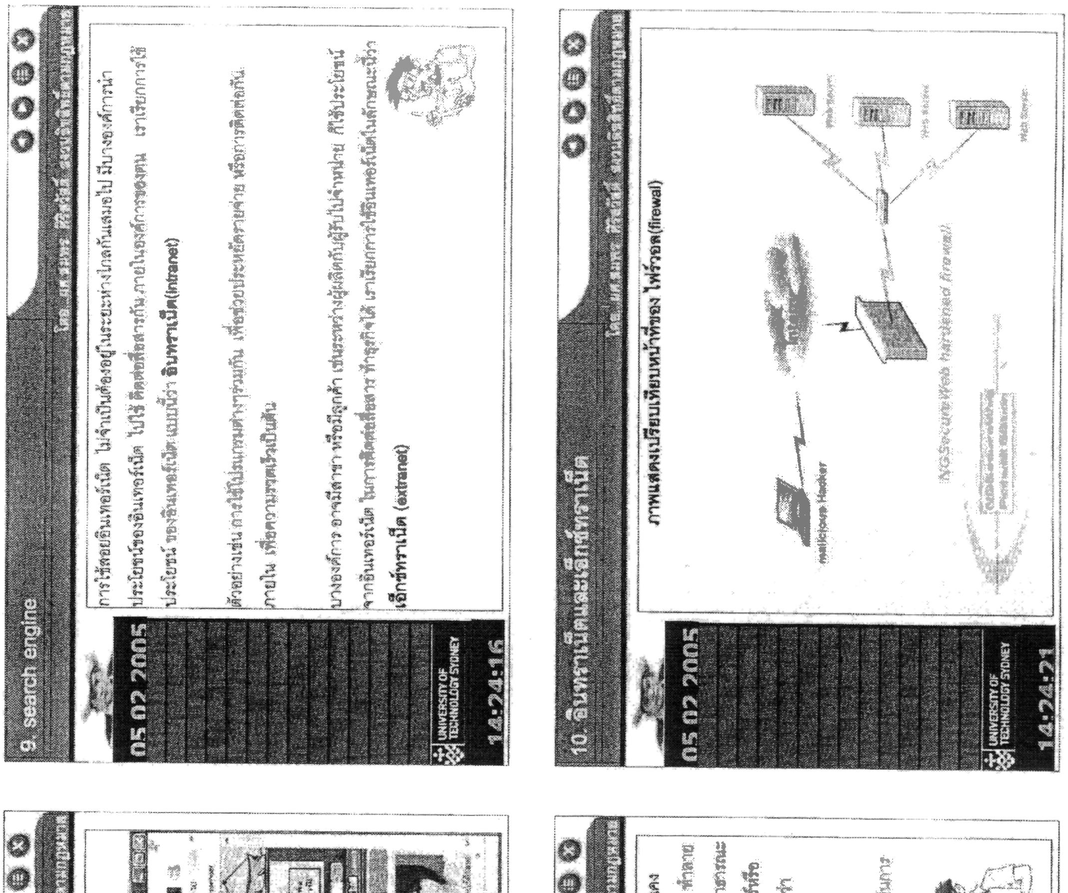

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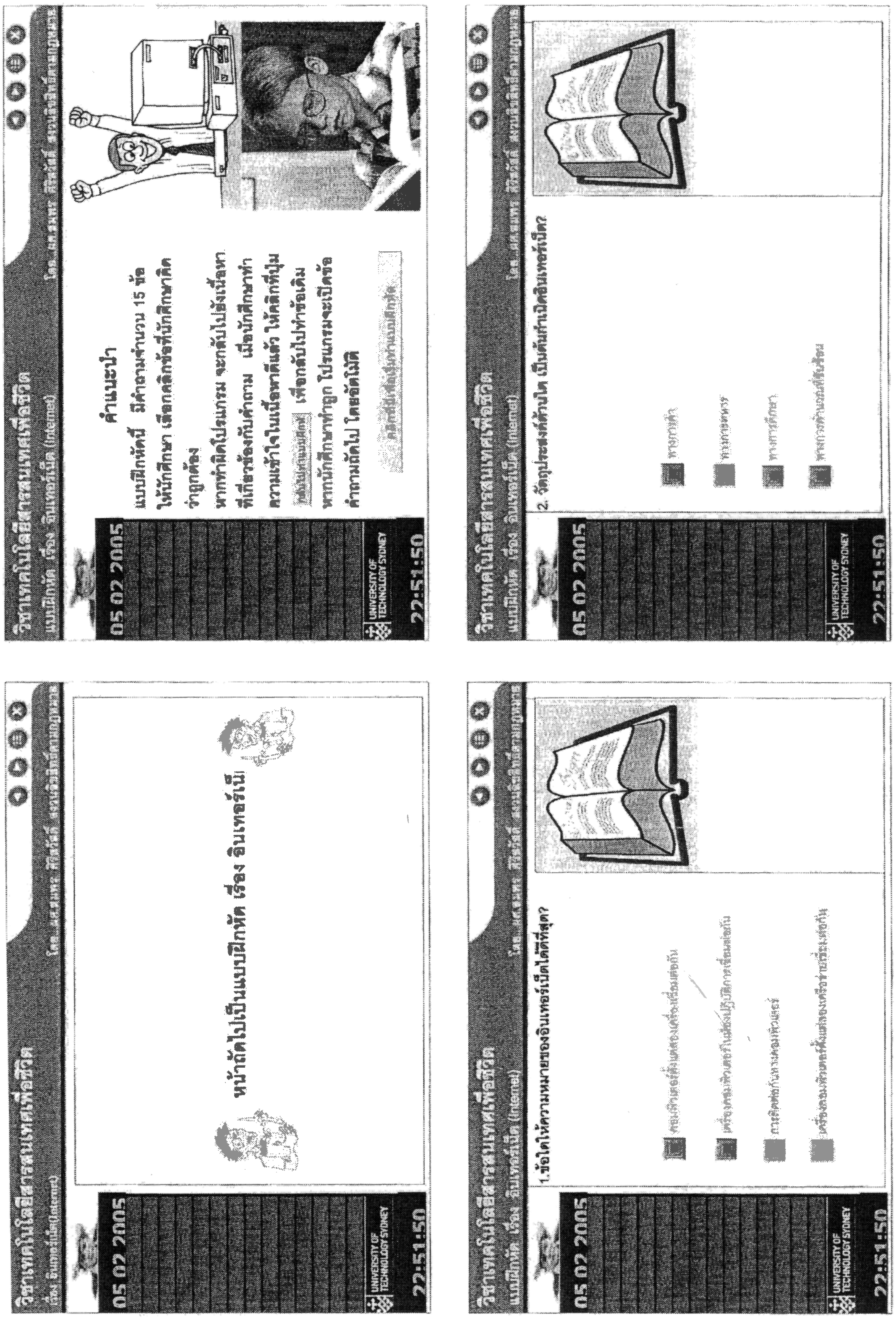

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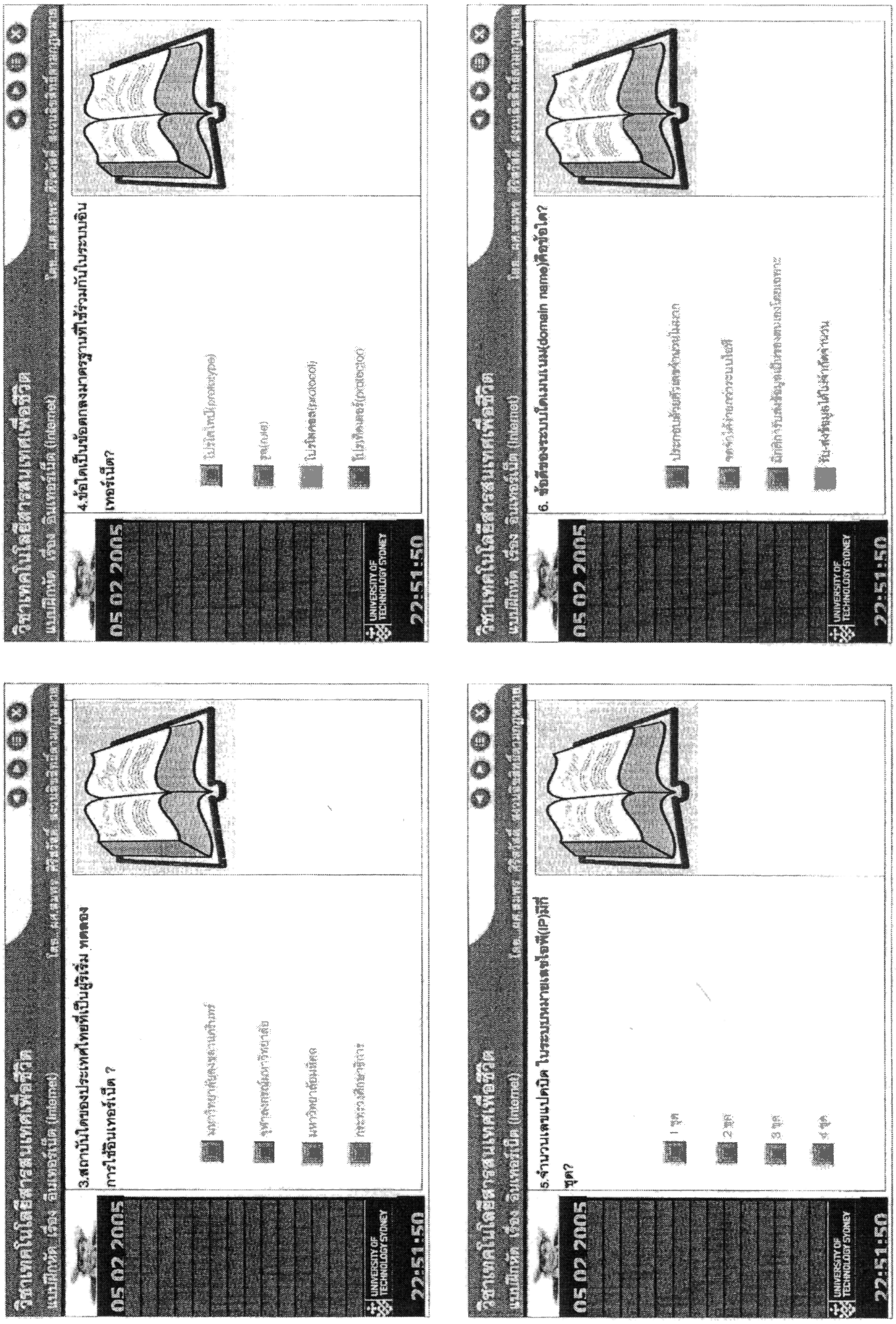

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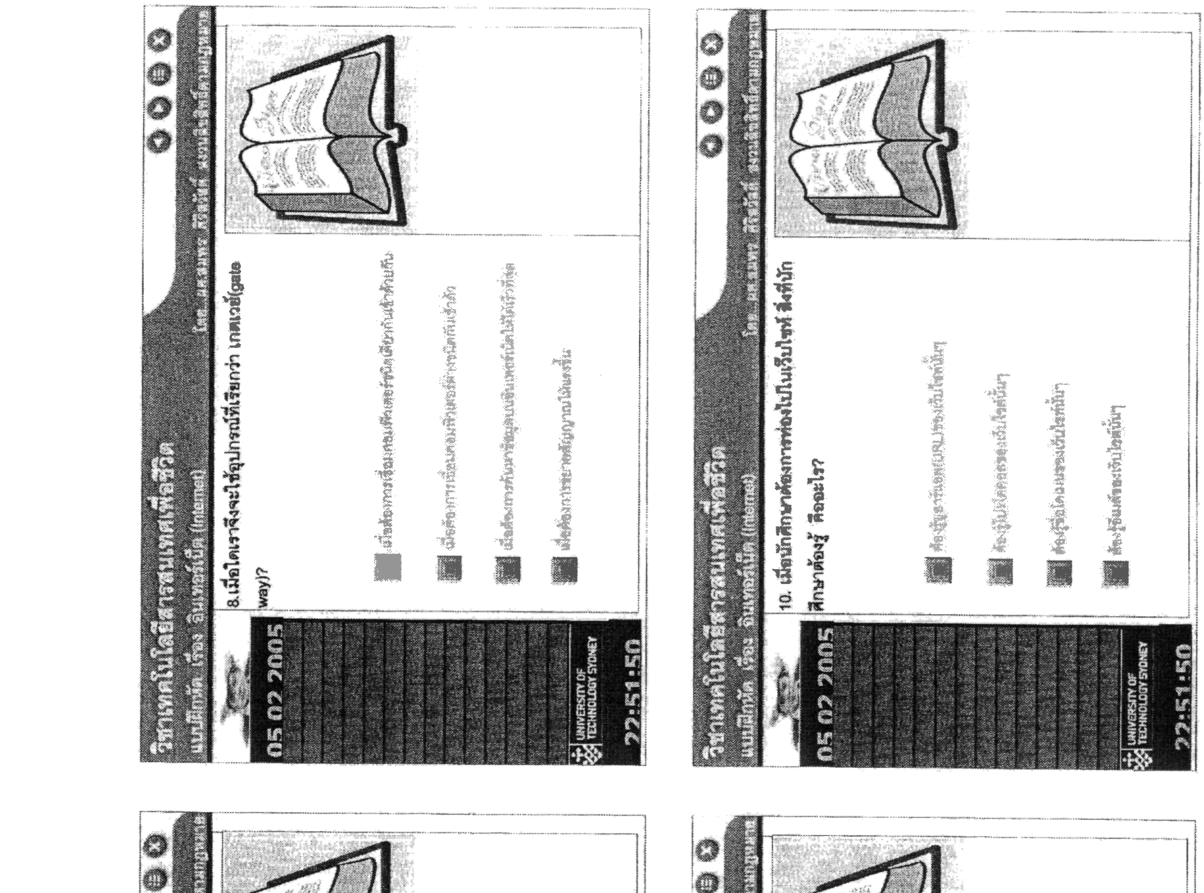

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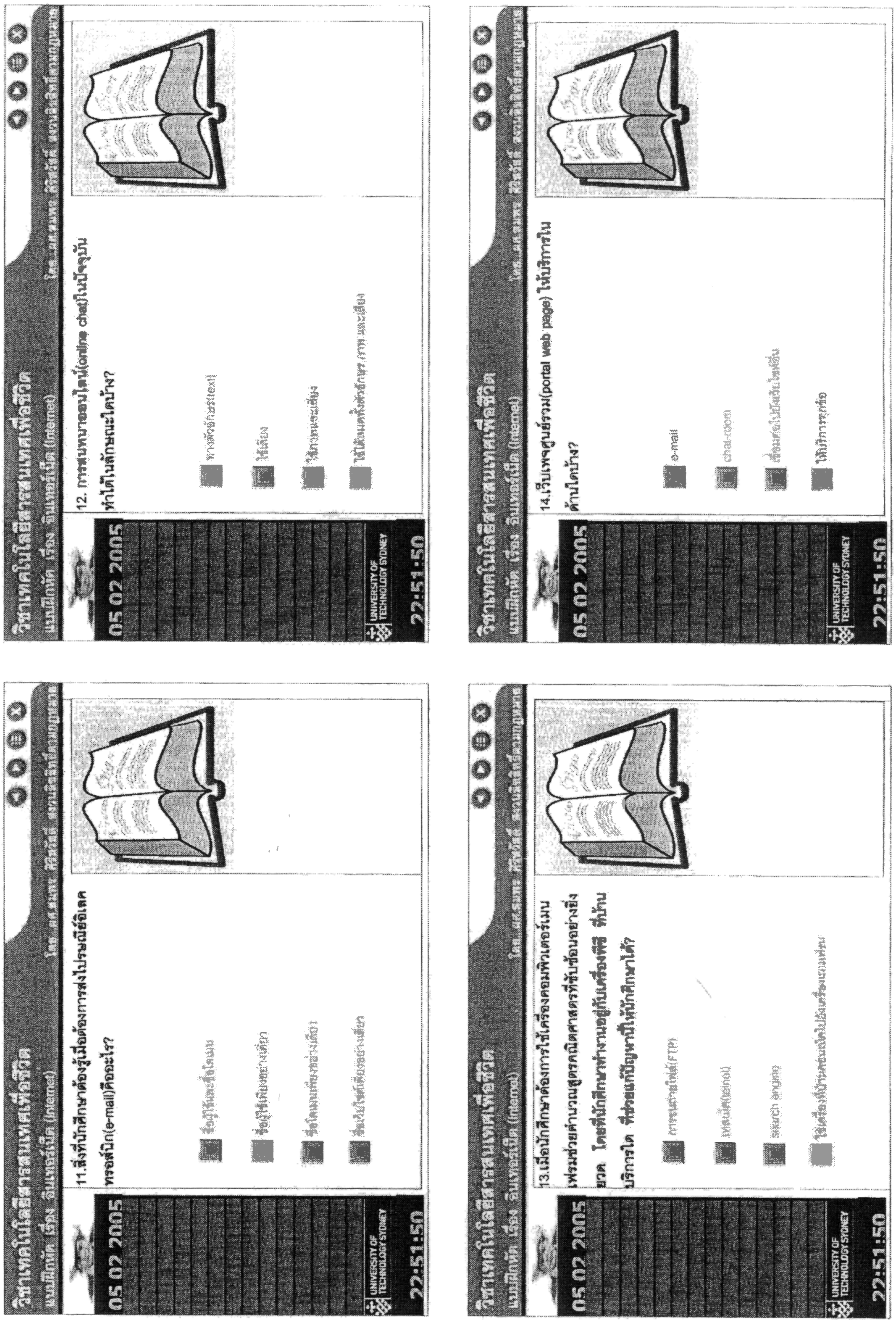

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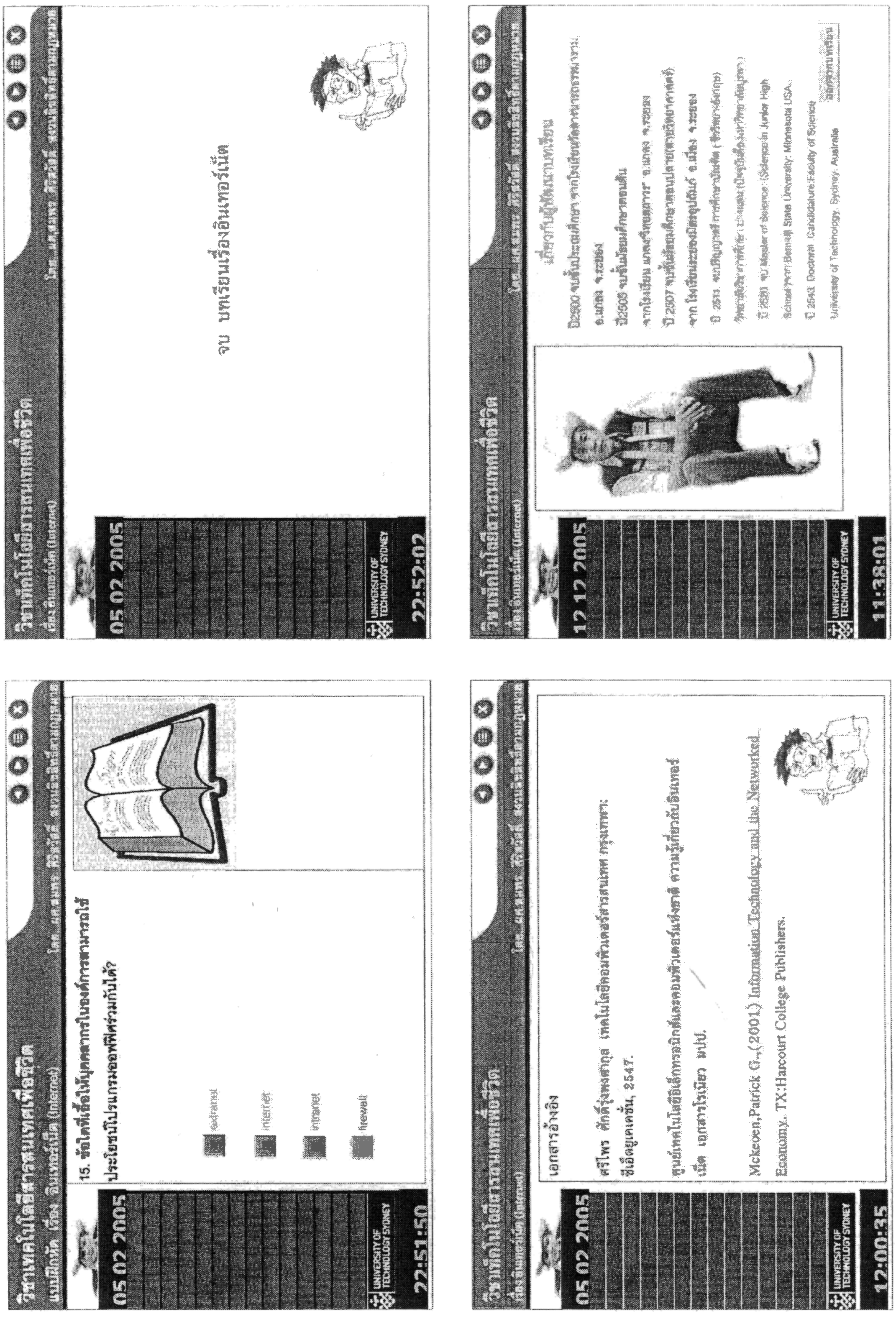

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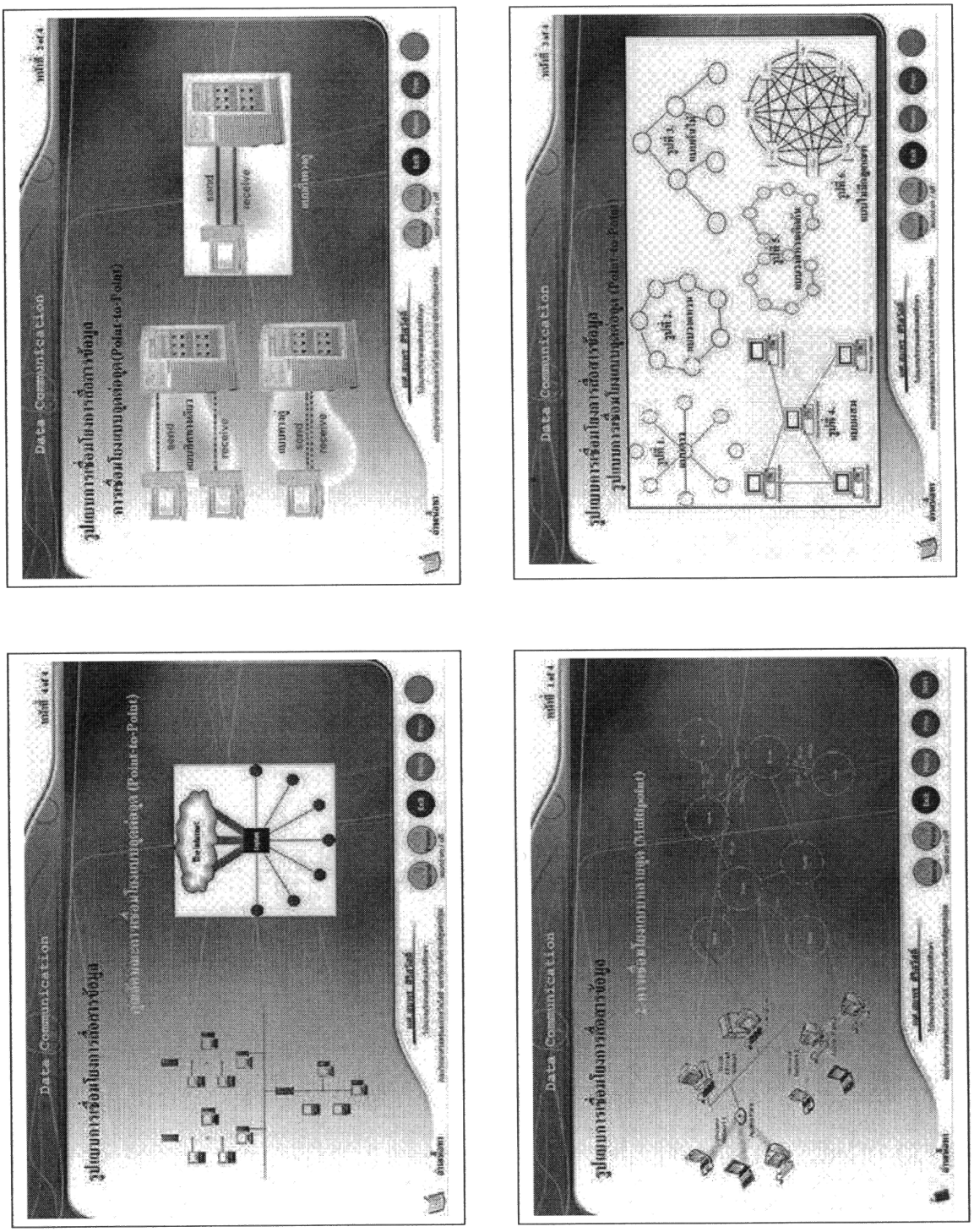
Figure B.30: Data communication.



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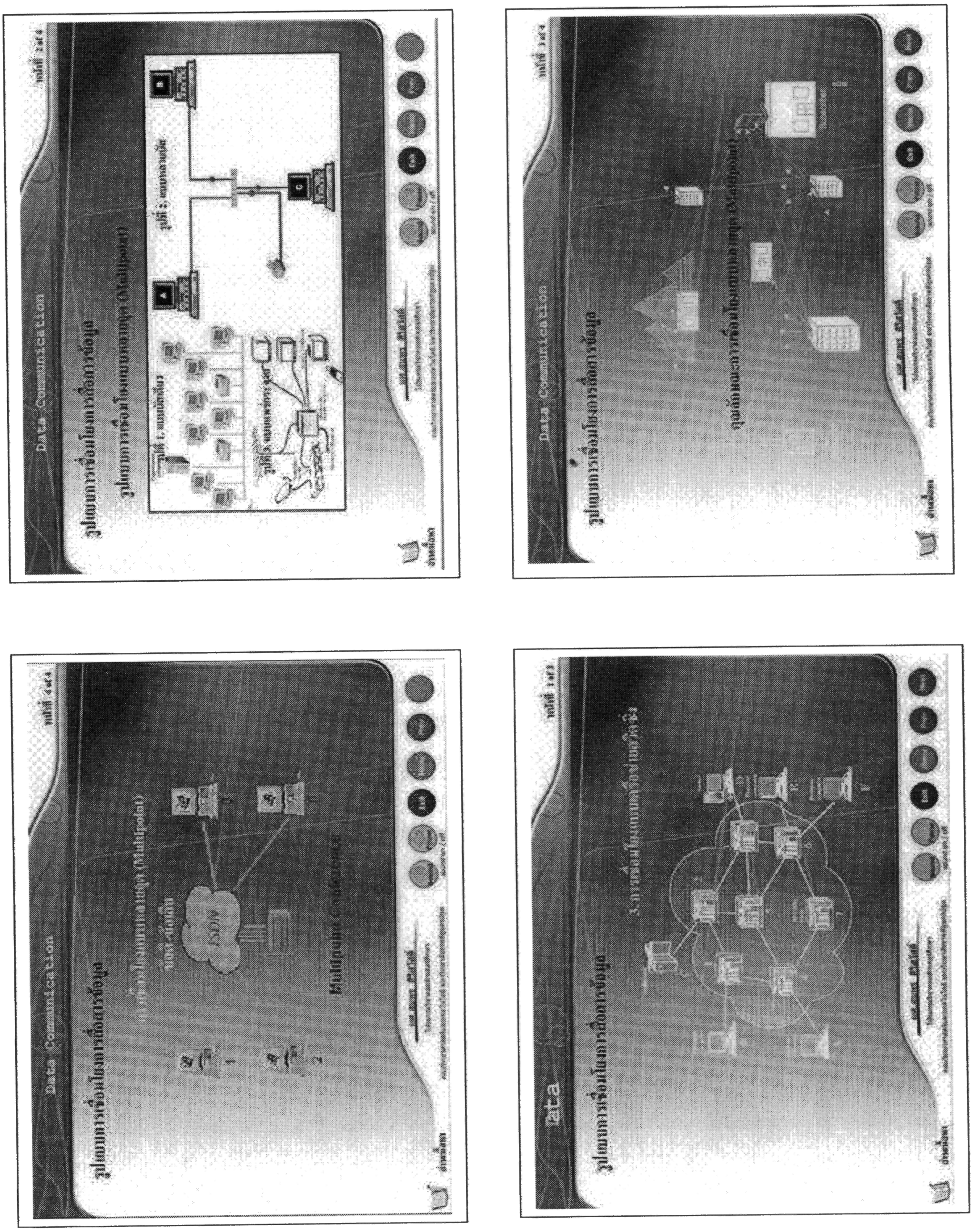

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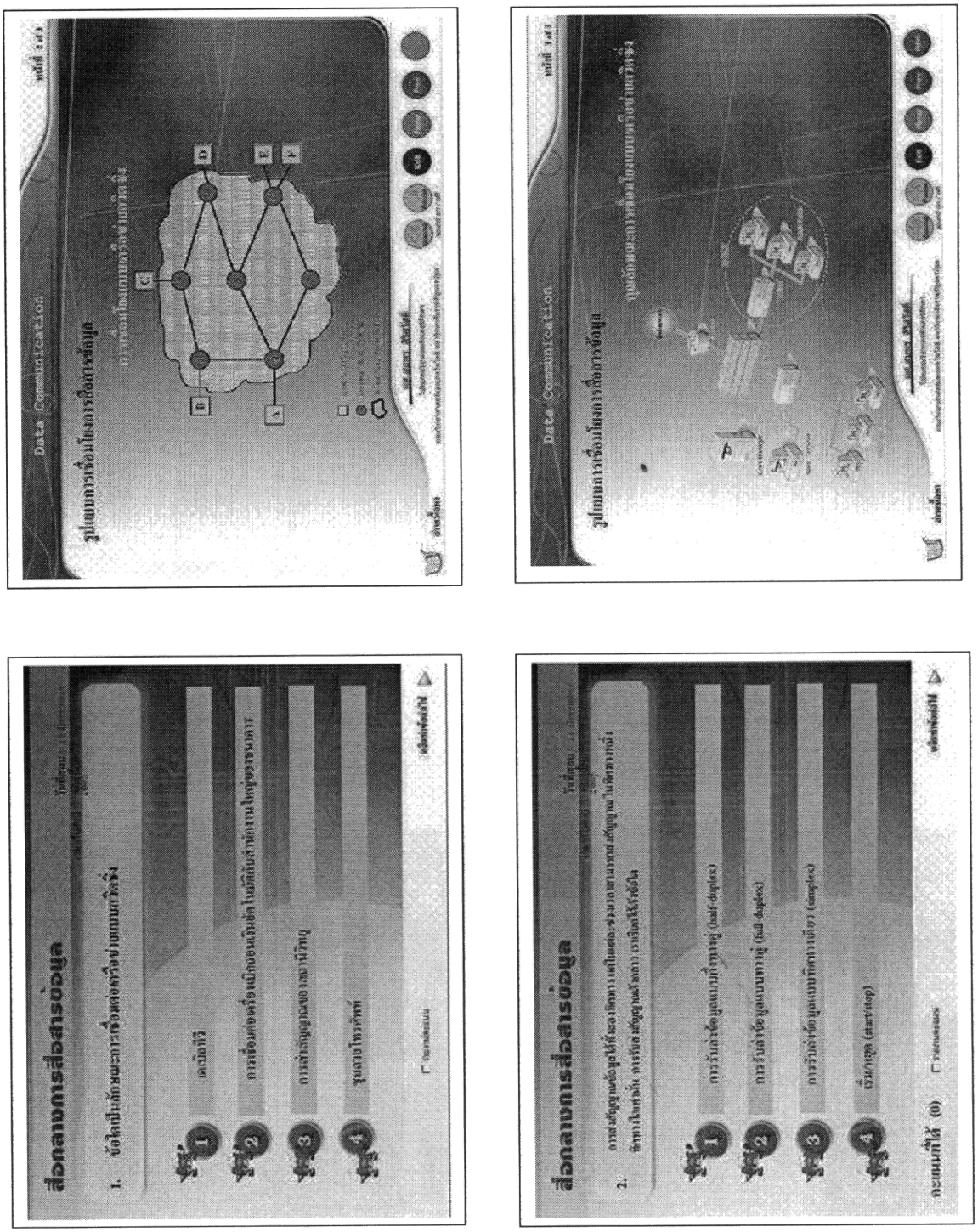

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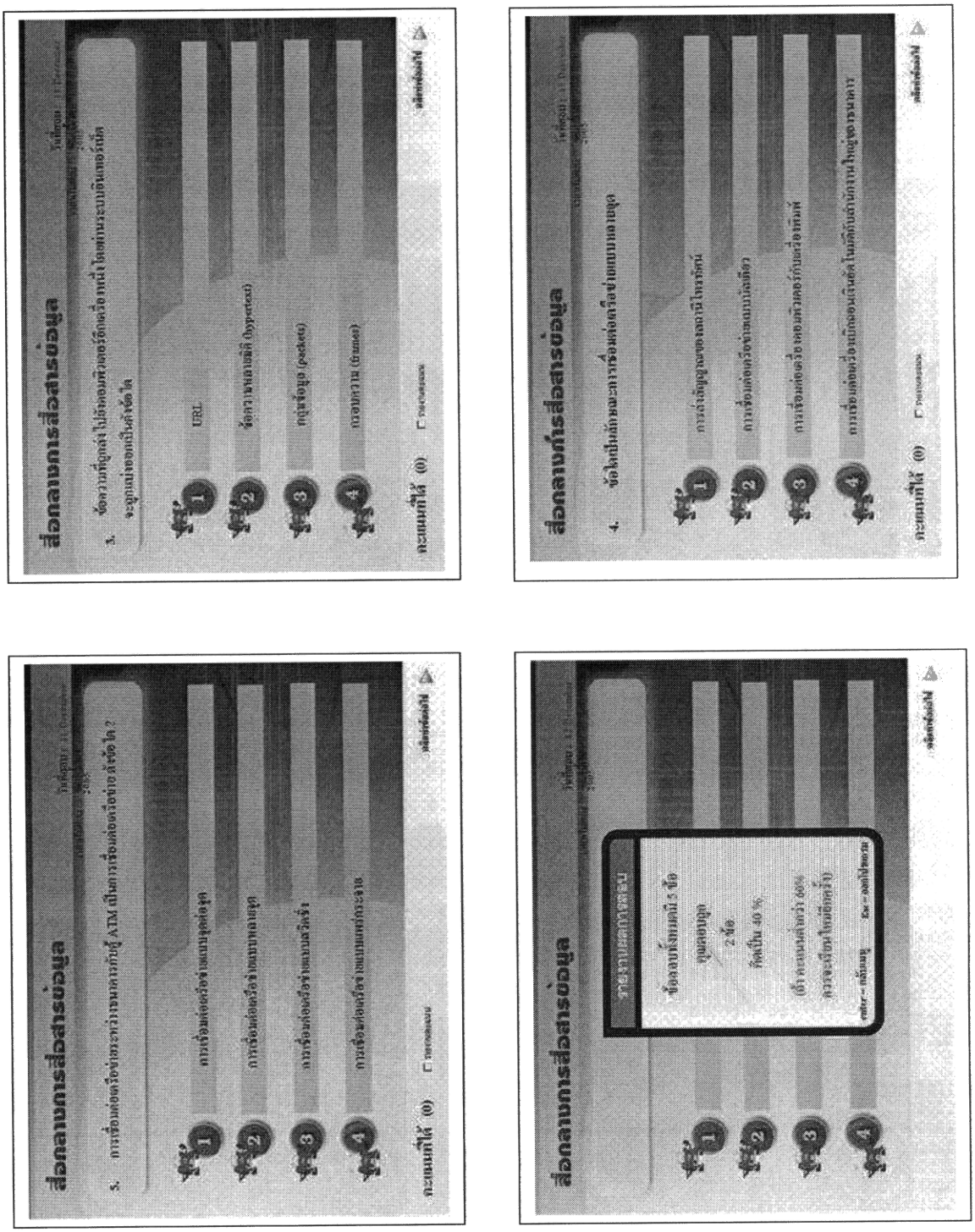

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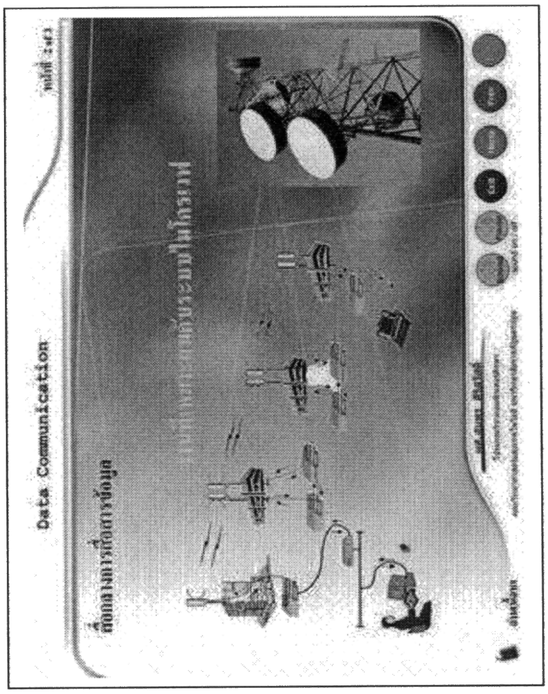
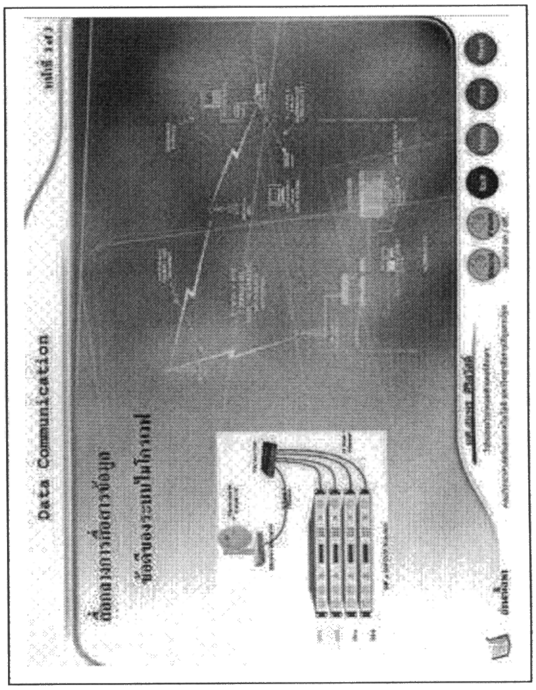
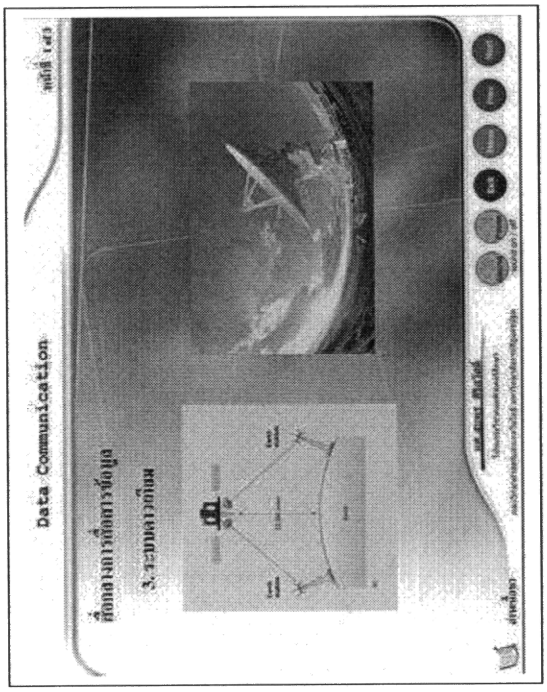






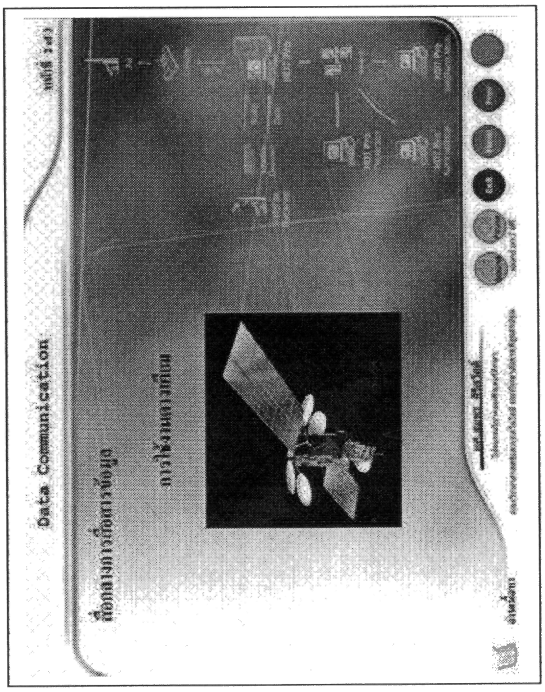
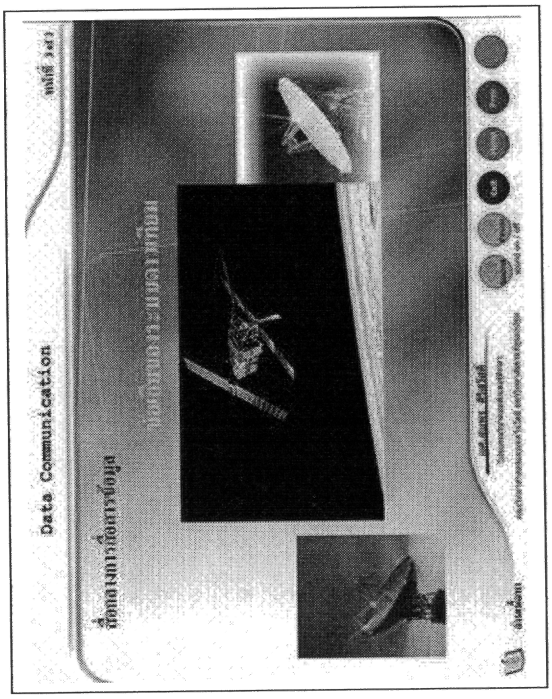
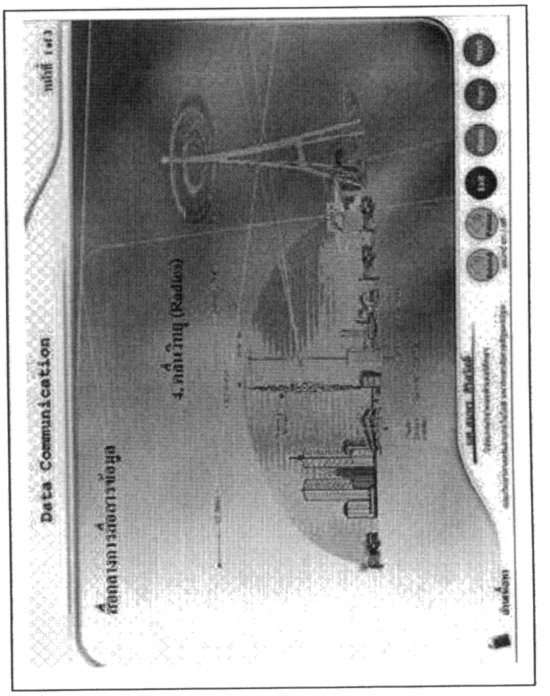
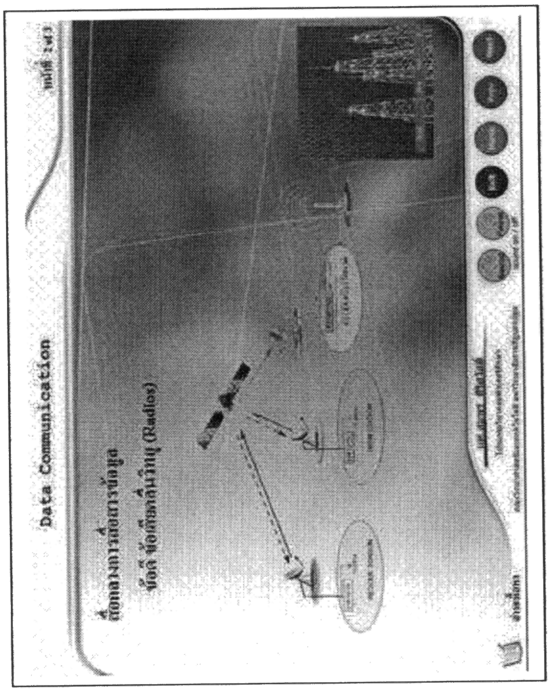


Figure B.35: Data communication (cont.)







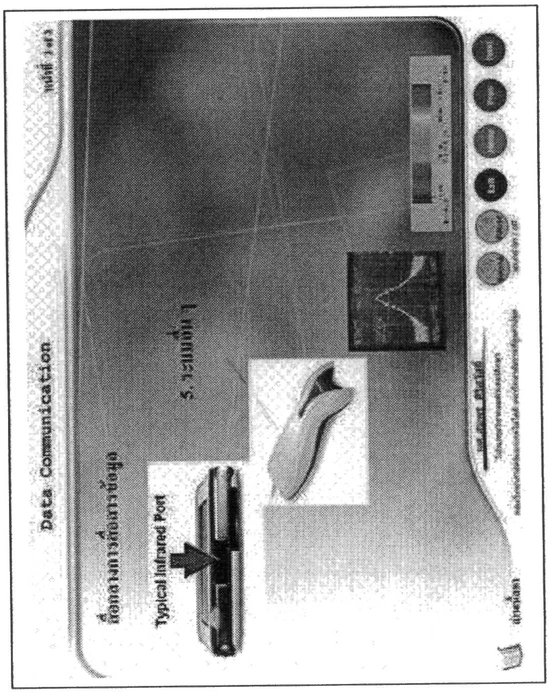


Figure B.36: Data communication (cont.)

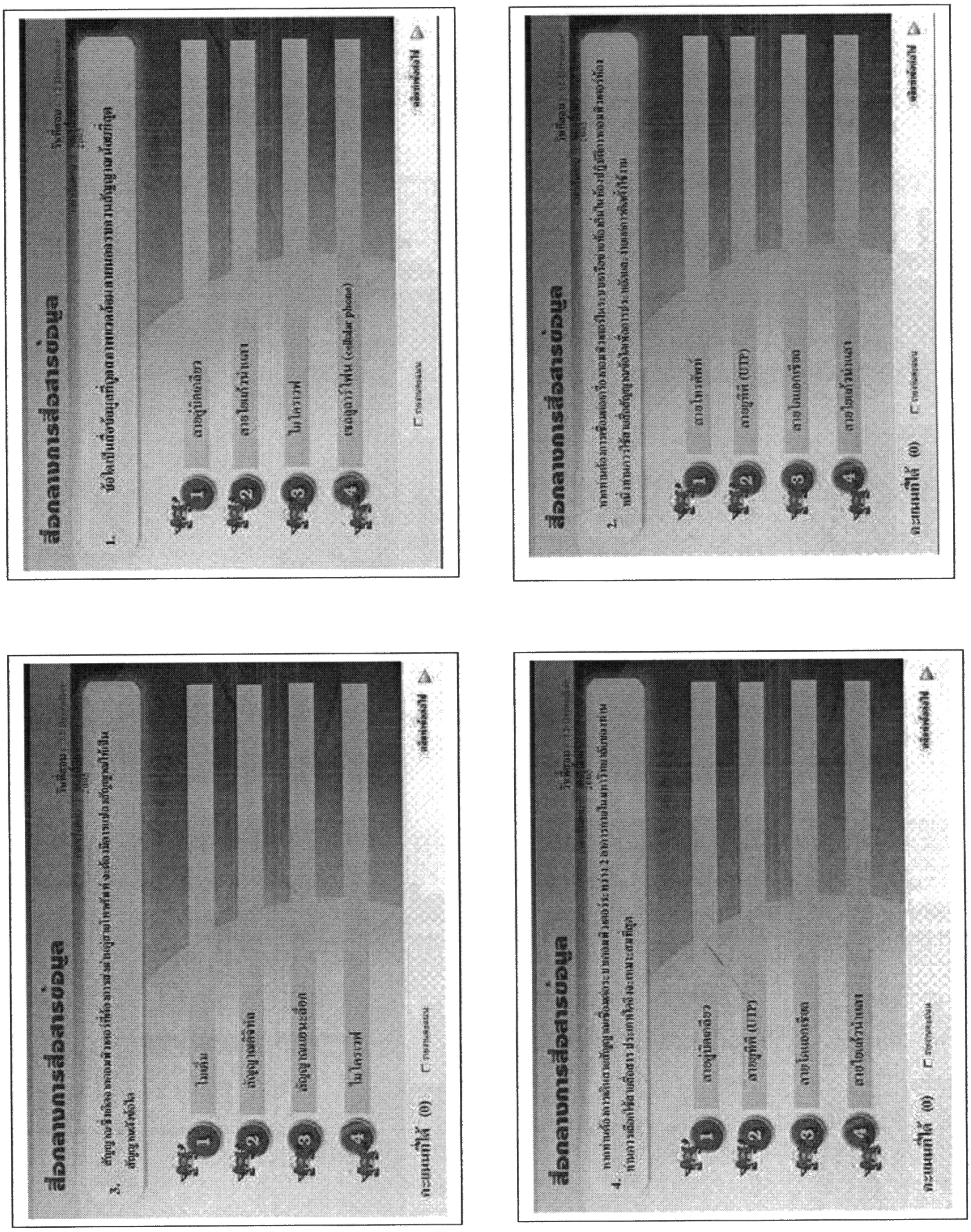
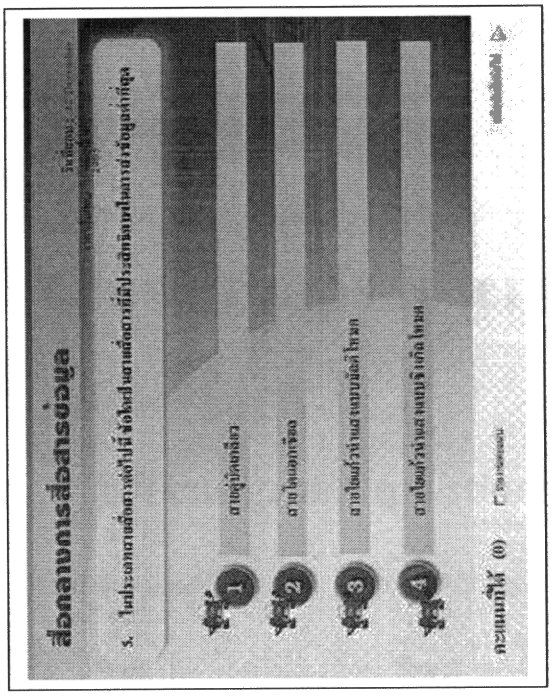
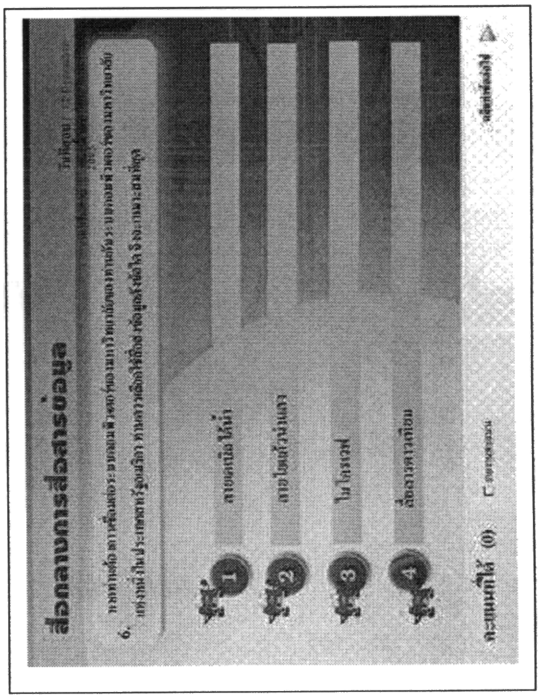


Figure B.37: Data communication (cont.)





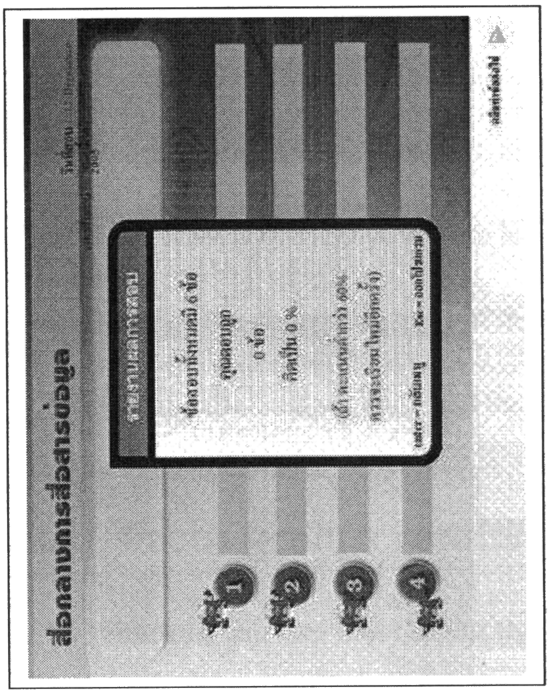


Figure B.38: Data communication (cont.)

Appendix C

Focus groups interviews

C.1 Focus group questions

Questions asked in focus group interviews for the experiments:

1. What did you like most about the CAI course?
2. What did you like least about the CAI course?
3. What is the most valuable thing you learned in this class?
4. What aspects of the lesson were most valuable?
5. What aspects of the lesson were least valuable?
6. Describe the strongest aspect of the CAI methodology.
7. Describe the weakest aspect of the CAI methodology.

C.2 Focus groups results (Experiment 1)

1. **What did you like most about the CAI course?**

   Student 1 I liked the history of computers, computer components; computers are good, they support my learning. I can learn more conveniently, faster and with more understanding.

   Student 2 (laughing) I have no idea.

Student 3 I like it all, we can apply the knowledge to our daily life and work.

Student 4 I like computer components and types of computers.

Student 5 Deep in content.

Student 6 Good, convenient for learning.

Student 7 Good.

2. **What did you like least about the CAI course?**

Student 1 CD-ROM, none.

Student 2 May be none.

Student 3 None of them.

Student 4 None of them.

Student 5 None of them.

Student 6 None of them.

Student 7 None of them.

3. **What is the most valuable thing you learned in this class?**

Student 1 About computer operation, knowing this can be used in work.

Student 2 Learning with CAI can apply to work in daily life. I have learned what computers can do. If I finish my studies, I will use computers at work. I developed skills in using computers and gained more knowledge.

Student 3 I had a chance to learn by myself, and know how to operate a computer.

Student 4 I don't know what to say.

Student 5 I don't know what to say.

Student 6 I don't know what to say.

Student 7 I don't know what to say.

4. **What aspects of the lesson were most valuable?**

Student 1 Parts of computer, computer operation.

Student 2 Computer components and function.

Student 3 Computer components and computers'devices.

Student 4 Known types of computer.

Student 5 Don't know what to say.

Student 6 Don't know what to say.

Student 7 Don't know what to say.

5. **What aspects of the lesson were least valuable?**

Student 1 None were least valuable. Every topic is important.

Student 2 I can not recall.

Student 3 All topics were equally important.

Student 4 None of them, content is important.

Student 5 I have no idea.

Student 6 I have no idea.

Student 7 I have no idea.

6. **Describe the strongest aspect of the CAI methodology.**

Student 1 We can apply it for daily life, such as printing out reports. In self study students must be determined to learn, if they aren't they will not understand. Students must have responsibility.

Student 2 It seems that learning by ourselves students have more responsibility. Students pay more attention to learning. With an instructor teaching in front of the class we can choose to learn or not to learn. Self study produces more knowledge.

Student 3 I have learned how to study by myself. It is better than an instructor teaching because with CAI if students don't pay attention they will not learn anything.

Student 4 Increase student's responsibility. More interested in learning.

Student 5 More responsibility, more eager to learn than traditional teaching.

Student 6 Don't know how to explain.

Student 7 Don't know how to explain.

7. **Describe the weakest aspect of the CAI methodology.**

Student 1 If we do not understand, we can not do it.

Student 2 Some students who do not want to learn may skip the lesson and do other activities like browsing the internet.

Student 3 Should give more detail in difficult topics.

Student 4 Students can be faced with some difficult parts of the lesson, because of difficult language and insufficient detail.

Student 5 No comment.

Student 6 No comment.

Student 7 No comment.

8. **Open-ended session**

Student 1 Good, students gained more responsibility, and learned more content. Learning with CAI students had to pay more attention.

Student 2 Students increased their responsibility. Instructor teaching makes students bored, they may fall asleep in class. Learning with CAI, students pay more attention; this methodology is good. I think it is good.

Student 3 Good, CAI lesson increased my friends' attention. They were eager to learn, they really wanted to know what is in the CAI lessons. They got to touch and play around with the computers.

Student 4 Different from instructor teaching, where students may play up and chat while class is going on. But learning with CAI, if students do not pay attention they will get nothing. Learning with CAI, students have to learn by themselves, which is different from traditional teaching where an instructor will tell you what to think and students have to follow the instructor's ideas. But learning with CAI students have to think on their own.

Student 5 Learning with CAI is probably better than traditional learning, because students have to behave themselves. In a class with an instructor students learn less content because they are talking while they are learning. Learning with

an instructor, he will always tell you how to solve the problem. Learning with CAI students have to make their own decisions and solve their own problems.

Student 6 Learning with CAI the students learned more contents. Students felt they wanted to learn and were eager to learn. Learning with an instructor, students lack eagerness to learn and do not have a chance to investigate for themselves; they just sit and listen to what the instructor says.

Student 7 Learning with CAI is good, it made me learn more contents. It is good because I can learn by myself and learn more (laugh). Good, student's responsibility was increased.

C.3 Focus groups results (Experiment 2)

1. **What did you like most about the CAI course?**

Student 1 I liked to learn how to construct web sites.

Student 2 I have learnt how to send and receive email and about using passwords.

Student 3 I have learnt the meaning of email and web sites.

Student 4 I like everything. I got a lot of information. I have learnt by myself. I would like to have handout sheets for students for revision.

Student 5 Same as my friends have mentioned, my friends have covered everything. I have learnt how to search for knowledge on the Internet and there is no need to go to the library.

Student 6 I have gained more knowledge. Should have revision sheets for students. I was writing notes from the screen and there wasn't time to learn.

Student 7 I have learnt that the Internet is valuable for many things, such as education and research.

2. **What did you like least about the CAI course?**

Student 1 I don't like history of the Internet.

Student 2 I prefer to have an instructor teach, I don't like studying by myself (alone).

Student 3 Study time too short for self-study. Time was spent writing notes; need handouts.

Student 4 Same as my friends, less time, cannot take note within the given time.

Student 5 Same as my friends. Not enough time to take notes within given time. Have to rush to take notes when I watch the monitor.

Student 6 The same. I want handouts, books or notes. My hand got tired when taking notes.

Student 7 Should print out sheets and give them to students. Instructor should interrupt every now and again to explain things while the lesson on the computer is going on.

3. **What is the most valuable thing you learned in this class?**

Student 1 Knowledge of how to send email, capable of sending email overseas. I didn't know how to send email before, after studying with CAI I now know.

Student 2 Same as my friends, I have learnt how to apply for an email account.

Student 3 I learnt to use the Internet. I can apply this when I have to do a report and submit it to my instructor. I will be able to search for information by myself.

Student 4 Same as my friends. I am able to find information on the Internet and I can do my report in order to submit it to my instructor.

Student 5 I have learnt about job seeking. Using the Internet we can find and apply for jobs as we wish.

Student 6 Regarding jobs, I have learned that there are sites with a lot of jobs in the same place.

Student 7 About e-commerce, email, chat and education etc.

4. **What aspects of the lesson were most valuable?**

Student 1 Colourful, contained sound, motivated students' enthusiasm to learn. Learning by reading a book may cause students to feel sleepy.

Student 2 Over all completely good. Relevant. This can not be done by reading a book.

Student 3 Over all, Good.

Student 4 Don't know what to say.

Student 5 Don't know what to say.

Student 6 Don't know what to say.

Student 7 Don't know what to say.

5. **What aspects of the lesson were least valuable?**

Student 1 Over all is good, but not enough time.

Student 2 Over all is good, self study offers the opportunity to revise. Reading book we can not practice.

Student 3 None of them.

Student 4 None of them.

Student 5 None of them.

Student 6 Same as my friends, None of them.

Student 7 None of them, as well.

6. **Describe the strongest aspect of the CAI methodology.**

Student 1 Good, very good. I have practised. I know how to send an email.

Student 2 Learn by ourselves, self-study, and no need to learn from a book.

Student 3 Colourful, motivating, made me more interested in learning.

Student 4 Feel free to learn, study and develop understanding myself, reading myself. No need to learn from books or an instructor.

Student 5 Good, it's free. Practice thinking and understanding by myself.

Student 6 Comfortable. If someday we can not come to class we can learn from a CD-ROM.

Student 7 Studying by myself is better than reading books. Figures and sound (in CAI) made me understand better than reading books or learning with an instructor.

7. **Describe the weakest aspect of the CAI methodology.**

Student 1 Some parts of the content contained not enough explanation.

Student 2 Too little time, need handouts. Should have a handbook for students.

Student 3 None of them.

Student 4 Every thing is good.

Student 5 Over all is completely good.

Student 6 None of them.

Student 7 None of them, over all is good.

8. **Open-ended session**

Student 1 This learning style is very good, students will pay more attention to their learning and not feel sleepy.

Student 2 Made me know how to learn by my self.

Student 3 I have learnt about the history of the Internet. I was able to use the CAI lessons my self; practising this way is better than reading books.

Student 4 Encourages students to know, to see, to proceed and to find out about the contents.

Student 5 Freedom to learn; more enthusiastic than with an instructor teaching. Because students keep talking while an instructor is teaching, they do not attempt to learn. Learning with CAI, students have to think, read, and take notes by themselves. This can make them learn and gain knowledge.

Student 6 Made me able to access the Internet, learn more about the topics and opened up the world.

Student 7 Made us familiar with computers, and to gain more skill in using computers.

C.4 Focus groups results (Experiment 3)

1. **What did you like most about the CAI course?**

Student 1 I wasn't anxious or uptight, because there was no instructor involved. We can play around with the computer, it is interesting.

Student 2 I like microwave communication systems. It is interesting, high frequency. Before this class I did not quite understand, but after the class I understand.

Student 3 I like it, it is good practice for students to work with a computer.

Student 4 I like it, learning myself. I took notes to be able to revise the lesson.

Student 5 I liked the figures and pictures presented in the lesson. This made it more meaningful and more interesting.

Student 6 It is not boring. The diagrams, pictures and sound contained in the lesson made it interesting.

Student 7 It is not boring. If it was taught by an instructor the contents would be plain and may have caused students to feel sleepy. This is self study.

2. **What did you like least about the CAI course?**

Student 1 Too much contents. I had to take a lot of notes. Should state only important parts.

Student 2 Too much contents, I had to take notes a lot.

Student 3 Too much contents. I didn't quite understand the CAI figures (too wide) should have more details.

Student 4 Contents is boring. Complicated navigation. Some student don't know how to navigate properly and end up skipping some content unintentionally.

Student 5 Confusing navigation. Sometimes jump over pages and sometimes don't have enough time to take notes.

Student 6 Too much contents, not enough time.

Student 7 The same. Too much contents. If I want to summarise I have to read everything, but there is not enough time given. Appropriate time should be longer, but if there is too much time then it is boring.

3. **What is the most valuable thing you learned in this class?**

Student 1 I have gained more knowledge than when learning with an instructor. I get more when I learn by myself.

Student 2 (laugh) I am free, if we were with an instructor we have to learn what he teaches, but learning with CAI we can jump back and forth as we wish.

Student 3 Practise learning by ourselves, no instructor to teach, thinking by ourselves, looking by ourselves, opening pages ourselves. I have gained knowledge about data communication.

Student 4 Before I knew a little bit, but I know more after this lesson. I have gained the skills for using a computer. I have freedom of learning. Graphics in CAI lesson made me more interested in the lesson. I now know what the new technology is.

Student 5 I have practised to finish my notes in time. I have read and revised. I have practised computer skills such as clicking to search for information and website navigation.

Student 6 I have benefited from reading, thinking, writing and summarizing the notes.

Student 7 Interesting, I can play around with a computer. I have learnt a lot of things and was able to choose topics in the order I liked.

4. **What aspects of the lesson were most valuable?**

Student 1 Satellite system sending information covers the whole world, I have increased my knowledge from before.

Student 2 Radio system can send information in every direction. I can not remember other uses.

Student 3 With the Internet we can chat with friends. Lessons contain sound, different from books.

Student 4 Satellite communications help us received up-to-date news. Reading a book can cause sleepiness, but learning with CAI is interesting because of its graphics and sound.

Student 5 Using satellites, we can catch up with things going on around the world.

Student 6 Regarding communication devices such as fibre optics, I now know each device's properties and which is most appropriate to use in different circumstances. I know the cost of those devices.

Student 7 With satellites, we can receive news from around the world.

5. **What aspects of the lesson were least valuable?**

Student 1 None of them, they are all useful.

Student 2 None of them.

Student 3 None of them, as well. The objective page and introduction page are not necessary, there is no need to have them. I didn't pay any attention to these pages because in fact we have to learn anyway.

Student 4 None of them.

Student 5 None of them.

Student 6 None of them.

Student 7 None of them.

6. **Describe the strongest aspect of the CAI methodology.**

Student 1 More interesting than reading books. Learning with a traditional class is boring. CAI is better because it is composed of figures and sound, and is more interesting.

Student 2 Best in content, because it is already summarised. Do not waste time reading a thick book.

Student 3 Included sound made CAI more interesting.

Student 4 Brief contents, easy to read and easy to understand.

Student 5 Student who do not like to read can listen to CAI lessons.

Student 6 Easy to learn, because of the graphics figures.

Student 7 Good brief contents. Sound made it easy for me to understand.

7. **Describe the weakest aspect of the CAI methodology.**

Student 1 I think, none of them.

Student 2 None of them.

Student 3 Some computers did not work properly. It is up to the learner. No weakest point in the CAI lesson.

Student 4 I would like to see one topic on one page, then there would be no need to turn over to other pages. It is confusing.

Student 5 None of them.

Student 6 None of them. I would like to have another CAI course ike this, I like it.

Student 7 I could understand it well; no weakest point on CAI methodology.

8. **Open-ended session**

Student 1 I want to learn with CAI again, I do not want to learn by instructor teaching as it is boring. This style of learning is self study, it's fun.

Student 2 Learning with CAI is fun, better than an instructor teaching. We can practice our understanding, we have to do our self practice and take responsibility for our work.

Student 3 I understand what I have learned, we have to employ our own ability. If we do not want to learn, we will not understand. Learning with an instructor teaching is sometimes boring because we have to sit and listen all the time. But learning with CAI I sometimes have a chance to talk to my friends. I have freedom.

Student 4 Contents is completely perfect, but should have more figures, especially in small details. I feel anxious when learning with an instructor. I feel stressed when learning with an instructor, but learning with CAI made me happy and it was fun.

Student 5 I would like to have this kind of class take place more and more. CAI lessons made students gain more responsibility. I wish other courses could have CAI lessons.

Student 6 CAI is a good learning method. It gives students practice in paying attention to learn and they learn more; it is much better than sitting and listening to an instructor. It's boring if an instructor keeps telling students what he has read from books. Some students might fall asleep. Learning with CAI, if students do not make enough effort, they cannot learn. This lesson motivated students to learn.

Student 7 I want to see learning by CAI take place again, because it is not boring. Students can spend their time efficiently. Students gained more responsibility and were eager to learn because of audio and graphics in the CAI lessons.

Appendix D

Test items

หมายเลขข้อสอบ.....

แบบทดสอบเรื่อง องค์ประกอบของเครื่องคอมพิวเตอร์และการทำงาน จำนวน 30 ข้อ เวลา 25 นาที

1. ข้อใดเป็นอุปกรณ์อิเลคทรอนิกส์ ที่สามารถ นำเข้าข้อมูล ประมวลผลแล้วแสดงผลลัพธ์ที่ได้ ให้เราเห็น

ก. disk drive

ข. printer

ค. computer

ง. system

2. ข้อใดกล่าว ไม่ถูกต้อง

ก. ซุปเปอร์คอมพิวเตอร์เป็นเครื่องคอมพิวเตอร์ที่มีขนาดใหญ่ที่สุด

ข. มินิคอมพิวเตอร์ มีขนดเล็กกว่าไมโครคอมพิวเตอร์

ค. เมนเฟรมคอมพิวเตอร์ มีขนาดใหญ่กว่าไมโครคอมพิวเตอร์

ง. มินิคอมพิวเตอร์มีขนาดเล็กกว่าเมนเฟรมคอมพิวเตอร์

3. คอมพิวเตอร์ชนิดใด ที่ใช้ในการพยากรณ์อากาศ

ก. ไมโครคอมพิวเตอร์

ข. มินิคอมพิวเตอร์

ค. เมนเฟรม

ง. ซุปเปอร์คอมพิวเตอร์

4. ข้อใดที่เป็นเครื่องคอมพิวเตอร์ที่ ส่งอีเมล์ได้ พกพาสะดวก แต่ป้อนข้อมูลได้ช้า และไม่มีแป้นพิมพ์

ก. โน้ตบุ๊ก(notebook)

ข. แล็บท็อป(laptop)

ค. พีดีเอ (PDA)

ง. คอมพิวเตอร์ชนิดฝังตัว (embedded computer)

5. เมื่อต้องการให้เครื่องคอมพิวเตอร์ เปรียบเทียบลายมือ ในบัตรประชาชน smart card แบบใหม่ของไทย ท่านคิดว่า ส่วนใดเป็นส่วนสำคัญที่สุด ที่ต้องเกี่ยวข้องในเรื่องนี้

ก. input unit

ข. control unit

ค. central processing unit

ง. output unit

6. ส่วนใดของเครื่องคอมพิวเตอร์ ที่ต้องทำหน้าที่เป็นลำดับแรก ในขณะใช้งาน

ก. input unit

ข. control unit

ค. central processing unit

ง. output unit

7. เมื่อหน่วยรับข้อมูล นำข้อมูลเข้ามาในเครื่องคอมพิวเตอร์แล้ว ต่อจากนั้น ข้อมูลจะถูกส่งไปยัง ณ ที่ใด

ก. หน่วยคำนวณและตรรกะ

ข. หน่วยความจำ

ค. หน่วยประมวลผลกลาง

ง. หน่วยควบคุม

8. ข้อใด คือหน่วยความจำหลัก

ก. floppy disk

ข. hard disk

ค. ROM

ง. RAM

21. ข้อใดกล่าวได้ถูกต้องมากที่สุด เกี่ยวกับ storage register

ก. อยู่ในALUทำหน้าที่เก็บข้อมูลที่จะใช้ในการประมวลผล

ข. อยู่ใน control unit ทำหน้าที่เก็บผลลัพธ์ ที่ได้จากการคำนวณ

ค. อยู่ใน CPU ทำหน้าที่ถอดรหัส แปลคำสั่ง

ง. อยู่ใน CPU ทำหน้าที่เก็บคำสั่ง รอการประมวลผล

22. คำสั่งที่รอเพื่อจะนำไปประมวลผล จะถูกเก็บไว้ที่ใด

ก. storage register

ข. memory unit

ค. instruction register

ง. arithmetic unit

23. ข้อใดเป็นภาษาที่เครื่องคอมพิวเตอร์ไม่ต้องแปล

ก. machine language

ข. assembly language

ค. high level language

ง. BASIC

24. ส่วนประกอบในข้อใดที่เก็บข้อมูลได้สูงสุด

ก. DVD

ข. CD-ROM

ค. hard disk

ง. removable disk

25. รอบการทำงานใดที่ ไม่ใช่ instruction cycle

ก. การถอดรหัส

ข. การนำผลลัพธ์ไปเก็บ

ค. การหาตำแหน่งของ operand

ง. การหาตำแหน่งของคำสั่งถัดไป

26. ส่วนประกอบคอมพิวเตอร์ในข้อใด ที่มีคุณสมบัติ ที่เรียกว่า volatile

ก. แผ่นดิสก์

ข. ฮาร์ดดิสก์

ค. รอม

ง. แรม

27. เหตุใดหน่วยความจำหลัก จึงสามารถทำงานร่วมกับโปรแกรม ที่มีขนาดใหญ่กว่าตัวมันเองได้

ก. เพราะโปรแกรมจะถูกบีบอัดให้เล็กลงกว่าหน่วยความจำหลัก ก่อนที่จะถูกเรียกใช้

ข. เฉพาะส่วนที่จะถูกใช้งานของโปรแกรมเท่านั้น ที่จะถูกนำเข้ามาในหน่วยความจำหลัก

ค. เพราะมีหน่วยเก็บข้อมูลสำรองเป็นตัวช่วย

ง. เป็นไปไม่ได้ ที่โปรแกรมที่มีขนาดใหญ่กว่าจะทำงานกับส่วนที่มีขนาดเล็กกว่าได้

28. แผ่น diskette ที่นักศึกษาใช้ประกอบการเรียนนั้น จัดเป็นส่วนประกอบใด ของคอมพิวเตอร์

ก. input unit

ข. output unit

ค. memory

ง. secondary storage

29. ข้อใด กล่าวไม่ถูกต้อง เกี่ยวกับ แผ่นบันทึก (floppy disk)

ก. พื้นที่ถูกแบ่งออกเป็นส่วนๆ รูปลิ่ม เรียกว่า เซ็คเตอร์ (sector)

ข. พื้นที่ถูกแบ่งออกเป็นกรอบสี่เหลี่ยม(frame) เล็กๆ แต่ละกรอบเก็บข้อมูลได้ 1 ไบท์

ค. แผ่นที่จะต้องนำไปฟอร์แมทก่อน จึงจะใช้ได้

ง. พื้นที่ถูกแบ่งออกเป็นวงๆ แต่ละวงเรียกว่า แทรค (track)

30. เราเรียก แผ่นดิสก์ที่ใช้บันทึก เพลง เสียง ภาพเคลื่อนไหว กราฟิก และ ภาพวีดิโอ ว่าอะไร

ก. CAD/CAM

ข. VCR

ค. VGA

ง. CD-ROM

Figure D.3: Test 1 (cont.)

9. โดยปกติ โปรแกรมที่ใช้งานในเครื่องคอมพิวเตอร์ จะถูกเก็บไว้ ณ ส่วนใด

ก. memory unit

ข. secondary unit

ค. RAM

ง. CPU

10. ส่วนประกอบสำคัญ ของหน่วยประมวลผลกลางคือ

ก. ทรานซิสเตอร์ (transistor)

ข. รีจิสเตอร์ (register)

ค. ชิป (chip)

ง. ไดโอด (diode)

11. หน่วยประมวลผลกลาง ประกอบไปด้วยส่วนต่างๆ ดังนี้

ก. หน่วยคำนวณและหน่วยความจำ

ข. หน่วยความจำและหน่วยตรรกะ

ค. หน่วยคำนวณและหน่วยควบคุม

ง. หน่วยควบคุมและหน่วยความจำ

12. ข้อใด ที่ทำหน้าที่เป็นสื่อกลางระหว่าง ALU กับหน่วยความจำ

ก. หน่วยควบคุม

ข. หน่วยเก็บข้อมูลสำรอง

ค. หน่วยรับข้อมูล

ง. หน่วยแสดงผล

13. หน่วยใด ที่ทำหน้าที่พิจารณาว่า จะทำอะไร กับข้อมูลดี

ก. หน่วยคำนวณ

ข. หน่วยตรรกะ

ค. หน่วยความจำ

ง. หน่วยควบคุม

14. ส่วนใดของเครื่องคอมพิวเตอร์ ที่ทำหน้าที่ในการเปรียบเทียบ เช่น มากกว่า-น้อยกว่า, ใช่-ไม่ใช่, ถูก-ผิด

ก. หน่วยคำนวณ

ข. หน่วยตรรกะ

ค. หน่วยความจำ

ง. หน่วยควบคุม

15. โปรแกรมที่สั่งให้เครื่องคอมพิวเตอร์ทำงานทันที เมื่อเปิดสวิทช์ ถูกเก็บไว้ ณ ที่ใด

ก. หน่วยความจำ (memory)

ข. ฮาร์ดดิสก์ (hard disk)

ค. แรม (RAM)

ง. รอม (ROM)

16. bit คืออะไร

ก. เลขสองหลัก คือ หลักหน่วยกับหลัก สิบ

ข. เลขหลักสอง

ค. จำนวนตัวเลขที่ประกอบกัน 2 ตัว

ง. เลขฐานสอง

17. ข้อใด คือส่วนที่จะบอกกับเครื่องคอมพิวเตอร์ว่า จะให้ทำอะไร

ก. operation code

ข. obstruction code

ค. operandatory

ง. operand

18. จากคำสั่ง ADD A, B ส่วนใดเป็นรหัสปฏิบัติการ

ก. ADD

ข. A

ค. B

ง. A และB

19. register ถูกออกแบบมาเพื่อวัตถุประสงค์ใด

ก. ช่วยในการคูณ กับ หาร

ข. ช่วยในการบวก กับ ลบ

ค. ช่วยในการเปรียบเทียบเชิงตรรกะ

ง. ช่วยให้เครื่องคอมพิวเตอร์ ทำงานได้เร็วขึ้น

20. ส่วนใดที่ เริ่มทำงานเป็นอันดับแรก ในขั้นตอนการประมวลผล

ก. memory

ข. instruction register

ค. control unit

ง. decoder circuit

Figure D.2: Test 1 (cont.)

หมายเลขข้อสอบ.....

แบบทดสอบเรื่อง อินเทอร์เน็ต จำนวน 30 ข้อ เวลา 25 นาที

1. อินเทอร์เน็ต (internet) หมายถึงอะไร

ก. เครือข่ายคอมพิวเตอร์

ข. คอมพิวเตอร์ตั้งแต่สองเครื่องเชื่อมต่อกัน

ค. ระบบเครือข่ายสากล

ง. เครือข่ายคอมพิวเตอร์ตั้งแต่สองเครือข่ายเชื่อมต่อกัน

2. ข้อใดเป็นปัจจัยที่ทำให้เกิดอินเทอร์เน็ต

ก. ปัจจัยทางการแพทย์

ข. ปัจจัยทางการทหาร

ค. ปัจจัยทางการค้าขาย

ง. ปัจจัยทางการศึกษา

3. องค์การที่ควบคุมดูแลมาตรฐานอินเทอร์เน็ตระดับโลกได้แก่ข้อใด

ก. W3C

ข. 3WC

ค. C3W

ง. World Internet Organization (WIO)

4. ข้อใดเป็นองค์การที่ ทำงานเพื่อการวิจัยและการศึกษาเกี่ยวกับอินเทอร์เน็ต

ก. Internet A

ข. Internet B

ค. Internet 2

ง. Internet 3

5.สถาบันใด เริ่มใช้อินเทอร์เน็ตเป็นครั้งแรก ในประเทศไทย

ก. จุฬาลงกรณ์มหาวิทยาลัย

ข. มหาวิทยาลัยมหิดล

ค. มหาวิทยาลัยเกษตรศาสตร์

ง. มหาวิทยาลัยสงขลานครินทร์

6. ระบบเครือข่ายอินเทอร์เน็ตที่ NECTECจัดตั้งขึ้นเมื่อปี พ.ศ. 2535 คือข้อใด

ก. ไทยสาร (ThaiSARN)

ข. ไทยคม (ThaiCom)

ค. ยูนิเน็ต (Uninet)

ง. สคูลเน็ต (Schoolnet)

7. เราเรียกผู้ให้บริการทางอินเทอร์เน็ต ว่าอะไร

ก. ISDN

ข. IP

ค. ISP

ง. USTP

8. ข้อใดที่ไม่เหมาะที่จะสอนด้วยระบบการสอนทางไกล (distance learning)

ก. การสอนการทำวิจัย

ข. การสอนกีฬา

ค. การสอนวรรณคดี

ง. การสอนคณิตศาสตร์

9. หมายเลข IP ขนาด 8 bit เก็บค่าเลขฐานสองได้กี่ค่า

ก. 255

ข. 256

ค. 257

ง. 258

10. จากตัวอย่าง sc.npru.ac.th ข้อใด คือชื่อโดเมนย่อยในระดับโดเมน

ก. sc

ข. npru

ค. ac

ง. th

1

Figure D.4: Test 2.

11. จากตัวอย่าง com1.ait.or.th ข้อใดคือเครือข่ายท้องถิ่น

ก. com1

ข. ait

ค. or

ง. th

12. ชื่อใดเป็นองค์การไม่แสวงหากำไร

ก. com

ข. gov

ค. org

ง. mil

13. ข้อใดที่หมายถึง สถาบันการศึกษา ในระบบชื่อโดเมนของไทย

ก. edu

ข. net

ค. or

ง. ac

14.ถ้านักศึกษาต้องการรับส่งข้อมูลได้รวดเร็ว และมีความน่าเชื่อถือสูง นักศึกษาควรเลือกการเชื่อมต่อกับระบบอินเทอร์เน็ตในข้อใด

ก. เชื่อมต่อผ่านโมเด็ม

ข. เชื่อมต่อกับ backbone

ค. เชื่อมต่อผ่านโทรศัพท์

ง. เชื่อมต่อกับ lease line

15. นักศึกษา มีเงินไม่มากนัก แต่จำเป็นต้องใช้อินเทอร์เน็ต นักศึกษาควรเลือกเชื่อมต่อ ระบบอินเทอร์เน็ตแบบใด จึงจะดีที่สุด

ก. เชื่อมต่อกับโครงข่ายหลัก

ข. เชื่อมต่อกับ back bone

ค. เชื่อมต่อกับโทรศัพท์

ง. เชื่อมต่อผ่านเกตเวย์ (gateway)

16. หากนักศึกษามีความจำเป็นต้องใช้สายเชื่อมต่อกับระบบเครือข่าย ที่มีระยะทางไกลเกินกว่ามาตรฐาน นักศึกษาต้องการอุปกรณ์ในข้อใด

ก. บริดจ์ (bridge)

ข. เราน์เตอร์ (rounter)

ค. เกตเวย์ (gateway)

ง. รีพีทเตอร์ (repeater)

17. ไฮเปอร์ลิ้งค์ (hyperlink) คืออะไร

ก. การเชื่อมโยงระหว่างคอมพิวเตอร์ในระบบเครือข่าย

ข. การเชื่อมโยงระหว่างระบบเครือข่าย สองระบบขึ้นไป

ค. การเชื่อมโยงระบบเอกสารบนอินเทอร์เน็ต

ง. การเชื่อมโยงระหว่าง ผู้ใช้อินเทอร์เน็ตกับผู้ให้บริการทางอินเทอร์เน็ต

18. ถ้านักศึกษาต้องการเขียนโปรแกรม สร้างเว็บเพ็จ ขึ้นเอง นักศึกษาจะเลือกข้อใด

ก. http

ข. html

ค. URL

ง. เพจเมกเกอร์ (page maker)

19. เมื่อนักศึกษาต้องการท่องไปใน web site นักศึกษาจะต้องอาศัย ข้อใด

ก. เพ็จเมกเกอร์ (page maker)

ข. ดาวน์โหลดเดอร์ (downloader)

ค. เว็บ บราวซิ่ง (web browsing)

ง. บราวเซอร์ (browser)

20. ข้อใดที่ไม่ใช่โปรแกรม ที่ใช้ท่องไปในโลกของอินเทอร์เน็ต

ก. Microsoft Internet Explorer

ข. Netscape Navigator

ค. msn

ง. ใช่ทุกข้อ

21. ข้อใด ใช้สำหรับค้นหาที่อยู่ของเว็บไซท์

ก. URL

ข. HTTP

ค. HTML

ง. UNDP

2

Figure D.5: Test 2 (cont.)

22. จากตัวอย่าง saijai@burapa.ac.th ข้อใดที่ระบุถึงชื่อเครื่องคอมพิวเตอร์

ก. saijai

ข. @

ค. burapa

ง. ac

23. ข้อใดที่ให้บริการเรื่อง การใช้กล้องวิดีโอ (web cam) เพื่อประกอบการใช้อินเทอร์เน็ต

ก. ไปรษณีย์อิเลคทรอนิกส์ (e-mail)

ข. เทลเน็ต (telnet)

ค. การขนถ่ายไฟล์ (file transfer protocol)

ง. การสนทนาออนไลน์ (online-chat)

24.นักศึกษาอยู่ที่มหาวิทยาลัยราชภัฏนครปฐม แต่ต้องการใช้เครื่องคอมพิวเตอร์ที่มหาวิทยาลัยชิคาโก โดยที่นักศึกษายังอยู่ที่นครปฐม จะต้องใช้บริการในข้อใด

ก. ไปรษณีย์อิเลคทรอนิกส์ (e-mail)

ข. เทลเน็ต (telnet)

ค.การขนถ่ายไฟล์ (file transfer protocol)

ง. การสนทนาออนไลน์ (online-chat)

25. ถ้านักศึกษาต้องการดาวน์โหลด (download)เพลงจากอินเทอร์เน็ต นักศึกษาจะใช้บริการ ในข้อใด

ก. ไปรษณีย์อิเลคทรอนิกส์ (e-mail)

ข. เทลเน็ต (telnet)

ค.การขนถ่ายไฟล์ (file transfer protocol)

ง. บริการค้นหา (search engine)

26. เว็บไซท์ที่ให้บริการ การค้นหา (search engine) และเป็นที่นิยม คือข้อใด

ก. Internet explorer กับ google.com

ข. Netscape Navigator กับ yahoo.com

ค. Internet explorer กับNetscape Navigator

ง. google.com กับ yahoo.com

27. ถ้านักศึกษาเป็นผู้จัดการโรงงาน และต้องการให้ทุกแผนกใช้โปรแกรมประยุกต์ excel ร่วมกัน นักศึกษาจะเลือกใช้ระบบในข้อใด จึงจะประหยัดที่สุด

ก. อินเทอร์เน็ต (internet)

ข. เอ็กซ์ทราเน็ต (extranet)

ค. อินทราเน็ต (intranet)

ง. แลน (LAN)

28.บริษัทแม่ ต้องการติดต่อกับตัวแทนจำหน่าย โดยสิ้นเปลืองค่าใช้จ่าย น้อยที่สุด ควรเลือกใช้ระบบใด

ก. อินเทอร์เน็ต (internet)

ข. เอ็กซ์ทราเน็ต (extranet)

ค. อินทราเน็ต (intranet)

ง. ขายตรง (direct sale)

29. นักศึกษาต้องการใช้เว็บไซท์ ที่ให้บริการหลากหลาย นักศึกษา จะเลือกใช้บริการในข้อใด

ก. portal web page

ข. multi web page

ค. home page

ง. search engine

30.ไฟล์วอลล์ (fire wall) คืออะไร

ก. กำแพงที่สร้างขึ้นมาเพื่อป้องกันอัคคีภัย ให้กับระบบเครือข่าย ขององค์การ

ข. ระบบป้องกันไวรัสคอมพิวเตอร์ ขององค์การ

ค. ระบบตรวจสอบ ผู้ที่จะเข้ามาในระบบเครือข่าย ขององค์การ

ง. ระบบมาตรฐานความแข็งแรง ในการป้องกันโจรกรรม ในองค์การ

3

Figure D.6: Test 2 (cont.)

หมายเลขข้อสอบ.....

แบบทดสอบเรื่อง การสื่อสารข้อมูล จำนวน 30 ข้อ เวลา 25 นาที

1. ข้อใดเป็นองค์ประกอบของการส่งข่าวสาร ที่สมบูรณ์ที่สุด
   - ก. ผู้ส่ง ผู้รับ
   - ข. ผู้ส่ง ผู้รับ ข่าวสาร
   - ค. ผู้รับ สื่อกลาง ข่าวสาร ผู้ส่ง
   - ง. ผู้รับ กติกาการส่ง สื่อกลาง ผู้ส่ง
2. สื่อกลาง (media) ในเรื่องการสื่อสารฯแบ่งออกเป็นกี่ชนิด
   - ก. สื่อที่เป็นโลหะ กับ สื่อที่เป็นของเหลว
   - ข. สื่อที่เป็นของเหลว กับ สื่อที่เป็นอากาศ
   - ค. สื่อที่เป็นอากาศ กับสื่อที่เป็นโลหะ
   - ง. สื่อที่กำหนดเส้นทางกับสื่อที่ไม่กำหนดเส้นทาง
3. ข้อใดคือลักษณะการเชื่อมโยงแบบจุดต่อจุด
   - ก. ไม่จำกัดความยาวของสายสื่อสาร
   - ข. ใช้สื่อสารเฉพาะเสียงเท่านั้น
   - ค. ใช้สื่อสารเฉพาะข้อความเท่านั้น
   - ง. เชื่อมต่อกับคอมพิวเตอร์ได้หลายตัว
4. ข้อใดเป็นลักษณะการเชื่อมโยงแบบจุดต่อจุดแบบกึ่งทางคู่ (half duplex)
   - ก. การรับสัญญาณวิทยุ
   - ข. การติดต่อวิทยุสื่อสาร
   - ค. การรับสัญญาณโทรทัศน์
   - ง. การพูดโทรศัพท์
5. ตู้ถอนเงิน ATMมีลักษณะการเชื่อมโยงแบบใด
   - ก. หลายจุด
   - ข. สวิตชิ่ง
   - ค. จุดต่อจุด
   - ง. แบบบัส
6. การเชื่อมโยงแบบหลายจุด ช่วยแก้ปัญหาด้านใด
   - ก. การใช้สายสัญญาณอย่างไม่มีประสิทธิภาพ
   - ข. การสิ้นเปลืองสายเชื่อมโยง
   - ค. การแก้ปัญหาในช่วงที่ไม่มีการรับส่งข้อมูล
   - ง. ถูกหมดทุกข้อ
7. ข้อใดเป็นการเชื่อมโยงแบบหลายจุด
   - ก. แบบดาว
   - ข. แบบแพร่กระจาย
   - ค. แบบต้นไม้
   - ง. แบบวงแหวน
8. เพราะเหตุใดการเชื่อมโยงแบบหลายจุด จึงต้องมีศูนย์กลางควบคุม
   - ก. เพราะป้องกันปัญหา ข้อมูลชนกัน
   - ข. เพราะส่งข้อมูลด้วยความเร็วสูงสุด
   - ค. เพราะมีข้อมูลเป็น จำนวนมาก
   - ง. เพราะมีการเชื่อมโยงหลายเส้นทางด้วยกัน
9. การเชื่อมโยงแบบเครือข่ายสวิตชิ่ง(switching network) ช่วยแก้ปัญหาในด้านใด
   - ก. การส่งข้อมูลพร้อมกัน
   - ข. ขีดจำกัดของความจุของสายสื่อสาร
   - ค. การผูกขาดการจองสายสื่อสารตลอดเวลา
   - ง. การจัดลรรให้สัมปทานความถี่
10. หากนักศึกษามีข้อมูลไม่มากนัก และต้องการส่งข้อมูลที่ไม่ต่อเนื่อง นักศึกษาจะเลือกการเชื่อมโยงแบบใด จึงจะดีที่สุด
    - ก. แบบจุดต่อจุด
    - ข. แบบหลายจุด
    - ค. แบบสวิตชิ่ง
    - ง. แบบวงแหวน

1

Figure D.7: Test 3

11. สิ่งที่นักศึกษาจะต้องคำนึงถึง เมื่อจะเลือกใช้สื่อกลาง (media)ในการสื่อสารคืออะไร

ก. ความสะดวกในการติดตั้ง

ข. ระยะทาง

ค. ความเร็วในการส่งผ่านข้อมูล

ง. ถูกทุกข้อ

12. ข้อใดกล่าวได้ถูกต้องมากที่สุด เกี่ยวกับสายคู่บิดเกลียว หรือ สายเกลียวคู่ (twisted pair cable)

ก. ใช้กับเครื่องรับ-ส่ง ที่อยู่ห่างกันมาก

ข. ใช้กับเครื่องรับ-ส่ง ที่อยู่ห่างกัน ไม่มาก

ค. ราคาปานกลาง

ง. เป็นสายเงินที่หุ้มด้วยฉนวน

13. เพราะเหตุใด ช่องทางสื่อสารแบบใช้สาย (wired cable) ชนิดสายคู่ จึงต้องบิดเป็นเกลียว

ก. เพื่อความสวยงาม

ข. เพื่อความแข็งแรง

ค. เพื่อลดความต้านทาน

ง. เพื่อป้องการรบกวนจากสนามแม่เหล็กไฟฟ้า

14. สายคู่บิดเกลียว 1 คู่ ใช้แทนช่องทางการสื่อสารได้กี่ช่องทาง

ก. 1 ช่องทาง

ข. 2 ช่องทาง

ค. 3 ช่องทาง

ง. 4 ช่องทาง

15. สายคู่บิดเกลียวชนิด UTPกับ STP ต่างกันอย่างไร

ก. สาย UTPมีตาข่ายโลหะหุ้ม แต่สาย STP ไม่มี

ข. สายUTP ไม่มีตาข่ายโลหะหุ้ม แต่สาย STP มี

ค. สายUTP ใช้กับLAN แบบ TOKEN RING แต่ STP ใช้กับ แบบ ETHERNET

ง. สาย UTPมีชนิดเดียว แต่สาย STP แบ่งออกเป็น 5 แคตกอรี่ (CATEGORY)

16. ระยะที่เหมาะสม สำหรับเครื่องคอมพิวเตอร์ที่ต่อเชื่อมกันโดยใช้สายคู่บิดเกลียว คือข้อใด

ก. 30 เมตร

ข. 50 เมตร

ค. 100 เมตร

ง. 150 เมตร

17. เส้นลวดเล็กๆที่ถักเป็นร่างแหในสายโคแอกเชียล(coaxial cable) มีไว้ทำอะไร

ก. เพื่อเพิ่มความแข็งแรงให้กับสาย

ข. ป้องกันการสูญเสียสัญญาณ

ค. ใช้เป็นสายส่งสัญญาณ

ง. เพื่อความสวยงาม

18. ข้อใดคือข้อที่บ่งลักษณะได้ดีที่สุดของสายโคแอกเชียล

ก. ส่งข้อมูลได้ทั้งแบบ broad band และ base band

ข. ราคาไม่แพงเมื่อเปรียบเทียบกับสายคู่บิดเกลียว

ค. ปลอดจากการรบกวนของคลื่นแม่เหล็กไฟฟ้า

ง. โค้งงอได้ ตามสภาพของบริเวณที่เดินสาย

19. ข้อใด ไม่ใช่ ลักษณะที่เหมาะสม สำหรับสายโคแอกเชียล

ก. ใช้กับระบบโทรศัพท์ทางไกล

ข. การเชื่อมโยงระยะสั้นๆ

ค. นิยมนำมามัดรวมกันเป็นกลุ่ม

ง. ใช้กับระบบ LAN

20. ส่วนใด ของสายใยแก้วนำแสง ที่ทำหน้าที่สะท้อนแสง

ก. ใยแก้วหรือพลาสติกชั้นใน

ข. ไม่มีการสะท้อนแสง เพราะแสงเดินมาตามใยแก้วพลาสติกชั้นในอยู่แล้ว

ค. ฉนวนที่หุ้มพลาสติกหรือใยแก้วชั้นนอก

ง. ใยแก้วที่หุ้มอยู่รอบนอกพลาสติกชั้นใน

21. ส่วนที่เรียกว่า jacket ของสายใยแก้วนำแสง ทำหน้าที่อะไร

ก. สะท้อนแสง

ข. โฟกัสแสงให้เข้ม

ค. ป้องกันความเสียหายจากการขีดข่วน

ง. ป้องกันการรบกวนจากคลื่นแม่เหล็กไฟฟ้า

2

Figure D.8: Test 3 (cont.)

22. ข้อใด ที่ ไม่สามารถ ใช้สายใยแก้วเป็นสื่อกลางได้

ก. เสียง

ข. ข้อมูล

ค. ภาพเคลื่อนไหว

ง. ใช้ได้ทุกข้อ

23. สื่อกลางชนิดใด ใช้เครื่องทวนสัญญาณน้อยกว่า ในระยะทางเท่าๆกัน

ก. สายเกลียวคู่

ข. สายโคแอกเชียล

ค. สายใยแก้วนำแสง

ง. สายกลม

24. ข้อใด คือข้อได้เปรียบของสายใยแก้ว นำแสง

ก. มีแบนด์วิดธ์กว้างกว่า

ข. มีแบนด์วิดธ์แคบกว่า

ค. ราคาถูก กว่า

ง. ไม่มีการสะท้อนกลับหมดภายใน

25. สายไฟเบอร์ออปติก(fiber optic) ใช้อะไรเป็นสื่อนำส่งข้อมูล

ก. ไฟฟ้า

ข. อำนาจแม่เหล็ก

ค. อำนาจแม่เหล็กไฟฟ้า

ง. แสง

26. จุดอ่อนของการใช้การสื่อสารระบบไมโครเวฟ คือข้อใด

ก. ค่าใช้จ่ายในการลงทุนสูงมาก

ข. การติดตั้งยุ่งยากมาก

ค. สัญญาณถูกรบกวนเมื่อฝนตก

ง. ติดตั้งได้เฉพาะบริเวณที่ราบเท่านั้น

27. เพราะเหตุใด สถานีส่งสัญญาณไมโครเวฟ จึงจำเป็นต้องคำนึงถึง เส้นสายตา (line of sight)

ก. เพราะแต่ละสถานี ต้องมองเห็นกันด้วยสายตา จึงจะส่งสัญญาณได้

ข. เพราะระยะทางที่จะสามารถส่งสัญญาณได้ จะต้องอยู่ในระยะสายตา

ค. เพราะทัศนะวิสัย มีผลต่อการส่งสัญญาณ

ง. เพราะส่วนโค้งของโลก จะบดบังสัญญาณ

28. ถ้าต้องการติดต่อสื่อสารกันได้ทั่วโลก โดยใช้ดาวเทียมจำนวนน้อยที่สุด จะต้องใช้กี่ดวง

ก. 2 ดวง

ข. 3 ดวง

ค. 4 ดวง

ง. 5 ดวง

29. ดาวเทียมส่งสัญญาณมายังสถานีภาคพื้นดิน ด้วยคลื่นชนิดใด

ก. อินฟราเรด (infrared)

ข. คลื่นวิทยุ (radio wave)

ค. ไมโครเวฟ (micro wave)

ง. คลื่นสั้น (short wave)

30. ข้อใดกล่าวได้ถูกต้อง เกี่ยวกับคลื่นวิทยุ

ก. ไม่กระจายคลื่น

ข. กระจายคลื่นไปรอบทิศทาง

ค. อัตราเร็วในการส่งข้อมูลต่ำ

ง. สามารถรวบรวมคลื่นให้อยู่ในแนวเดียวกันได้

3

Figure D.9: Test 3 (cont.)

Appendix E

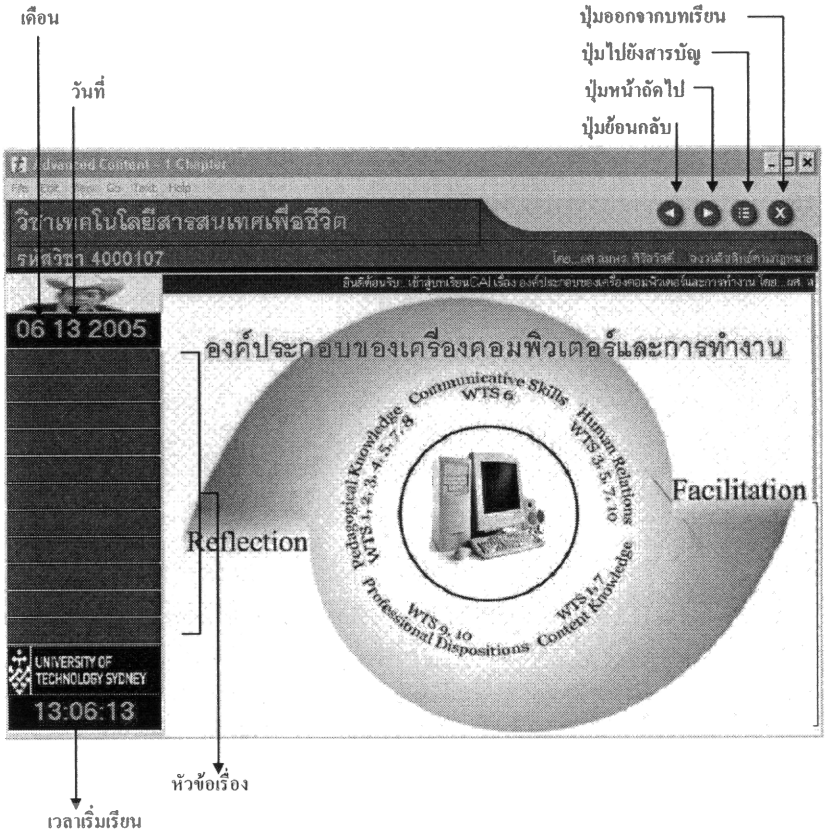
Guide sheets

คู่มือการใช้บทเรียนคอมพิวเตอร์ช่วยสอน
เรื่อง
องค์ประกอบของเครื่องคอมพิวเตอร์และการทำงาน

เมื่อนักศึกษาต้องการใช้บทเรียนคอมพิวเตอร์ช่วยสอน ให้ปฏิบัติดังนี้

1. เปิดสวิตช์เครื่องคอมพิวเตอร์
2. สวมหูฟัง
3. คลิกคลิกที่ ไอคอน 

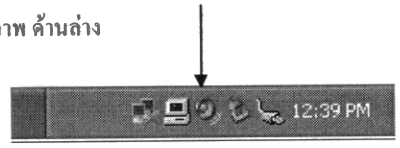
บนหน้าจอคอมพิวเตอร์ นักศึกษาจะเข้าสู่บทเรียน ตามภาพด้านล่างนี้



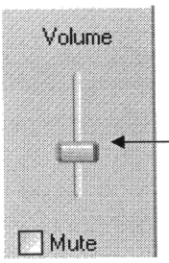
โปรดพลิก

Figure E.1: Student guide sheets for Experiment 1.

4. นักศึกษาจะเลือกคลิกปุ่มไปยังสารบัญ เพื่อเลือกเรียน ตามหัวข้อที่นักศึกษาสนใจ หรือนักศึกษาจะเลือกคลิกที่หัวข้อเรื่อง ด้านซ้ายมือโดยตรงก็ได้ ซึ่งจะมีอยู่ทุกหน้า แต่ทางที่ดี นักศึกษาน่าจะคลิกหัวข้อเรื่องไปตามลำดับ จะดีกว่า
5. ข้อควรระวัง ! เมื่อนักศึกษา พบตัวอักษรสีแดง ในบทเรียน **นักศึกษา ต้องคลิก ที่ตัวอักษรสีแดง** นั้น เนื่องจากยังมีรายละเอียดที่น่าสนใจซ่อนอยู่
6. การปรับความดังของเสียง ให้นักศึกษา คลิกที่ ไอคอนรูป ลำโพง ที่ task bar (กรอบด้านล่างสุด ซ้ายมือ ของวินโดว์) ดังภาพ ด้านล่าง



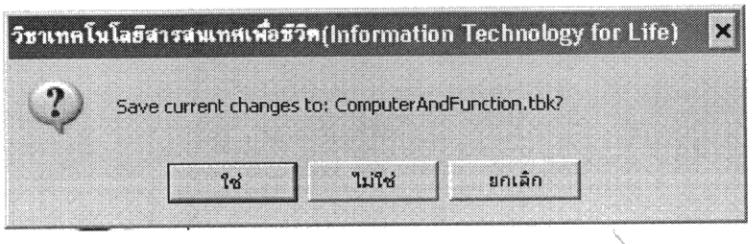
7. ภาพของส่วนที่ควบคุมความดังของเสียง(volume control) ก็จะปรากฏขึ้น ดังภาพด้านล่าง



ปุ่มเลื่อนขึ้น-ลง เพื่อกำหนดความดัง มาก-น้อย ของเสียง

ให้นักศึกษา ใช้เมาส์ชี้ไปยังปุ่ม บนส่วนควบคุม ความดังของเสียง แล้วลากเมาส์ขึ้นหรือลง เพื่อปรับความดังของเสียงให้ พอเหมาะ หลังจากนั้น ให้คลิกบริเวณที่ว่าง บนหน้าจอ(desk top) เพื่อปิด ส่วนควบคุมความดังของเสียง

8. เมื่อต้องการออกจากบทเรียน ให้คลิกที่ปุ่ม X ด้านบนขวามือของ บทเรียน จะมีกรอบข้อความให้ยืนยันความประสงค์อีกครั้ง ดังภาพด้านล่าง



ให้นักศึกษา คลิกที่ปุ่ม "ไม่ใช่" (NO) หากต้องการเลิกเรียนจริงๆ
แต่ถ้านักศึกษาเปลี่ยนใจ อยากกลับไปเรียนต่อ ให้คลิกที่ปุ่ม "ยกเลิก" (CANCEL)

ขอให้นักศึกษา เรียนอย่างมีความสุขกับบทเรียนคอมพิวเตอร์ช่วยสอน(CAI)นี้

Figure E.2: Student guide sheets for Experiment 1 (cont.).

คู่มือการใช้บทเรียนคอมพิวเตอร์ช่วยสอน

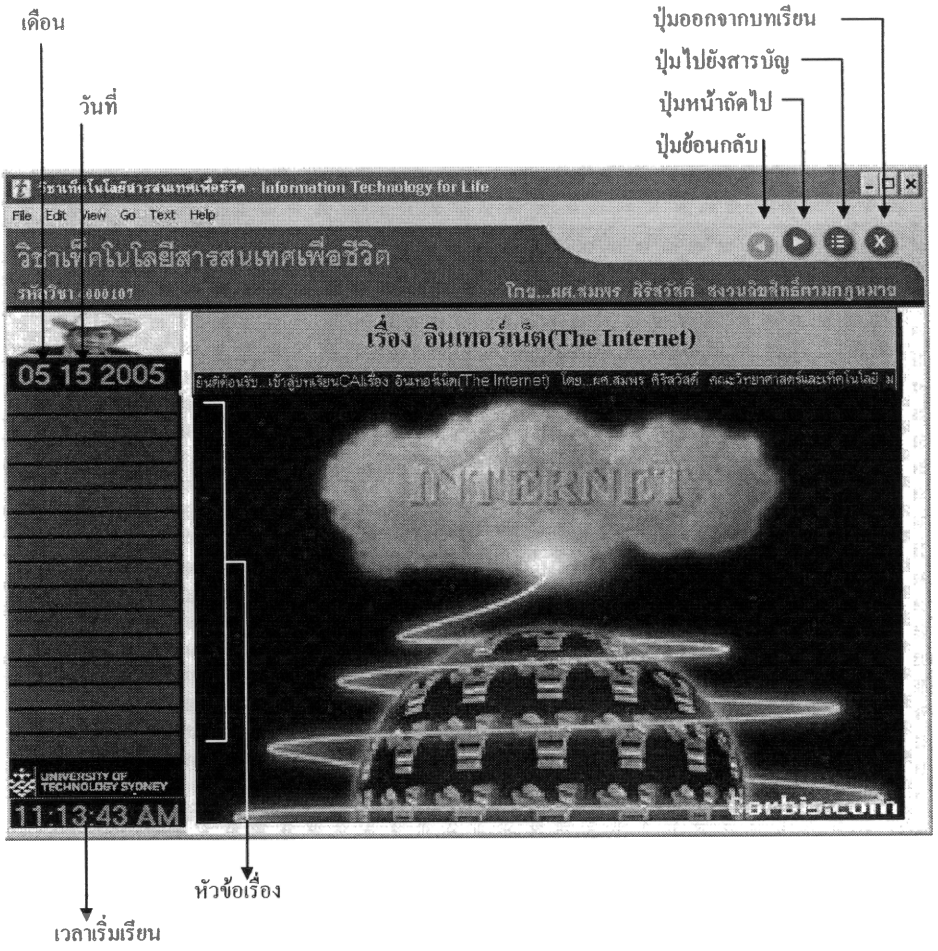
เรื่อง

อินเทอร์เน็ต(The Internet)

เมื่อนักศึกษาต้องการใช้บทเรียนคอมพิวเตอร์ช่วยสอน ให้ปฏิบัติดังนี้

1. เปิดสวิตช์เครื่องคอมพิวเตอร์
2. สวมหูฟัง
3. คลิกคลิกที่ ไอคอน 

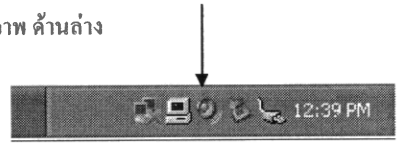
บนหน้าจอคอมพิวเตอร์ นักศึกษาจะเข้าสู่บทเรียน ตามภาพด้านล่างนี้



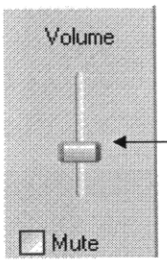
โปรดพลิก

Figure E.3: Student guide sheets for Experiment 2.

4. นักศึกษาจะเลือกคลิกปุ่มไปยังสารบัญ เพื่อเลือกเรียน ตามหัวข้อที่นักศึกษาสนใจ หรือนักศึกษาจะเลือกคลิกที่หัวข้อเรื่อง ด้านซ้ายมือโดยตรงก็ได้ ซึ่งจะมีอยู่ทุกหน้า แต่ทางที่ดี นักศึกษาน่าจะคลิกหัวข้อเรื่องไปตามลำดับ จะดีกว่า
5. ข้อควรระวัง ! เมื่อนักศึกษา พบตัวอักษรสีแดง ในบทเรียน **นักศึกษา ต้องคลิก ที่ตัวอักษรสีแดง** นั้น เนื่องจากยังมีรายละเอียดที่น่าสนใจซ่อนอยู่
6. การปรับความดังของเสียง ให้นักศึกษา คลิกที่ ไอคอนรูป ลำโพง ที่ task bar (กรอบด้านล่างสุด ซ้ายมือ ของวินโดว์) ดังภาพ ด้านล่าง



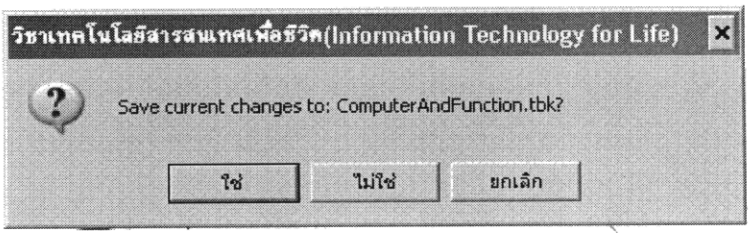
7. ภาพของส่วนที่ควบคุมความดังของเสียง(volume control) ก็จะปรากฏขึ้น ดังภาพด้านล่าง



ปุ่มเลื่อนขึ้น-ลง เพื่อกำหนดความดัง มาก-น้อย ของเสียง

ให้นักศึกษา ใช้เมาส์ชี้ไปยังปุ่ม บนส่วนควบคุม ความดังของเสียง แล้วลากเมาส์ขึ้นหรือลง เพื่อปรับความดังของเสียงให้ พอเหมาะ หลังจากนั้น ให้คลิกบริเวณที่ว่าง บนหน้าจอ(desk top) เพื่อปิด ส่วนควบคุมความดังของเสียง

8. เมื่อต้องการออกจากบทเรียน ให้คลิกที่ปุ่ม X ด้านบนขวามือของ บทเรียน จะมีกรอบข้อความให้ยืนยันความประสงค์อีกครั้ง ดังภาพด้านล่าง



ให้นักศึกษา คลิกที่ปุ่ม "ไม่ใช่" (NO) หากต้องการเลิกเรียนจริงๆ
แต่ถ้านักศึกษาเปลี่ยนใจ อยากกลับไปเรียนต่อ ให้คลิกที่ปุ่ม "ยกเลิก" (CANCEL)

ขอให้นักศึกษา เรียนอย่างมีความสุขกับบทเรียนคอมพิวเตอร์ช่วยสอน(CAI)นี้

Figure E.4: Student guide sheets for Experiment 2 (cont.).

คู่มือการใช้บทเรียนคอมพิวเตอร์ช่วยสอน

เรื่อง

การสื่อสารข้อมูล

นักศึกษา ควรทำความเข้าใจ การใช้บทเรียนให้ถ่องแท้เสียก่อน โดยการศึกษา จากคำแนะนำการใช้บทเรียนนี้ ก่อนที่จะเริ่มใช้โปรแกรม บทเรียนคอมพิวเตอร์ช่วยสอน

<u>เข้าสู่บทเรียน</u>

เมื่อนักศึกษาต้องการใช้บทเรียนคอมพิวเตอร์ช่วยสอน ให้ปฏิบัติดังนี้

1. เปิดสวิตซ์เครื่องคอมพิวเตอร์
2. สวมหูฟัง
3. คลิกคลิกที่ ไอคอน 

บนหน้าจอคอมพิวเตอร์ นักศึกษาจะเข้าสู่บทเรียน ตามภาพ ด้านล่างนี้

ให้นักศึกษา รอสักครู่ ภาพบนหน้าจอจะเปลี่ยนไปโดยอัตโนมัติ ดังภาพ หน้าถัดไป

Figure E.5: Student guide sheets for Experiment 3.

<u>บทเรียน</u>

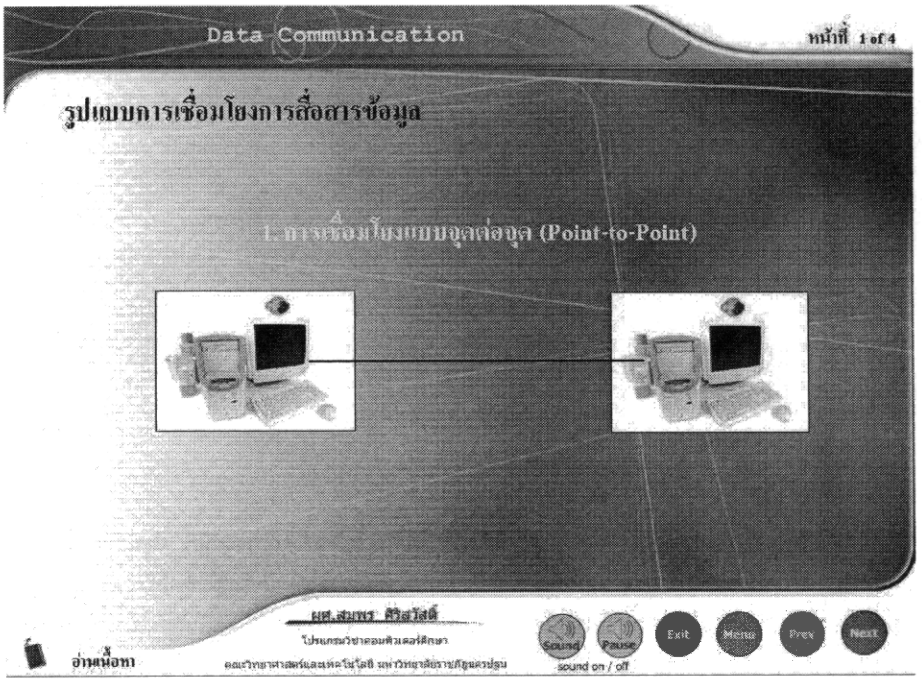
จากภาพด้านบน จะมี หัวข้อเนื้อเรื่อง(ตัวอักษรสีเขียว) อยู่ 2 หัวข้อด้วยกัน คือ

1. รูปแบบการเชื่อมโยงการสื่อสารข้อมูล
2. สื่อกลางการสื่อสารข้อมูล

นักศึกษาเลือกคลิก คลิกบนหัวข้อใดๆ ตามที่นักศึกษาสนใจ จะปรากฏ หัวข้อย่อย ตาม ภาพ นี้

Figure E.6: Student guide sheets for Experiment 3 (cont.).

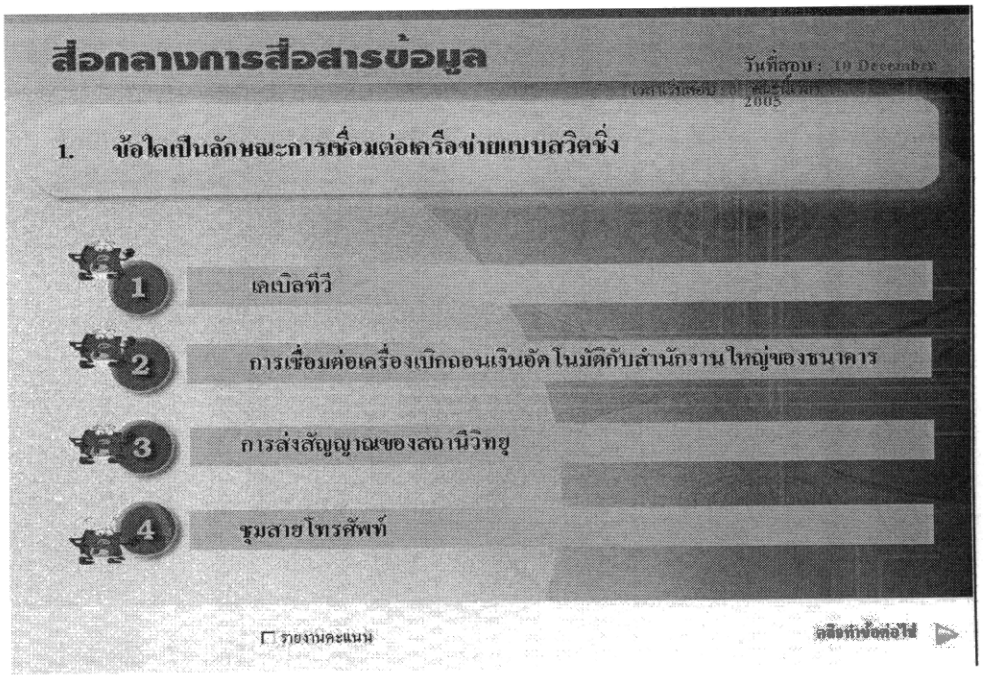
นักศึกษาสามารถ เลือกเรียน หัวข้อย่อยเรื่องใดๆ โดยการคลิก คลิก บนชื่อเรื่อง นั้นๆ
หากนักศึกษา ต้องการความช่วยเหลือ ให้คลิก คลิกที่ปุ่มวงกลม ตัว T ในวงกลมสีแดง ด้านล่างของกรอบภาพ
นักศึกษาต้องการ อ่านวัตถุประสงค์ ให้ คลิก คลิก ที่ ปุ่มวงกลม ตัว O ในวงกลมสีม่วง ด้านล่างของกรอบภาพ
หากนักศึกษา ต้องการออกจากบทเรียน ให้ คลิก คลิก ที่ ปุ่มวงกลม ตัว E ในวงกลมสีแดง ด้านล่างของกรอบภาพ
ภาพด้านล่างเป็นภาพ ตัวอย่างเนื้อหา ในบทเรียนนี้



ที่ด้านล่างขวามือ ของกรอบภาพ มีปุ่มสำหรับ อำนวยความสะดวกในการเรียน ดังนี้
คลิกปุ่ม Sound เมื่อต้องการฟังเสียงบรรยาย
คลิกปุ่ม Pause เมื่อต้องการปิดเสียงบรรยายชั่วคราว
คลิกปุ่ม Exit เมื่อต้องการออกจากบทเรียน
คลิกปุ่ม Menu เมื่อต้องการกลับไปเลือกเรียน หัว ข้อ อื่นๆ
คลิกปุ่ม Prev เมื่อต้องการย้อนกลับไปหน้าเดิม
คลิกปุ่ม Next เมื่อต้องการเปิดหน้าถัดไป
คลิก ข้อความ อ่านเนื้อหา ที่ด้านล่างซ้ายมือของกรอบภาพ เมื่อต้องการอ่านเนื้อหาเพิ่มเติม
<u>แบบฝึกหัด</u>
ที่บริเวณท้าย หัวข้อ เรื่อง จะมีภาพ หนังสือ สีแดง ดัง ภาพ ด้านล่าง คลิกที่ภาพนี้ เมื่อต้องการทำแบบฝึกหัด

Figure E.7: Student guide sheets for Experiment 3 (cont.)

ภาพตัวอย่าง แบบฝึกหัด



นักศึกษา เลือกตอบ โดย คลิก ที่ ตัวเลข 1, หรือ 2, หรือ 3, หรือ 4 ในวงกลม หน้า ข้อเลือก หากนักศึกษา ทำถูก โปรแกรมจะเปิดข้อใหม่ให้ โดยอัตโนมัติ

หากนักศึกษา เลือกข้อผิด จะมีตัวอักษร กระพริบ ให้นักศึกษา เลือกข้อใหม่ หลังจากที่ทำข้อสุดท้ายเสร็จแล้ว ให้นักศึกษา คลิก ที่ ข้อความ **รายงานคะแนน** ทางด้านล่างขวามือของกรอบภาพ จะปรากฏ กรอบรายงานคะแนน ตามภาพ ด้านล่างนี้

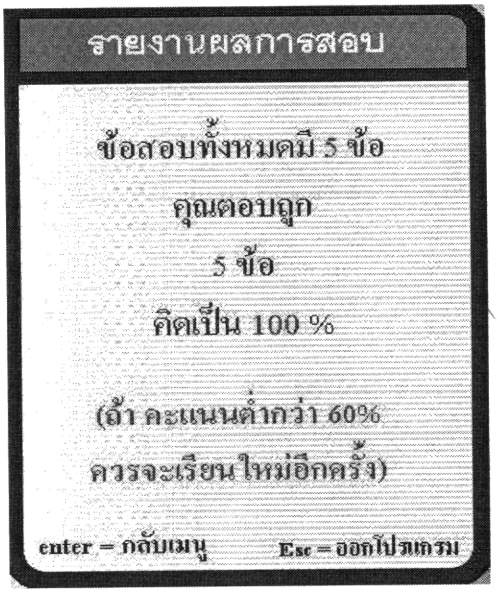


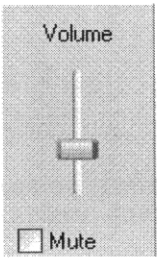
Figure E.8: Student guide sheets for Experiment 3 (cont.)

นักศึกษา สามารถ เลือกที่จะเรียน ต่อไป โดยคลิก ที่ ข้อความ **กลับเมนู** เพื่อเลือกเรียนในหัวข้อถัดไป หรือ หาก นักศึกษาไม่ประสงค์จะเรียนต่อ ให้คลิกที่ ข้อความ **ออกจากโปรแกรม** ที่อยู่ด้านล่างในกรอบภาพ รายงานผลการสอบ

<u>การปรับเสียงบรรยาย</u>

การปรับความดังของเสียง ให้นักศึกษา คลิกที่ ไอคอนรูป ลำโพง ที่ task bar (กรอบด้านล่างสุด ซ้ายมือของวินโดว์) ดังภาพ ด้านล่าง

ภาพของส่วนที่ควบคุมความดังของเสียง(volume control) ก็จะปรากฏขึ้น ดังภาพด้านล่าง



ให้นักศึกษา ใช้เมาส์ชี้ไปยังปุ่ม บนส่วนควบคุม ความดังของเสียง แล้วลากเมาส์ขึ้นหรือลง เพื่อปรับความดังของเสียงให้ พอเหมาะ หลังจากนั้น ให้คลิกบริเวณที่ว่าง บนหน้าจอ(desk top) เพื่อปิด ส่วนควบคุมความดังของเสียง

ขอให้นักศึกษา เรียนอย่างมีความสุขกับบทเรียนคอมพิวเตอร์ช่วยสอน(CAI) นี้

Figure E.9: Students' guide sheets experiment 3 (cont.).

Appendix F

Consent form

UNIVERSITY OF TECHNOLOGY, SYDNEY
CONSENT FORM - STUDENT RESEARCH

I Mr., Ms..... agree to participate in the research project entitled "Using CAI software to teach an Information Technology for Life course in Thailand"; which is being conducted by Mr. Somporn Sirisawad, 85/70 Moo 3 Mataiman Road, Muang Nakhonpathom 73000, Thailand, phone:(+66) 034 261 412 (home), mob. (+66) 070 495 994, in candidature for his Doctor of Technology in Science degree at the University of Technology, Sydney.

I understand that the purpose of this research is to investigate student achievements using a Computer Aided Instruction (CAI) approach to teaching, and to compare the results to those from traditional delivery methods currently in use. I also understand that evaluation of the different teaching methods will be achieved by taking a test (consisting of multiple choice questions), and completing a questionnaire. This study is motivated by modern educational trends which are increasingly taking advantage of advancing technology to help the classroom instructor to teach and revise new content using computers. Only one topic, of one hour's duration, will be taught by CAI; the other topics will follow traditional delivery methods.

I understand that my participation in this research is volunteer and will not involve me in any physical risks, although I may possibly feel uncomfortable in a psychological or emotional sense, if, for example, I do not like the new method of course delivery, or if I lack the necessary skills for undertaking Computer Aided Instruction courses. I am aware that I can contact Mr.Somporn Sirisawad or his supervisor Dr.Walter Kaleff. Alternately, if I should have concerns that I may not feel at ease discussing with either of these people, I understand that I will be able to discuss them with the RINP vice-President(academic) Assistant Prof. Dr Natakan Angtong (034-261051) who is in no way involved in this project. Further, I understand that I am free to withdraw my participation from this research project at any time I wish and without giving a reason; such withdrawal will not prejudice my future care or academic progress.

I agree that Mr.Somporn Sirisawad has answered all my questions fully and clearly. I further agree that the research data gathered from this project may be published in a form that does not identify me in any way.

_____ ___/___/___
Signed by

_____ ___/___/___
Witnessed by

NOTE:
This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Research Ethics Officer, Ms Susanna Davis (ph: 02 - 9514 1279, Susanna.Davis@uts.edu.au). Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

Figure F.1: English-language version of consent form completed by all students participating in the research.

มหาวิทยาลัยเทคโนโลยี,เมืองซิดนีย์
หนังสือยินยอม เข้าร่วมโครงการวิจัยของนักศึกษา

UNIVERSITY OF TECHNOLOGY SYDNEY

ข้าพเจ้า นาย, นางสาว.....ยินดีเข้าร่วมโครงการวิจัยเรื่อง"การพัฒนาและประเมินผล การใช้บทเรียนคอมพิวเตอร์ช่วยสอน "วิชา เทคโนโลยีสารสนเทศเพื่อชีวิต" ณ มหาวิทยาลัยราชภัฏนครปฐม ประเทศไทย" ผู้วิจัยชื่อ นายสมพร ศิริสวัสดิ์ อยู่บ้านเลขที่ 85/70 หมู่3 ถนนมาลัยแมน อ.เมือง จังหวัด นครปฐม 73000 โทรศัพท์(บ้าน) +66 034 261 412 มือถือ +66 070 495 994 ซึ่งผู้วิจัยกำลังศึกษาอยู่ในระดับปริญญาเอก สาขา Doctor of Technology in Science ณ มหาวิทยาลัยเทคโนโลยี,เมืองซิดนีย์

ข้าพเจ้าเข้าใจวัตถุประสงค์ของงานวิจัยนี้ดีว่า ผู้วิจัยต้องการศึกษาหาสัมฤทธิผลทางการศึกษาของนักศึกษาเมื่อใช้คอมพิวเตอร์ช่วยสอน และต้องการเปรียบเทียบผลการสอนกับวิธีการสอนแบบปกติโดยทั่วไป และข้าพเจ้าเข้าใจดีว่าจะมี การประเมินผลการเรียนในทั้งสองวิธีนี้โดย การทดสอบ(แบบเลือกตอบ) และการตอบแบบสอบถาม งานวิจัยนี้เกิดจากแนวโน้มของการศึกษาสมัยใหม่ที่นำความก้าวหน้าทางเทคโนโลยีมาช่วยสอนในชั้นเรียน โดยใช้คอมพิวเตอร์ปรับปรุงเนื้อหาในบทเรียนใหม่. ผู้วิจัยจะพัฒนาบทเรียนคอมพิวเตอร์ช่วยสอนขึ้นมา 3 บทเรียน โดยใช้เวลาเรียนประมาณบทเรียนละ 1 ชั่วโมง ส่วนบทเรียนอื่นใช้วิธีสอนปกติ

ข้าพเจ้าเข้าใจดีว่าการเข้าร่วมโครงการวิจัยครั้งนี้จะไม่มีความเสี่ยงทางกายภาพใดๆเกิดขึ้น ถึงแม้ว่า ข้าพเจ้าอาจมีความรู้สึก อาจไม่ค่อยสบายใจหรือมีเหตุอื่น เช่นรู้สึกไม่ค่อยชอบวิธีการเรียนแบบใหม่นี้ หรือ ข้าพเจ้าขาดทักษะในการใช้บทเรียนคอมพิวเตอร์ช่วยสอน

ข้าพเจ้าตระหนักดีว่า หากข้าพเจ้ามีข้อสงสัยใดๆในงานวิจัยนี้ ข้าพเจ้าสามารถติดต่อกับ นายสมพร ศิริสวัสดิ์ หรือ Dr Walter Kalceff ซึ่งเป็นอาจารย์ที่ปรึกษาของนายสมพร ศิริสวัสดิ์ หรือติดต่อกับ ผู้ช่วยศาสตราจารย์ ดร. ณัฐกาญจน์ อ่างทอง รองอธิการบดีฝ่ายวิชาการ มหาวิทยาลัยราชภัฏนครปฐม(โทรศัพท์ 034-261041)ได้ และข้าพเจ้ามีอิสระที่จะถอนตัวออกจากการเข้าร่วมในโครงการวิจัยนี้ได้ตลอดเวลา ตามที่ข้าพเจ้าต้องการ โดยมิต้องชี้แจงเหตุผลใดๆทั้งสิ้น และการถอนตัวบอกเลิกความร่วมมือนี้จะไม่มีผลใดๆต่อการเรียนในอนาคตของข้าพเจ้า

ข้าพเจ้าขอยืนยันว่า นายสมพร ศิริสวัสดิ์ ได้ให้ความกระจ่างแจ้ง โดยตอบคำถามของข้าพเจ้าทุกคำถามอย่างถี่ถ้วนและชัดเจนแล้ว และข้าพเจ้ายินดีให้นำ ข้อมูลที่ได้จากงานวิจัยนี้ออกตีพิมพ์เผยแพร่โดยต้องไม่ระบุถึงตัวข้าพเจ้าไม่ว่าในกรณีใดก็ตาม

ลงชื่อ.....ผู้ให้ความยินยอม วันที่...../มิถุนายน/ 2548

ลงชื่อ.....พยาน วันที่...../มิถุนายน/2548

Figure F.2: Thai-language consent form completed by all students participating in the research.

หมายเหตุ

การศึกษานี้ได้รับการตรวจสอบโดย คณะกรรมการจรรยาบรรณในการทำวิจัยที่เกี่ยวข้องกับบุคคล แห่งซิดนีย์ (Sydney Human Research Ethics Committee) ของ มหาวิทยาลัยเทคโนโลยี, ซิดนีย์ หากท่านมีปัญหาใดๆที่ท่านไม่ได้รับความร่วมมือแก้ไข หรือแก้ไขไม่ได้ จากผู้ทำวิจัย โปรดติดต่อ คณะกรรมการจรรยาบรรณ (Ethics Committee) โดยผ่านทาง เจ้าหน้าที่ จรรยาบรรณในการทำวิจัย(Research Ethics Officer) Ms Susana Davis(โทรศัพท์ 02-9514-1279) หรือ Susana.Davis@uts.edu.au คำร้องเรียนของท่านจะได้รับการพิจารณาสืบสวนอย่างเต็มที่และทุกอย่างจะถูกเก็บไว้เป็นความลับ และท่านจะได้รับแจ้งผลการพิจารณาจากคณะกรรมการจรรยาบรรณ

Figure F.3: Thai-language consent form (continued).

Appendix G

Item difficulty and discrimination

Table G.1: Item Difficulty and Discrimination for test items in "Computer Components and Functions".

Item	Difficulty	Discrimination
1	0.60	0.38
2	0.24	0.25
3	0.44	0.25
4	0.68	0.25
5	0.54	0.21
6	0.68	0.35
7	0.31	0.67
8	0.23	0.56
9	0.38	0.55
10	0.31	0.22
11	0.32	0.28
12	0.29	0.28
13	0.57	0.28
14	0.59	0.27
15	0.35	0.67
16	0.79	0.43
17	0.44	0.75

Continued on next page

Table G.1 – continued from previous page

Item	Difficulty	Discrimination
18	0.76	0.36
19	0.42	0.27
20	0.50	0.45
21	0.32	0.55
22	0.32	0.25
23	0.35	0.36
24	0.73	0.56
25	0.40	0.50
26	0.27	0.44
27	0.25	0.35
28	0.62	0.55
29	0.56	0.45
30	0.68	0.35

Table G.2: Item Difficulty and Discrimination for test items in "The Internet".

Item	Difficulty	Discrimination
1	0.65	0.38
2	0.78	0.63
3	0.39	0.75
4	0.22	0.50
5	0.74	0.75
6	0.48	0.50
7	0.48	0.88
8	0.70	0.38
9	0.70	0.25
10	0.43	0.25
11	0.35	0.25

Continued on next page

Table G.2 – continued from previous page

Item	Difficulty	Discrimination
12	0.57	0.38
13	0.70	0.25
14	0.48	0.50
15	0.74	0.25
16	0.57	0.63
17	0.39	0.38
18	0.52	0.25
19	0.52	0.38
20	0.39	0.25
21	0.30	0.50
22	0.22	0.25
23	0.57	0.63
24	0.70	0.25
25	0.70	0.50
26	0.74	0.25
27	0.52	0.38
28	0.39	0.25
29	0.39	0.25
30	0.43	0.38

Table G.3: Item Difficulty and Discrimination for test items in "Data Communication".

Item	Difficulty	Discrimination
1	0.43	0.57
2	0.38	0.43
3	0.52	0.57
4	0.76	0.29
5	0.67	0.57

Continued on next page

Table G.3 – continued from previous page

Item	Difficulty	Discrimination
6	0.24	0.43
7	0.57	0,71
8	0.48	0.57
9	0.43	0.71
10	0.67	0.29
11	0.52	0.57
12	0.62	0.29
13	0.48	0.71
14	0.38	0.43
15	0.38	0.57
16	0.67	0.71
17	0.48	0.57
18	0.24	0.29
19	0.33	0.43
20	0.57	0.43
21	0.71	0.29
22	0.62	0.71
23	0.52	0.57
24	0.29	0.43
25	0.57	0.71
26	0.43	0.57
27	0.76	0.43
28	0.71	0.43
29	0.43	0.71
30	0.62	0.43

Appendix H

Students' GPA Scores

Table H.1: GPA scores of control group.

No.	GPA	No.	GPA	No.	GPA	No.	GPA
1	2.48	21	2.12	41	2.69	61	2.86
2	2.68	22	2.91	42	2.25	62	2.56
3	3.32	23	2.53	43	2.41	63	2.88
4	2.40	24	2.24	44	2.52	64	2.76
5	2.42	25	2.88	45	2.74	65	3.16
6	3.05	26	2.21	46	2.36	66	2.64
7	2.65	27	3.53	47	2.36	67	2.18
8	3.11	28	2.23	48	2.96	68	2.86
9	2.96	29	2.39	49	3.05	69	2.79
10	2.48	30	2.19	50	2.69	70	2.67
11	2.59	31	2.38	51	2.19	71	2.23
12	2.39	32	2.23	52	2.72	72	3.21
13	2.94	33	2.84	53	2.80	73	2.28
14	3.20	34	3.15	54	2.32	74	2.58
15	2.92	35	2.69	55	2.44	75	2.62
16	2.95	36	3.34	56	2.59	76	3.21
17	2.23	37	3.00	57	2.24	77	2.33
18	2.35	38	2.86	58	2.52	78	2.46
19	2.68	39	2.28	59	2.51	79	2.64
20	2.41	40	2.58	60	3.06	80	2.20

Table H.2: GPA scores of experiment group.

No.	GPA	No.	GPA	No.	GPA	No.	GPA
1	3.44	21	2.46	41	2.15	61	2.91
2	3.35	22	2.34	42	2.79	62	2.81
3	3.04	23	3.03	43	2.52	63	3.00
4	1.60	24	2.69	44	2.15	64	2.78
5	2.65	25	1.91	45	2.02	65	2.25
6	2.48	26	1.94	46	3.21	66	2.19
7	1.87	27	2.77	47	2.34	67	2.24
8	2.18	28	3.47	48	3.37	68	2.82
9	3.38	29	3.47	49	2.32	69	2.08
10	1.89	30	3.48	50	2.48	70	2.72
11	2.88	31	2.63	51	3.39	71	3.46
12	2.53	32	3.31	52	3.20	72	2.70
13	0.39	33	3.26	53	2.38	73	2.49
14	2.78	34	2.56	54	2.68	74	3.25
15	1.93	35	2.38	55	2.55	75	2.73
16	1.56	36	2.50	56	2.85	76	2.57
17	2.25	37	1.99	57	3.47	77	3.31
18	3.13	38	2.69	58	2.61	78	2.69
19	1.86	39	2.79	59	3.37	79	2.44
20	2.43	40	2.70	60	3.11	80	3.25

Appendix I

Pre-test and post-test scores

Table I.1: Control Group pre-test scores.

No.	Experiment 1	Experiment 2	Experiment 3
1	10	9	11
2	11	5	13
3	14	9	11
4	8	8	13
5	8	5	10
6	13	3	13
7	8	6	5
8	12	7	14
9	12	9	11
10	10	6	7
11	6	9	9
12	9	10	13
13	11	7	10
14	6	9	8
15	14	7	14
16	6	6	12
17	9	6	10
18	6	6	10

Continued on next page

Table I.1 – continued from previous page

No.	Experiment 1	Experiment 2	Experiment 3
19	9	7	12
20	6	7	9
21	11	8	13
22	10	6	12
23	8	4	12
24	8	7	16
25	9	9	11
26	4	7	11
27	13	7	7
28	11	10	14
29	8	12	11
30	7	6	9
31	9	4	10
32	9	9	10
33	8	8	11
34	9	9	6
35	9	6	9
36	6	10	8
37	11	9	11
38	6	6	8
39	6	7	10
40	11	2	7
41	10	6	7
42	7	10	9
43	7	9	12
44	9	7	10
45	10	8	8
46	12	8	13
47	12	6	8

Continued on next page

Table I.1 – continued from previous page

No.	Experiment 1	Experiment 2	Experiment 3
48	10	6	10
49	8	3	5
50	7	7	11
51	7	5	9
52	8	6	9
53	7	9	11
54	8	7	10
55	11	6	11
56	12	11	9
57	11	11	10
58	9	6	10
59	8	8	12
60	14	10	11
61	12	2	9
62	5	8	15
63	8	9	12
64	9	5	13
65	6	10	8
66	8	10	12
67	9	8	11
68	11	9	12
69	12	5	11
70	13	6	7
71	8	7	13
72	10	6	13
73	12	8	7
74	7	9	10
75	7	6	9
76	9	6	12

Continued on next page

Table I.1 – continued from previous page

No.	Experiment 1	Experiment 2	Experiment 3
77	10	9	12
78	7	7	11
79	9	13	11
80	4	13	14

Table I.2: Experiment Group pre-test scores.

No.	Experiment 1	Experiment 2	Experiment 3
1	6	10	9
2	11	5	12
3	5	5	13
4	15	9	10
5	8	6	10
6	11	5	12
7	6	6	9
8	6	9	10
9	8	7	13
10	12	9	15
11	10	9	6
12	12	8	14
13	10	10	8
14	7	7	5
15	11	7	10
16	10	7	14
17	6	10	9
18	15	11	8
19	4	6	11
20	9	12	12

Continued on next page

Table I.2 – continued from previous page

No.	Experiment 1	Experiment 2	Experiment 3
21	8	9	12
22	3	11	13
23	7	10	11
24	8	7	11
25	3	12	13
26	8	4	10
27	5	6	9
28	5	5	6
29	8	8	14
30	9	7	11
31	6	8	12
32	14	11	7
33	9	11	9
34	10	14	13
35	6	9	13
36	8	10	7
37	7	7	10
38	13	7	12
39	7	14	14
40	9	9	11
41	8	8	10
42	8	9	14
43	6	10	10
44	8	9	17
45	12	9	9
46	6	6	8
47	5	12	12
48	14	7	13
49	8	9	9

Continued on next page

Table I.2 – continued from previous page

No.	Experiment 1	Experiment 2	Experiment 3
50	12	8	17
51	10	9	11
52	9	10	11
53	8	7	8
54	7	9	13
55	6	5	13
56	7	6	11
57	11	7	10
58	11	5	6
59	9	7	12
60	9	7	9
61	8	10	12
62	8	7	7
63	7	14	14
64	8	8	9
65	10	7	16
66	9	10	11
67	5	9	13
68	7	4	9
69	6	13	11
70	7	6	5
71	9	7	7
72	14	11	8
73	4	4	11
74	9	5	13
75	11	10	9
76	6	9	8
77	8	7	15
78	11	8	14

Continued on next page

Table I.2 – continued from previous page

No.	Experiment 1	Experiment 2	Experiment 3
79	10	8	7
80	8	8	13

Table I.3: Control Group post-test scores.

No.	Experiment 1	Experiment 2	Experiment 3
1	14	8	12
2	13	6	11
3	12	13	15
4	12	9	12
5	10	12	9
6	11	10	13
7	9	7	10
8	11	12	13
9	9	10	10
10	14	12	10
11	9	15	7
12	10	14	9
13	9	8	15
14	15	11	12
15	14	13	17
16	11	8	14
17	9	5	13
18	8	11	12
19	9	12	10
20	11	12	10
21	14	14	13
22	10	8	14

Continued on next page

Table I.3 – continued from previous page

No.	Experiment 1	Experiment 2	Experiment 3
23	14	15	12
24	12	11	13
25	12	13	11
26	12	10	14
27	14	14	9
28	12	13	12
29	9	12	12
30	10	11	11
31	16	10	15
32	6	6	11
33	12	8	16
34	12	15	9
35	7	11	13
36	10	13	8
37	9	10	11
38	12	12	13
39	6	9	13
40	10	11	13
41	11	11	13
42	13	12	11
43	11	6	13
44	7	9	9
45	11	10	10
46	9	14	10
47	10	5	14
48	15	10	12
49	14	11	13
50	9	14	11
51	8	9	12

Continued on next page

Table I.3 – continued from previous page

No.	Experiment 1	Experiment 2	Experiment 3
52	5	15	16
53	8	6	13
54	14	15	12
55	18	16	13
56	10	7	12
57	10	17	12
58	13	15	9
59	10	10	12
60	11	7	10
61	10	15	12
62	9	16	14
63	9	8	14
64	7	11	13
65	7	16	9
66	13	11	10
67	8	5	8
68	6	9	6
69	10	13	14
70	11	10	12
71	5	17	15
72	13	13	6
73	7	9	8
74	15	13	12
75	13	10	11
76	11	12	18
77	15	11	10
78	7	7	12
79	11	9	11
80	8	11	15

Table I.4: Experiment Group post-test scores.

No.	Experiment 1	Experiment 2	Experiment 3
1	12	21	18
2	14	17	14
3	11	18	15
4	17	10	13
5	11	13	8
6	7	10	12
7	14	9	10
8	16	17	11
9	16	12	23
10	11	12	14
11	8	3	7
12	10	8	12
13	18	19	14
14	11	7	16
15	12	14	12
16	18	12	11
17	9	13	16
18	14	29	23
19	11	11	14
20	16	16	10
21	19	14	13
22	12	14	14
23	6	11	13
24	13	12	15
25	8	14	15
26	9	10	11
27	14	13	19

Continued on next page

Table I.4 – continued from previous page

No.	Experiment 1	Experiment 2	Experiment 3
28	9	10	15
29	7	10	14
30	8	21	14
31	9	12	12
32	18	18	16
33	9	10	9
34	16	20	19
35	9	12	15
36	14	16	16
37	12	14	13
38	10	19	17
39	17	18	15
40	10	4	13
41	12	13	13
42	12	21	13
43	10	8	14
44	11	9	12
45	14	17	12
46	15	19	14
47	13	18	13
48	18	20	21
49	13	17	12
50	14	13	11
51	17	20	16
52	14	15	16
53	12	14	12
54	14	12	14
55	11	19	8
56	11	10	14

Continued on next page

Table I.4 – continued from previous page

No.	Experiment 1	Experiment 2	Experiment 3
57	15	10	10
58	20	24	16
59	11	12	13
60	14	15	13
61	14	14	15
62	12	13	11
63	15	22	22
64	12	21	12
65	12	13	18
66	12	14	10
67	14	12	8
68	20	19	17
69	11	14	14
70	17	16	14
71	17	15	19
72	11	12	11
73	11	15	13
74	13	10	13
75	10	12	12
76	13	10	10
77	16	15	13
78	12	15	16
79	13	15	13
80	15	16	18

Appendix J

Attitude surveys

Doctor of Technology Research Project

Development and Evaluation of a CAI course in "Information Technology for Life"

at Nakhon-Pathom Rajabhat University, Thailand.

The purpose of this survey is to investigate student attitudes toward CAI lessons. Your assistance is requested to evaluate various aspects of the given CAI lesson, which is composed of 3 topics from the course Information Technology for Life, course code 4000107, as shown below:

- Computer and components.
- The Internet.
- Data communication.

After you have finished the lesson, please indicate your opinion about the various aspects of the CAI lesson by marking the relevant box with a tick (✓) on the questionnaire form.

Your responses will have absolutely no effect on your grade in this course. All responses will be kept in strictest confidence. I greatly appreciate your time and effort in completing this survey.

Participant's general information (please tick ✓ the relevant box)

Gender ☐ male ☐ female

Do you have your own computer at home or at the dormitory? ☐ yes ☐ no

Sample

Item	List	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
0	Nakhon-Pathom Rajabhat University is the best university in Nakhon-Pathom province.				✓	

Please answer questions below (30 items)

Item	List	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
1	Global Items Overall, I would rate the quality of the CAI contents as excellent.					
2	Overall, I would rate the quality of the CAI lesson as excellent.					

Figure J.1: Experimental group questionnaire form.

Item	List	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
	CAI Characteristics					
3	CAI lesson was organized well.					
4	CAI lesson made difficult topics easily understandable.					
5	CAI lesson held my attention.					
6	CAI lesson uses teaching methods well suited to the topics.					
7	CAI lesson made the subject interesting.					
8	CAI lesson provided me with a lot of knowledge on the course topics.					
9	I would like to take another course taught using CAI.					
	Objectives					
10	Objectives of this CAI topic were clearly stated.					
11	I knew what is expected of me in this topic.					
12	The CAI topic objectives were achieved in the lesson.					
	Difficulty					
13	The level of difficulty of this topic was appropriate for me.					
14	This topic is one of the most difficult I've taken.					
15	I can learn more from reading books than using CAI.					
	Student Development.					
16	I had to put in more effort when learning with CAI.					
17	CAI lesson required more time and effort than others at this level.					
18	I felt frustrated while taking CAI lessons.					
19	I always prepare before coming to class.					
20	Studying with CAI made me keen to learn more.					
21	I feel that I performed up to my potential with CAI lesson.					

Figure J.2: Experimental group questionnaire form (cont.)

Item	List	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
22	The CAI lesson improved my understanding of concepts in this field.					
23	I developed the ability to solve actual problems in this field with this CAI lesson.					
24	I developed skills in critical thinking with this CAI lesson.					
25	The CAI lesson increased my interest in the subject matter.					
26	I enjoyed learning about this subject matter.					
27	I felt free when taking the CAI lesson.					
28	This CAI lesson made me more aware of my interests and talents.					
29	I had adequate time to complete the exercises in this CAI lesson.					
30	CAI lesson motivated me to do my best.					

Suggestions

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Thank you

Researcher

Figure J.3: Experimental group questionnaire form (cont.)

UNIVERSITY OF TECHNOLOGY SYDNEY

Doctor of Technology Research Project

Development and Evaluation of a CAI course in "Information Technology for Life"

at Nakhon-Pathom Rajabhat University, Thailand.

The purpose of this survey is to investigate student attitudes toward instructors' style and methods in traditional learning. Your assistance is requested to evaluate various aspects of the given lesson, which is composed of 3 topics from the course Information Technology for Life, course code 4000107, as shown below:

- Computers' components and functions.
- The Internet.
- Data communication.

After you have finished the lesson, please indicate your opinion about the extent of your agreement or disagreement by placing a tick (✓) in the appropriate column.

Your responses will have absolutely no effect on your grade in this course. All responses will be kept in strictest confidence. I greatly appreciate your time and effort in completing this survey.

Participant's general information (please tick ✓ the relevant box)

Gender ☐ male ☐ female

Do you have your own computer at home or at the dormitory? ☐ yes ☐ no

Sample

Item	List	Strongly disagree	Disagree	Undecided	Agree	Strongly disagree
0	Nakhon Pathom Rajabhat University is the best university in Nakhon Pathom province.				✓	

Please answer questions below (30 items)

Item	List	Strongly disagree	Disagree	Undecided	Agree	Strongly disagree
1	Global Items Overall, I would rate the quality of this lesson as excellent.					
2	Overall, I would rate this instructor as excellent.					

Figure J.4: Control group questionnaire form

Item	List	Strongly disagree	Disagree	Undecided	Agree	Strongly disagree
3	Instructor Characteristics My instructor organized this lesson well.					
4	My instructor makes difficult topics easily understandable.					
5	My instructor held my attention.					
6	My instructor uses teaching methods well suited to the lesson.					
7	My instructor made the subject interesting.					
8	My instructor is knowledgeable on course topics.					
9	I would like to take another course from this instructor.					
10	Objectives Objectives of this topic were clearly stated.					
11	I knew what is expected of me in this topic.					
12	Announced topic objectives agree with what is taught.					
13	Difficulty The level of difficulty of this topic was appropriate for me.					
14	This topic is one of the most difficult I've taken.					
15	I can learn more from books than from this instructor.					
16	Student Development. I had to put in more effort when learning with this instructor.					
17	The lesson required more time and effort than others at this level.					

Figure J.5: Control group questionnaire form (cont.)

Item	List	Strongly disagree	Disagree	Undecided	Agree	Strongly disagree
18	Learning with this instructor is very frustrating.					
19	I always prepare before coming to class.					
20	Studying with this instructor made me keen to learn more.					
21	I feel that I performed up to my potential with this lesson.					
22	I learned a lot from this lesson.					
23	I developed the ability to solve actual problems in this field.					
24	I developed skills in critical thinking with this lesson.					
25	This lesson increased my interest in the subject matter.					
26	I enjoyed learning about this subject matter.					
27	I felt free , with out anyone forcing me to study.					
28	This lesson made me more aware of my interests and talents.					
29	I had adequate time to complete the exercises in this lesson.					
30	An instructor motivated me to do my best.					

Suggestions

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Thank you

Figure J.6: Control group questionnaire form (cont.)

UNIVERSITY OF TECHNOLOGY SYDNEY

แบบสอบถาม

โครงการวิจัย วิทยานิพนธ์คุษฎีบัณฑิตสาขาเทคโนโลยี

เรื่อง: การพัฒนาและประเมินผล การใช้บทเรียนคอมพิวเตอร์ช่วยสอน "วิชา เทคโนโลยีสารสนเทศเพื่อชีวิต"

ณ มหาวิทยาลัยราชภัฏนครปฐม ประเทศไทย

แบบสอบถามนี้ ผู้วิจัย มีความประสงค์ที่ จะทราบเจตคติของนักศึกษาที่มีต่อ บทเรียนคอมพิวเตอร์ช่วยสอน (CAI) ใน รายวิชา เทคโนโลยีสารสนเทศเพื่อชีวิต รหัสวิชา 4000107 ที่นักศึกษา ได้ศึกษา มาแล้ว เรื่อง

- องค์ประกอบของเครื่องคอมพิวเตอร์และการทำงาน
- อินเทอร์เน็ต
- การสื่อสารข้อมูล

แบบสอบถามนี้ ไม่มีผลใดๆ ต่อนักศึกษา ทั้งสิ้น ข้อมูลทั้งหมด จะถูกเก็บไว้เป็นความลับ ขอให้นักศึกษาช่วย ตอบข้อคำถาม ตามความรู้สึกของนักศึกษาจริง ๆ

ข้อมูลทั่วไปเกี่ยวกับผู้ตอบแบบสอบถาม (โปรดใส่เครื่องหมาย ✓ลงในช่องสี่เหลี่ยม)

เพศ ❑ ชาย ❑ หญิง

นักศึกษามีเครื่องคอมพิวเตอร์ใช้ที่บ้านหรือที่หอพักไม่ ❑ มี ❑ไม่มี

เจตคติที่มีต่อบทเรียนคอมพิวเตอร์ช่วยสอน

โปรดใส่เครื่องหมาย ✓ลงในช่องที่ตรงกับความคิดเห็นหรือความรู้สึกของนักศึกษา (ข้อละ 1ช่อง เท่านั้น)

ตัวอย่าง

ข้อที่	รายการ	ไม่เห็นด้วยอย่างยิ่ง	ไม่เห็นด้วย	ไม่แน่ใจ	เห็นด้วย	เห็นด้วยอย่างยิ่ง
0	มหาวิทยาลัยราชภัฏนครปฐม เป็นสถาบันอุดมศึกษาที่ดีที่สุด ในจังหวัดนครปฐม				✓	

โปรด ตอบคำถามต่อไปนี้(30 ข้อ)

ข้อที่	รายการ	ไม่เห็นด้วยอย่างยิ่ง	ไม่เห็นด้วย	ไม่แน่ใจ	เห็นด้วย	เห็นด้วยอย่างยิ่ง
1	ภาพรวม โดยภาพรวม คุณภาพของ เนื้อหาในบทเรียนนี้ อยู่ในเกณฑ์ ดีมาก					
2	โดยภาพรวม คุณภาพของบทเรียนคอมพิวเตอร์ช่วยสอน(CAI) นี้ อยู่ในเกณฑ์ ดีมาก					

โปรดพลิก

Figure J.7: Experimental group questionnaire form (Thai)

ข้อที่	รายการ	ไม่เห็นด้วยอย่างยิ่ง	ไม่เห็นด้วย	ไม่แน่ใจ	เห็นด้วย	เห็นด้วยอย่างยิ่ง
3	<u>คุณลักษณะของบทเรียนคอมพิวเตอร์ช่วยสอน (CAI) นี้</u> บทเรียนคอมพิวเตอร์ช่วยสอน ถูกจัดทำมาเป็นอย่างดี					
4	บทเรียนคอมพิวเตอร์ช่วยสอน ช่วยทำเรื่องยากให้เป็นเรื่องง่าย					
5	บทเรียนคอมพิวเตอร์ช่วยสอน ช่วยกระตุ้นให้ข้าพเจ้าสนใจในการเรียน					
6	วิธีสอนในบทเรียนคอมพิวเตอร์ช่วยสอน มีความเหมาะสม					
7	คอมพิวเตอร์ช่วยสอน ช่วยทำให้บทเรียนน่าสนใจ					
8	บทเรียนคอมพิวเตอร์ช่วยสอน เต็มเปี่ยมไปด้วยความรู้					
9	ข้าพเจ้าอยากเรียน ด้วยบทเรียนคอมพิวเตอร์ช่วยสอนอีก					
10	<u>วัตถุประสงค์</u> บทเรียนคอมพิวเตอร์ช่วยสอน ได้ชี้แจงวัตถุประสงค์ไว้อย่างชัดเจน					
11	ข้าพเจ้ารู้ดีว่า ข้าพเจ้ามุ่งหวังสิ่งใด จากบทเรียนนี้					
12	บทเรียนคอมพิวเตอร์ช่วยสอน ดำเนินไปตามวัตถุประสงค์ที่ได้แจ้งไว้					
13	<u>ความยากง่าย</u> ความยาก-ง่าย ของบทเรียนคอมพิวเตอร์ช่วยสอนนี้ มีความเหมาะสม กับข้าพเจ้า					
14	บทเรียนคอมพิวเตอร์ช่วยสอนนี้ เป็นบทเรียนที่ยากที่สุด เท่าที่ข้าพเจ้าได้เคยเรียนมา					
15	ข้าพเจ้าได้รับความรู้จากการอ่านหนังสือมากกว่าจากการเรียนด้วยบทเรียนคอมพิวเตอร์ช่วยสอน					
16	<u>การพัฒนาตนเอง</u> การเรียนโดยใช้บทเรียนคอมพิวเตอร์ช่วยสอนนี้ ทำให้ข้าพเจ้าต้องใช้ความพยายามในการเรียนเป็นอย่างมาก					

โปรดพลิก

Figure J.8: Experimental group questionnaire form (Thai) cont.

ข้อที่	รายการ	ไม่เห็นด้วยอย่างยิ่ง	ไม่เห็นด้วย	ไม่แน่ใจ	เห็นด้วย	เห็นด้วยอย่างยิ่ง
17	บทเรียนคอมพิวเตอร์ช่วยสอน ทำให้ข้าพเจ้าต้องใช้เวลาเรียนมากกว่า บทเรียนอื่นๆ ในระดับเดียวกัน					
18	ข้าพเจ้ารู้สึกเครียด ขณะเรียนโดยใช้บทเรียนคอมพิวเตอร์ช่วยสอน					
19	ข้าพเจ้าเตรียมตัว ก่อนเข้าเรียนโดยใช้คอมพิวเตอร์ช่วยสอน					
20	ข้าพเจ้ารู้สึก กระตือรือร้นอยากเรียนมากขึ้น เมื่อเรียนด้วยบทเรียนคอมพิวเตอร์ช่วยสอน					
21	ข้าพเจ้ารู้สึกว่า ได้ใช้ความสามารถอย่างเต็มที่ กับบทเรียนคอมพิวเตอร์ช่วยสอน					
22	ข้าพเจ้า ได้เรียนรู้มากมาย จากบทเรียนคอมพิวเตอร์ช่วยสอน					
23	บทเรียนคอมพิวเตอร์ช่วยสอน ช่วยพัฒนา ทักษะความสามารถในการแก้ปัญหาของข้าพเจ้า					
24	บทเรียนคอมพิวเตอร์ช่วยสอน ช่วยพัฒนาทักษะทางด้าน การคิดอย่างพินิจพิเคราะห์ของข้าพเจ้า					
25	บทเรียนคอมพิวเตอร์ช่วยสอน ช่วยเพิ่มระดับความสนใจ ในเนื้อหาของข้าพเจ้า ให้สูงขึ้น					
26	ข้าพเจ้าสนุกสนานกับการเรียน เมื่อเรียนด้วยบทเรียนคอมพิวเตอร์ช่วยสอน					
27	ข้าพเจ้ารู้สึกเป็นอิสระ เมื่อเรียนด้วยบทเรียนคอมพิวเตอร์ช่วยสอน					
28	บทเรียนคอมพิวเตอร์ช่วยสอน ช่วยให้ข้าพเจ้าตระหนักถึง ความสนใจและความสามารถพิเศษของตัวข้าพเจ้าเอง					
29	เวลาที่ใช้ในการทำแบบฝึกหัดในบทเรียนคอมพิวเตอร์ช่วยสอน มีความเหมาะสม					
30	บทเรียนคอมพิวเตอร์ช่วยสอน ช่วยกระตุ้นให้ข้าพเจ้าได้เรียนอย่างเต็มกำลังความสามารถของข้าพเจ้า					

โปรดพลิก

Figure J.9: Experimental group questionnaire form (Thai) cont.

ข้อเสนอแนะอื่นๆ

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ขอขอบคุณ

ผู้วิจัย

Figure J.10: Experimental group questionnaire form (Thai) cont.

UNIVERSITY OF TECHNOLOGY SYDNEY

แบบสอบถาม

โครงการวิจัย วิทยานิพนธ์ดุษฎีบัณฑิตสาขาเทคโนโลยี

เรื่อง: การพัฒนาและประเมินผล การใช้บทเรียนคอมพิวเตอร์ช่วยสอน "วิชา เทคโนโลยีสารสนเทศเพื่อชีวิต"

ณ มหาวิทยาลัยราชภัฏนครปฐม ประเทศไทย

แบบสอบถามนี้ ผู้วิจัย มีความประสงค์ที่ จะทราบเจตคติของนักศึกษาที่มีต่อ บทเรียนคอมพิวเตอร์ช่วยสอน (CAI) ในรายวิชา เทคโนโลยีสารสนเทศเพื่อชีวิต รหัสวิชา 4000107 ที่นักศึกษา ได้ศึกษา มาแล้ว เรื่อง

- องค์ประกอบของเครื่องคอมพิวเตอร์และการทำงาน
- อินเทอร์เน็ต
- การสื่อสารข้อมูล

แบบสอบถามนี้ ไม่มีผลใดๆ ต่อนักศึกษา ทั้งสิ้น ข้อมูลทั้งหมด จะถูกเก็บไว้เป็นความลับ ขอให้นักศึกษาช่วย ตอบข้อคำถาม ตามความรู้สึกของนักศึกษาจริง ๆ

ข้อมูลทั่วไปเกี่ยวกับผู้ตอบแบบสอบถาม (โปรดใส่เครื่องหมาย ✓ลงในช่องสี่เหลี่ยม)

เพศ ☐ ชาย ☐ หญิง

นักศึกษามีเครื่องคอมพิวเตอร์ใช้ที่บ้านหรือที่หอพักไม่ ☐ มี ☐ไม่มี

เจตคติที่มีต่อบทเรียนคอมพิวเตอร์ช่วยสอน

โปรดใส่เครื่องหมาย ✓ลงในช่องที่ตรงกับความคิดเห็นหรือความรู้สึกของนักศึกษา (ข้อละ 1ช่อง เท่านั้น)

ตัวอย่าง

ข้อที่	รายการ	ไม่เห็นด้วยอย่างยิ่ง	ไม่เห็นด้วย	ไม่แน่ใจ	เห็นด้วย	เห็นด้วยอย่างยิ่ง
0	มหาวิทยาลัยราชภัฏนครปฐม เป็นสถาบันอุดมศึกษาที่ดีที่สุด ในจังหวัดนครปฐม				✓	

โปรด ตอบคำถามต่อไปนี้(30 ข้อ)

ข้อที่	รายการ	ไม่เห็นด้วยอย่างยิ่ง	ไม่เห็นด้วย	ไม่แน่ใจ	เห็นด้วย	เห็นด้วยอย่างยิ่ง
1	ภาพรวม โดยภาพรวม คุณภาพของ เนื้อหาในบทเรียนนี้อยู่ในเกณฑ์ ดีมาก					
2	โดยภาพรวม คุณภาพของบทเรียนคอมพิวเตอร์ช่วยสอน(CAI) นี้ อยู่ในเกณฑ์ ดีมาก					

โปรดพลิก

Figure J.11: Control group questionnaire form (Thai)

ข้อที่	รายการ	ไม่เห็นด้วยอย่างยิ่ง	ไม่เห็นด้วย	ไม่แน่ใจ	เห็นด้วย	เห็นด้วยอย่างยิ่ง
	<u>คุณลักษณะของผู้สอน</u>					
3	ผู้สอนได้จัดเตรียมบทเรียนมาเป็นอย่างดี					
4	ผู้สอน ช่วยทำเรื่องยากให้เป็นเรื่องง่าย					
5	ผู้สอน ช่วยกระตุ้นให้ข้าพเจ้าสนใจในการเรียน					
6	ผู้สอนใช้วิธีสอนอย่างเหมาะสม					
7	ผู้สอน ช่วยทำให้บทเรียนน่าสนใจ					
8	ผู้สอน มีความรู้เต็มเปี่ยม					
9	ข้าพเจ้าอยากเรียน กับผู้สอนท่านนี้อีก					
	<u>วัตถุประสงค์</u>					
10	ผู้สอน ได้ชี้แจงวัตถุประสงค์ไว้อย่างชัดเจน					
11	ข้าพเจ้ารู้ดีว่า ข้าพเจ้ามุ่งหวังสิ่งใด จากบทเรียนนี้					
12	ผู้สอน ดำเนินการสอนไปตามวัตถุประสงค์ที่ได้แจ้งไว้					
	<u>ความยากง่าย</u>					
13	ความยาก-ง่าย ในบทเรียนนี้ มีความเหมาะสม กับข้าพเจ้า					
14	บทเรียนนี้ เป็นบทเรียนที่ยากที่สุด เท่าที่ข้าพเจ้าได้เคยเรียนมา					
15	ข้าพเจ้าได้ความรู้จากการอ่านหนังสือมากกว่า จากการเรียนกับผู้สอนท่านนี้					
	<u>การพัฒนาตนเอง</u>					
16	ผู้สอนท่านนี้ ทำให้ข้าพเจ้าต้องใช้ความพยายามในการเรียนเป็นอย่างมาก					
17	ข้าพเจ้าต้องใช้เวลามากกว่า บทเรียนอื่นๆ ในระดับเดียวกัน เมื่อเรียนกับผู้สอนท่านนี้					
18	ข้าพเจ้ารู้สึกเครียดขณะเรียน กับผู้สอนท่านนี้					
19	ข้าพเจ้าเตรียมตัวล่วงหน้า ก่อนเข้าเรียนเสมอ					
20	ข้าพเจ้า กระตือรือร้น อยากเรียนมากขึ้น เมื่อได้เรียนกับผู้สอนท่านนี้					
21	ข้าพเจ้ารู้สึกว่า ได้ใช้ความสามารถอย่างเต็มที่ กับบทเรียนนี้					

Figure J.12: Control group questionnaire form (Thai) cont.

ข้อที่	รายการ	ไม่เห็นด้วยอย่างยิ่ง	ไม่เห็นด้วย	ไม่แน่ใจ	เห็นด้วย	เห็นด้วยอย่างยิ่ง
22	ข้าพเจ้า ได้เรียนรู้มากมาย จากบทเรียนนี้					
23	ผู้สอน ช่วยให้ข้าพเจ้าได้พัฒนาความสามารถในการแก้ปัญหา					
24	ผู้สอน ช่วยให้ข้าพเจ้าได้พัฒนาทักษะ ทางด้านการคิดอย่างพินิจพิเคราะห์					
25	ผู้สอน ช่วยทำให้ข้าพเจ้าสนใจเนื้อหาในบทเรียนมากยิ่งขึ้น					
26	ข้าพเจ้าสนุกสนานกับการเรียน เมื่อเรียนกับผู้สอนท่านนี้					
27	ข้าพเจ้ารู้สึกเป็นอิสระ เมื่อเรียนกับผู้สอนท่านนี้					
28	ผู้สอน ช่วยให้ข้าพเจ้า ตระหนักถึง ความสนใจและความสามารถพิเศษของตัวข้าพเจ้าเอง					
29	เวลาที่ใช้ในการทำแบบฝึกหัดในบทเรียนนี้ มีความเหมาะสม					
30	ผู้สอน ช่วยกระตุ้นให้ข้าพเจ้าได้เรียนอย่างเต็มกำลังความสามารถของข้าพเจ้า					

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Figure J.13: Control group questionnaire form (Thai) cont.

J.1 Summary of attitude survey results

J.1.1 Experiment 1 (Experiment Group)

$N = 104$

Gender: Male = 5, Female = 88, NA = 11

Students owned computers: yes = 28, no = 64, NA = 12

Table J.1: Attitude survey results from Experiment Group for Experiment 1.

Questions	SD	D	U	A	SA	NA
Global Items						
1. Overall, I would rate the quality of the CAI contents as excellent.	0	0	6	**84**	13	1
2. Overall, I would rate the quality of the CAI lesson as excellent.	0	0	13	**81**	9	1
3. CAI lesson was organized well.	0	1	9	**81**	12	1
4. CAI lesson made difficult topics easily understandable.	0	1	18	**69**	16	0
5. The CAI lesson held my attention.	0	4	13	**68**	18	1
6. The CAI lesson used teaching methods which are well suited to the topics.	0	1	8	**83**	12	0
7. The CAI lesson made the subject interesting.	0	0	6	**64**	33	1
8. CAI lesson provided me with a lot of knowledge on the course topics.	0	1	17	**75**	11	0
9. I would like to take another course taught using CAI.	0	3	15	**61**	25	0
Objectives						
10. Objectives of this CAI topic were clearly stated.	0	1	9	**75**	18	1
11. I knew what is expected of me in this topic.	0	0	19	**77**	8	0

Continued on next page

Table J.1 – continued from previous page

Questions	SD	D	U	A	SA	NA
12. The CAI topic objectives were achieved in the lesson.	0	0	13	85	6	0
Difficulty						
13. The level of difficulty of this topic was appropriate for me.	0	0	12	82	9	1
14. This topic is one of the most difficult I've taken.	8	31	36	28	1	0
15. I can learn more from reading books than using CAI.	3	27	36	37	1	0
Student Development						
16. I had to put in more effort when learning with CAI.	2	13	19	65	5	0
17. CAI lesson required more time and effort than others at this level.	1	35	25	40	2	1
18. I felt frustrated while taking CAI lessons.	16	48	16	19	4	1
19. I always prepared before coming to class.	0	12	42	48	1	1
20. Studying with CAI made me keen to learn more.	0	3	16	75	9	1
21. I feel that I performed up to my potential with the CAI lesson.	0	2	17	75	9	1
22.The CAI lesson improved my understanding of concepts in this field.	0	3	6	77	17	1
23. I developed the ability to solve actual problems in this field with this CAI lesson.	0	4	18	67	14	1
24. I developed skills in critical thinking with this CAI lesson.	0	2	22	64	15	1
25. The CAI lesson increased my interest in the subject matter.	0	1	14	71	17	1
26. I enjoyed learning about this subject matter.	0	1	13	65	24	1

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Table J.1 – continued from previous page

Questions	SD	D	U	A	SA	NA
27. I felt free when taking the CAI lesson.	0	3	13	**60**	26	2
28. This CAI lesson made me more aware of my interests and talents.	0	3	22	**67**	11	1
29. I had adequate time to complete the exercises in this CAI lesson.	0	2	19	**70**	12	1
30. This CAI lesson motivated me to do my best.	0	1	15	**67**	20	1

Suggestions/comments:

1. I liked it, it was fun.
2. I want to study more lessons like this.
3. I want more time to learn, because I like very much to learn with CAI.
4. There should be more of this kind of learning.

J.1.2 Experiment 2 (Experiment Group)

$N = 90$

Gender: Male = 5, Female = 73, NA = 12

Students owned computers: yes = 23, no = 52, NA = 15

Table J.2: Attitutude survey results from Experiment Group for Experiment 2.

Questions	SD	D	U	A	SA	NA
Global Items						
1. Overall, I would rate the quality of the CAI contents as excellent.	0	1	5	75	8	1
2. Overall, I would rate the quality of the CAI lesson as excellent.	0	2	16	66	5	1
3. CAI lesson was organized well.	0	2	8	75	5	0
4. CAI lesson made difficult topics easily understandable.	0	3	27	56	4	0
5. The CAI lesson held my attention.	0	2	20	57	11	0
6. The CAI lesson used teaching methods which are well suited to the topics.	0	3	20	62	5	0
7. The CAI lesson made the subject interesting.	0	4	10	63	12	1
8. CAI lesson provided me with a lot of knowledge on the course topics.	0	0	17	58	15	0
9. I would like to take another course taught using CAI.	0	2	20	61	6	0
Objectives						
10. Objectives of this CAI topic were clearly stated.	1	0	13	71	5	0
11. I knew what is expected of me in this topic.	0	1	17	63	8	1
12. The CAI topic objectives were achieved in the lesson.	0	1	12	67	9	1
Difficulty						

Continued on next page

Table J.2 – continued from previous page

Questions	SD	D	U	A	SA	NA
13. The level of difficulty of this topic was appropriate for me.	0	1	18	63	8	0
14. This topic is one of the most difficult I've taken.	8	24	21	30	6	1
15. I can learn more from reading books than using CAI.	2	18	39	25	6	0
Student Development						
16. I had to put in more effort when learning with CAI.	1	13	17	53	6	0
17. CAI lesson required more time and effort than others at this level.	0	19	20	49	1	1
18. I felt frustrated while taking CAI lessons.	3	37	21	24	5	0
19. I always prepared before coming to class.	0	8	31	47	4	0
20. Studying with CAI made me keen to learn more.	0	2	17	63	7	1
21. I feel that I performed up to my potential with the CAI lesson.	0	1	23	55	11	0
22.The CAI lesson improved my understanding of concepts in this field.	0	0	10	70	10	0
23. I developed the ability to solve actual problems in this field with this CAI lesson.	0	1	23	55	11	0
24. I developed skills in critical thinking with this CAI lesson.	0	0	18	60	12	0
25. The CAI lesson increased my interest in the subject matter.	0	3	13	63	10	1
26. I enjoyed learning about this subject matter.	0	1	21	59	9	0
27. I felt free when taking the CAI lesson.	0	2	11	55	21	1
28. This CAI lesson made me more aware of my interests and talents.	0	2	13	65	10	0

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Table J.2 – continued from previous page

Questions	SD	D	U	A	SA	NA
29. I had adequate time to complete the exercises in this CAI lesson.	0	1	9	67	13	0
30. This CAI lesson motivated me to do my best.	0	0	17	60	13	0

Suggestions/comments:

1. Teaching with computers is good, but students want handouts. It is convenient and makes it easier to understand.

J.1.3 Experiment 3 (Experiment Group)

$N = 95$

Gender: Male = 7, Female = 75, NA = 13

Students owned computers: yes = 23, no = 55, NA = 17

Table J.3: Attitutude survey results from Experiment Group for Experiment 3.

Questions	SD	D	U	A	SA	NA
Global Items						
1. Overall, I would rate the quality of the CAI contents as excellent.	0	2	6	**81**	5	1
2. Overall, I would rate the quality of the CAI lesson as excellent.	0	2	8	**79**	5	1
3. CAI lesson was organized well.	0	4	4	**74**	13	0
4. CAI lesson made difficult topics easily understandable.	0	3	24	**56**	12	0
5. The CAI lesson held my attention.	0	5	13	**57**	19	1
6. The CAI lesson used teaching methods which are well suited to the topics.	0	2	10	**76**	7	0
7. The CAI lesson made the subject interesting.	0	1	9	**66**	18	1
8. CAI lesson provided me with a lot of knowledge on the course topics.	0	2	8	**69**	16	0
9. I would like to take another course taught using CAI.	0	4	9	**65**	16	1
Objectives						
10. Objectives of this CAI topic were clearly stated.	0	1	11	**74**	9	0
11. I knew what is expected of me in this topic.	0	1	16	**61**	15	2
12. The CAI topic objectives were achieved in the lesson.	0	3	12	**75**	5	0
Difficulty						

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Table J.3 – continued from previous page

Questions	SD	D	U	A	SA	NA
13. The level of difficulty of this topic was appropriate for me.	0	3	14	74	3	1
14. This topic is one of the most difficult I've taken.	4	33	26	25	5	2
15. I can learn more from reading books than using CAI.	0	24	25	37	9	0
Student Development						
16. I had to put in more effort when learning with CAI.	0	7	20	54	14	0
17. CAI lesson required more time and effort than others at this level.	3	24	28	36	3	1
18. I felt frustrated while taking CAI lessons.	7	35	19	29	5	0
19. I always prepared before coming to class.	1	3	26	59	5	1
20. Studying with CAI made me keen to learn more.	0	3	16	61	15	0
21. I feel that I performed up to my potential with the CAI lesson.	0	1	13	72	9	0
22.The CAI lesson improved my understanding of concepts in this field.	0	1	12	61	20	1
23. I developed the ability to solve actual problems in this field with this CAI lesson.	0	2	11	62	19	1
24. I developed skills in critical thinking with this CAI lesson.	0	2	13	63	16	1
25. The CAI lesson increased my interest in the subject matter.	0	2	12	56	25	0
26. I enjoyed learning about this subject matter.	0	1	15	62	17	0
27. I felt free when taking the CAI lesson.	0	1	5	66	23	0
28. This CAI lesson made me more aware of my interests and talents.	0	2	18	65	10	0

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Table J.3 – continued from previous page

Questions	SD	D	U	A	SA	NA
29. I had adequate time to complete the exercises in this CAI lesson.	2	4	10	66	11	2
30. This CAI lesson motivated me to do my best.	0	1	13	64	17	0

Suggestions/comments:

1. It is a good method of teaching, but there should be handouts for students.

J.1.4 Experiment 1 (Control Group)

$N = 151$

Gender: Male = 35, Female = 112, NA = 4

Students owned computers: yes = 55, no = 90, NA = 6

Table J.4: Attitutude survey results from Control Group for Experiment 1.

Questions	SD	D	U	A	SA	NA
Global Items.						
1. Overall, I would rate the quality of this lesson as excellent.	0	3	12	**124**	12	0
2. Overall, I would rate this instructor as excellent.	0	0	9	**111**	31	0
Instructor Characteristics.						
3. My instructor organized this lesson well.	1	4	17	**106**	21	2
4. My instructor makes difficult topics easily understandable.	4	13	50	**75**	8	1
5. My instructor held my attention.	1	10	37	**86**	16	1
6. My instructor used teaching methods well suited to the lesson.	1	8	29	**94**	18	1
7. My instructor made the subject interesting.	0	5	36	**94**	15	1
8. My instructor is knowledgeable on the course topics.	0	1	16	**89**	44	0
9. I would like to take another course with this instructor.	2	3	35	**87**	21	3
Objectives.						
10. Objectives of this topic were clearly stated.	1	4	26	**104**	15	1
11. I knew what is expected of me in this topic.	1	3	28	**97**	21	1
12. Announced topic objectives agreed with what was taught.	1	4	20	**111**	12	3
Difficulty						

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Table J.4 – continued from previous page

Questions	SD	D	U	A	SA	NA
13. The level of difficulty of this topic was appropriate for me.	1	6	47	**89**	7	1
14. This topic is one of the most difficult I've taken.	4	41	**60**	39	6	1
15. I can learn more from books than from this instructor.	15	**51**	43	41	0	1
Student Development.						
16. I had to put in more effort when learning with this instructor.	2	20	38	**80**	10	1
17. The lesson required more time and effort than others at this level.	4	42	**52**	49	3	1
18. Learning with this instructor is very frustrating.	23	**66**	28	27	5	2
19. I always prepare before coming to class.	7	13	60	**65**	3	3
20. Studying with this instructor made me keen to learn more.	2	2	60	**81**	5	1
21. I feel that I performed up to my potential with this lesson.	2	4	33	**100**	11	1
22. I learned a lot from this lesson.	1	4	37	**92**	10	7
23. I developed the ability to solve actual problems in this field.	1	3	33	**98**	8	8
24. I developed skills in critical thinking with this lesson.	0	6	20	**106**	12	7
25. This lesson increased my interest in the subject matter.	0	3	31	**100**	8	9
26. I enjoyed learning about this subject matter.	1	9	39	**81**	13	8
27. I felt free, without anyone forcing me to study.	0	8	27	**86**	22	8
28. This lesson made me more aware of my interests and talents.	0	5	31	**97**	11	7

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Table J.4 – continued from previous page

Questions	SD	D	U	A	SA	NA
29. I had adequate time to complete the exercises in this lesson.	0	4	35	92	13	7
30. The instructor motivated me to do my best.	1	4	31	95	13	7

Suggestions/comments:

1. 15 of the 22 students said that the instructor spoke too quickly, making it difficult for students to take notes.
2. Students commented that they should be given a handout of the course outline.
3. The instructor's teaching was good.
4. The lesson was boring. There should be some activities for the students during the class.

J.1.5 Experiment 2 (Control Group)

$N = 103$

Gender: Male = 28, Female = 67, NA = 8

Students owned computers: yes = 24, no = 63, NA = 16

Table J.5: Attitutude survey results from Control Group for Experiment 2.

Questions	SD	D	U	A	SA	NA
Global Items.						
1. Overall, I would rate the quality of this lesson as excellent.	0	1	9	**81**	10	2
2. Overall, I would rate this instructor as excellent.	0	0	8	**68**	25	2
Instructor Characteristics.						
3. My instructor organized this lesson well.	0	1	5	**70**	27	0
4. My instructor makes difficult topics easily understandable.	2	7	40	**49**	5	0
5. My instructor held my attention.	0	8	**43**	**43**	9	0
6. My instructor used teaching methods well suited to the lesson.	0	4	12	**77**	10	0
7. My instructor made the subject interesting.	0	2	20	**65**	15	1
8. My instructor is knowledgeable on course topics.	0	2	15	41	**45**	0
9. I would like to take another course with this instructor.	0	0	26	**56**	21	0
Objectives.						
10.Objectives of this topic were clearly stated.	0	1	19	**68**	13	2
11. I knew what was expected of me in this topic.	0	0	21	**71**	10	1
12. Announced topic objectives agreed with what was taught.	0	1	17	**71**	14	0
Difficulty.						

Continued on next page

Table J.5 – continued from previous page

Questions	SD	D	U	A	SA	NA
13. The level of difficulty of this topic was appropriate for me.	1	3	33	59	7	0
14. This topic is one of the most difficult I've taken.	7	33	40	20	2	1
15. I can learn more from books than from this instructor.	9	44	22	21	4	3
Student Development.						
16. I had to put in more effort when learning with this instructor.	2	19	32	45	5	0
17. The lesson required more time and effort than others at this level.	11	32	25	31	3	1
18. Learning with this instructor is very frustrating.	21	43	23	13	2	1
19. I always prepare before coming to class.	2	16	54	26	5	0
20. Studying with this instructor made me keen to learn more.	2	5	33	56	6	1
21. I feel that I performed up to my potential with this lesson.	1	0	21	69	12	0
22. I learned a lot from this lesson.	1	3	18	64	14	3
23. I developed the ability to solve actual problems in this field.	1	3	20	66	10	3
24. I developed skills in critical thinking with this lesson.	1	2	11	75	12	2
25. This lesson increased my interest in the subject matter.	1	1	22	65	12	2
26. I enjoyed learning about this subject matter.	1	8	31	50	9	4
27. I felt free, without anyone forcing me to study.	1	2	16	59	23	2
28. This lesson made me more aware of my interests and talents.	1	4	26	62	8	2

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Table J.5 – continued from previous page

Questions	SD	D	U	A	SA	NA
29. I had adequate time to complete the exercises in this lesson.	0	0	23	64	14	2
30. The instructor motivated me to do my best.	0	4	28	56	13	2

Suggestions/comments:

1. 5 of the 8 students said that the instructor spoke too quickly, making it difficult for students to take notes.
2. This instructor should come and teach the whole course to me.
3. There should be computers available for students to practice their work.
4. The instructor is knowledgeable. I was not frustrated in his class, and hence was eager to learn.

J.1.6 Experiment 3 (Control Group)

$N = 106$

Gender: Male = 23, Female = 66, NA = 17

Students owned computers: yes = 27, no = 58, NA = 21

Table J.6: Attitutude survey results from Control Group for Experiment 3.

Questions	SD	D	U	A	SA	NA
Global Items.						
1. Overall, I would rate the quality of this lesson as excellent.	0	2	18	75	10	1
2. Overall, I would rate this instructor as excellent.	0	3	12	74	15	2
Instructor Characteristics.						
3. My instructor organized this lesson well.	0	1	14	79	12	0
4. My instructor makes difficult topics easily understandable.	0	3	34	60	9	0
5. My instructor held my attention.	1	5	33	63	4	0
6. My instructor used teaching methods well suited to the lesson.	0	2	23	70	10	1
7. My instructor made the subject interesting.	0	3	26	64	13	0
8. My instructor is knowledgeable on the course topics.	0	0	17	63	24	2
9. I would like to take another course with this instructor.	0	2	29	61	13	1
Objectives.						
10. Objectives of this topic were clearly stated.	0	0	26	66	12	2
11. I knew what was expected of me in this topic.	0	1	25	69	10	1
12. Announced topic objectives agreed with what is taught.	0	2	25	67	12	0
Difficulty.						

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Table J.6 – continued from previous page

Questions	SD	D	U	A	SA	NA
13. The level of difficulty of this topic was appropriate for me.	3	6	42	**49**	6	0
14. This topic is one of the most difficult I've taken.	6	17	**40**	38	4	1
15. I can learn more from books than from this instructor.	7	16	35	**41**	5	2
Student Development.						
16. I had to put in more effort when learning with this instructor.	2	14	38	**44**	8	0
17. The lesson required more time and effort than others at this level.	5	17	38	**42**	3	1
18. Learning with this instructor is very frustrating.	12	23	29	**35**	5	2
19. I always prepare before coming to class.	2	8	**49**	42	4	1
20. Studying with this instructor made me keen to learn more.	2	6	32	**62**	4	0
21. I feel that I performed up to my potential with this lesson.	1	2	25	**69**	9	0
22. I learned a lot from this lesson.	1	3	22	**66**	9	5
23. I developed the ability to solve actual problems in this field.	1	4	18	**69**	9	5
24. I developed skills in critical thinking with this lesson.	1	1	15	**73**	12	4
25. This lesson increased my interest in the subject matter.	1	2	20	**70**	9	4
26. I enjoyed learning about this subject matter.	1	2	25	**65**	9	4
27. I felt free, without anyone forcing me to study.	1	3	15	**63**	19	5
28. This lesson made me more aware of my interests and talents.	1	2	28	**63**	8	4

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Table J.6 – continued from previous page

Questions	SD	D	U	A	SA	NA
29. I had adequate time to complete the exercises in this lesson.	0	6	26	**61**	8	5
30. The instructor motivated me to do my best.	1	3	16	**70**	12	4

Suggestions/comments:

1. 4 of the 8 students said that the instructor spoke too quickly, making it difficult for students to take notes.
2. 2 of the 8 students said the lesson was very good.
3. There was not enough time to complete all the material presented in this lesson.

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