2006

The Development of the Collaborative Intelligent Computer-Assisted Instruction Model Using Computer Network (CICAI Model)

W Arreerard
KMITNB

S Sanrach
KMITNB

M Tiantong
KMITNB

Originally published in the Proceedings of the EDU-COM 2006 International Conference. Engagement and Empowerment: New Opportunities for Growth in Higher Education, Edith Cowan University, Perth Western Australia, 22-24 November 2006.

Arreerard, W., Sanrach, C, and Tiantong, M. The Development of the Collaborative Intelligent Computer-Assisted Instruction Model Using Computer Network (CICAI Model

Arreerard, W[1]., Sanrach, C[2]. and Tiantong, M.[3]

[1]Department of Computer Education
KMITNB, Bangkok THAILAND
E-mail : Wittaya@rmu.ac.th

[2]Department of Computer Education
KMITNB, Bangkok THAILAND
E-mail : Jsr@kmitnb.ac.th

[3]Department of Computer Education
KMITNB, Bangkok THAILAND
E-mail : Mtt@kmitnb.ac.th

ABSTRACT

The purpose of this research was to construct the CICAI model, to develop the lessons based on the CICAI model, to compare the achievement of students who learned with the developed lessons to students who had a regular class and to survey the satisfaction of students with the developed lessons, and 5) assess a thinking-skill process after learning with the developed lessons. The research instruments used were five rating-scale questionnaire and achievement test. The sample subjects were ten experts and sixty students. The research statistics used were mean, standard deviation and t-test.

Results of the research were as follows: According to the opinions of the experts toward the CICAI model, it was found that the average degree of the opinions was high (mean = 4.44), S.D. = 0.57). In regard the average degree of the opinions of the experts toward the developed lessons was high (mean= 4.37, S.D. = 0.54). According to the comparison of students' achievement, it indicated that the scores of the experimental group (mean = 79.10) and the controlled group (mean = 62.30) were significantly different. The average degree of students' satisfaction with the developed lessons was high (mean = 4.55, S.D. = 0.62). In regard to a thinking-skill process, it indicated that the score of the thinking-skill process after learning with the developed lessons (mean = 28.37) was significantly higher than before learning with the developed lessons (mean = 12.40) at .the 0.05 level.

In conclusion, the findings indicate that the CICAI model is an efficient model, and the effectiveness of the model is a basic standard criterion of the CICAI model. Further study, the CICAI model will be applied to a new different group of students such as level of education, major study, age, sex, etc.

INTRODUCTION

At present the computer technology, computer network and internet network have been developed continually. It is obvious that the modern technology has been used for educational purposes gradually. The potentiality of the modern technology enables students to learn collaboratively and continually (Wichuda 1999). Furthermore, the educational technology provides an opportunity with an inter-personal interactive learning system to learn anytime and anywhere independently. And the online-learning system decreases the interval of the differences in time, place and participants. Result of the online-learning system indicated that the level of the achievement was satisfying (Jaitip 1999).

Computer-based Training (CBT) and Computer-Aided Instruction (CAI) have been developed for the instructional purpose. It is obvious that the efficiency and high speed of the internet network has been adapted to the online-learning system called Web-Based Instruction (WBI), or Web-Based Training (WBT). The Intelligent Computer-Assisted Instruction (ICAI) or the Intelligent Tutoring System (ITS) is an efficient lessons regarding to the individual difference of learners (Beck et al 1996). The system of the lessons is flexible to learners. The system of management provides a teacher to work with a learner, analyse learners' needs and background knowledge and get suitable and quick feedback (Damrongwong 1997).

However, the computer-assisted instruction is individual lessons, or a none-interactive lesson. Therefore, the researcher is interested in developing the collaborative intelligent computer-assisted instruction, which the lessons are designed focusing on the principles of the computer-assisted instruction and collaborative learning. The learning system focuses on the needs and individual differences of learners. The learners are able to share their experience in learning with the collaborative intelligent computer-assisted instruction to their friends. The lessons provide learners to get creative idea, problem-solving skills, and also self-study skills.

PURPOSE OF THE RESEARCH

The purposes of this research were to 1) construct the CICAI model, 2) develop the lessons based on the CICAI model, 3) compare the achievement of students who learned with the developed lessons to students who had a regular class, 4) survey the satisfaction of students with the developed lessons, and 5) study a thinking-skill process after learning with the developed lessons.

RELATED WORK

Woolf claimed that ICAI consists of 4 components: student module, pedagogical module, domain knowledge module, expert module and communication module but Beck et al. (1996) supported that ICAI has the same components like ICAI of Woolf, but the expert module is an independent module separated from a domain knowledge module. Limance and Raymund (1998) presented a new model of a collaborative learning system with an agent. The researcher has presented an architectural system consisted of 3 main models: tutor model (contents and exercises), student model (personal information), and spy model (pedagogical agent). CSILE (Computer Supported Intentional Learning Environment) (Scardamalia 1999) is an open interactive learning system, which teachers and learners are able to interact and share their knowledge, and also create new knowledge by selecting a communication mode. WebCT (McConnell 2000) is a system of bulletin board communication, which all participants can communicate immediately by e-mail. CALE (Computer Assisted Learning and Exploration) (Mahling et al. 1995) is a collaborative problem-based-learning system. It was used for a medical study taught with an electronic blackboard. There was the example of PBL on the electronic blackboard divided into 3 groups: observed facts, hypothesis and need more information. Web ICL (Jianhua and Akahori 2000) is a collaborative learning system, which the roles of teachers were assigned to an instructional management such as student management grouping management, information management. The teachers were able to communicate with students through Synchronous and Asynchronous communication tools. The evaluation of students was divided into 2 types: a group work and an individual work. Guo and Sun (2002) suggested integrating the mechanic of CSCL with the collaborative intelligent computer-assisted instruction model. The mechanic system is able to control students to work and also give them suggestion and recommendation. Jianhua et al. (2001) presented the collaborative web-based learning environment, and suggested that the learning environment should consist of 3-4 learners and learn with supported communication tool.

RESEARCH METHODOLOGY

Scope of the research

The contents focused on Computer programming and Algorithm (4121103), a core course in computer science curriculum of the Computer Science Program at Rajabhat Maha Sarakham University, THAILAND. The course description was about the components and function of

hardware and software, a variety of computer languages, principles of computer programming and operating including the procedure and development of computer programming, design and analysis of structure including Algorithm design of sequential decision, repetition, modular and recursion.

Procedure

Procedure of the research consisted of five steps: 1) develop the model of Collaborative Intelligent Computer-Assisted Instruction: CICAI and check the effectiveness by the experts. 2) develop the lessons based on the CICAI model consisting of: 2.1) design architecture of the lessons. 2.2) design domain knowledge of the lessons. 2.3) design student module and content module.2.4) design collaborative online learning environment. 2.5) develop the lessons with computer language and check the effectiveness of the lessons. 2.6) assess the effectiveness of the lessons based on the criteria E1/E2. 2.7) examine the effectiveness of the instructional techniques used in the lessons by the experts. 3) try out the lessons accordance with the research design as follows : 3.1) do pre-test on both an experimental group and a controlled group. 3.2) assess a thinking skill process of an experimental group before learning with the lessons. 3.3) try out based on the research design. 3.4) assess the achievement of both the experimental group and controlled group after learning with the lessons. 3.5) assess a thinking skill process after learning with the lessons. And 4) evaluation of the experiment consisted of data collection, analysis and conclusion.

Experimental Design

An experimental design: Randomize controlled group pretest-posttest design

Table-1 The experimental design

Sample Subjects	Pretest	Treatment	Posttest
Experimental group (E1R)	T1, T2	X1	T1, T2
Controlled group (CR)	T1	-	T1

X1 is learning with the developed lessons.
T1 is Pretest and Posttest of the achievement.
T2 is Pretest and Posttest of the thinking skill process.

Subject

The sample subjects were divided into two groups: 1) Ten experts were divided into two groups. Group 1 was five experts in evaluating the quality of the CICAI model, and the other was five experts in evaluating the quality of the lessons. 2) Sixty students of the Computer Science Program at Rajabhat Maha Sarakham University were divided into two groups of thirty students, an experimental group (E1R) and a controlled group (CR).

Research Instruments

The research instruments consisted of: 1) Three forms of Rating-scale questionnaire for evaluating CICAI, and the lessons and surveying the satisfaction of students. 2) One hundred items of pretest and posttest of an achievement test. And 3) Thirty six items of a thinking skill process test.

Research Statistics

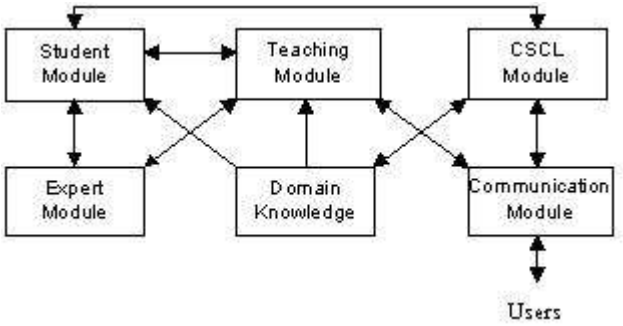
The research statistics used were as follows: 1) Mean and standard deviation were used to analyse the opinions of the experts toward the CICAI model and the lessons, and also analysed the opinions of students toward the lessons. 2) T-test was used to analyse the average scores of pretest and posttest, and the average scores of the thinking skill process of the experimental group and controlled group.

RESULTS OF THE RESEARCH

The results were divided into two parts:
Part-1: The development of CICAI and lessons.
Part-2: The results of the research.

Part-1: The Development of the CICAI
The CICAI Model

The model of the CICAI consisted of 6 modules integrated the components of ICAI whose five components were student module, expert module, domain knowledge module, teaching module and communication module with the module of CSCL. The ICAI module was designed to present the contents based on students' background, whereas, the CSCL module was designed to provide learners with collaborative learning environment. The six modules were shown in the figure 1.



Figfure-1 The components of the CICAI.

Figure 1 illustrated 6 modules of CICAI as follows: 1) expert module was used to analyse of the background knowledge of students, content analysis and topic order, and data collection. 2) Domain knowledge was used to collect the contents, exercises and tests. 3) Student module was used to collect the students' information, the progress of the students and learning styles of the students. 4) Teaching module concerned with content collection and management based on the students' background knowledge. 5) Communication module was used to control the interaction between users and system and 6) CSCL was used to support the roles of a teacher in collaborative learning: grouping students, checking students' works, making a test, announcement or question, and also the roles of students in collaborative learning: group work and announcement and question.

Moreover, all modules were connected and shared the data with another module. 1) The expert module analysed the background knowledge of students using the data from the student module, and sent back the data of their background knowledge to the student module. 2) The content module was connected and shared the data with the student module, the teaching module and the CSCL module. 3) The student module was connected and shared the data with the expert module and the teaching module. 4) The teaching module was connected and shared the data with the expert module, the student module, the content module, and communication module. 5) The communication module was designed to present the contents of the lessons to students, and group work and individual work tasks from the CSCL module. 6) The CSCL module was connected and shared the data with the student module, the content module and the communication module.

The Evaluation of the CICAI

The CICAI model was evaluated by the experts presented in table-1.

Table-1 The Opinions of the experts toward the CICAI model.

Items	X	S.D.	Degree of Opinion
1. The overall components	4.50	0.54	high
2. Function of expert module	4.33	0.82	high
3. Domain knowledge module	4.70	0.50	Very high
4. Function of student module	4.67	0.52	Very high
5. Function of teaching module	4.50	0.50	high
6. Function of communication module	4.17	0.75	high
7. Function of CSCL module	4.33	0.82	high
Total	4.45	0.63	high

The results indicated that the average degree of the opinions of the experts toward the CICAI model was high (X = 4.45 and S.D. = 0.63).

Part-1: The Development of Lessons.

Architectural Design

The architectural design of lessons illustrated as in the figure-2.

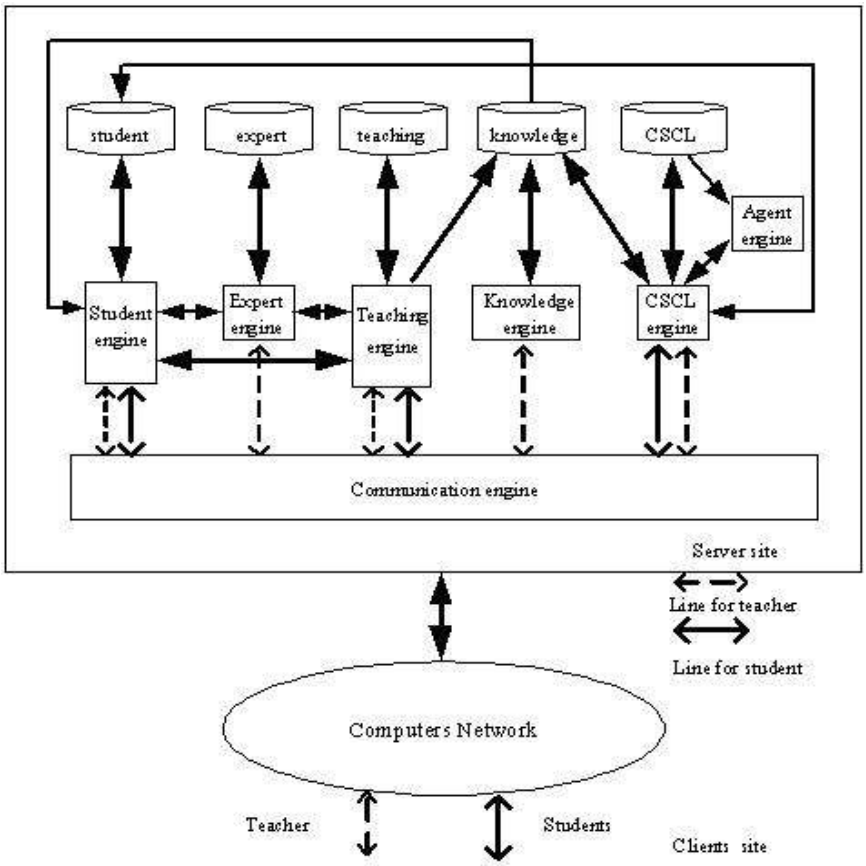


Figure-2 the architectural design of lessons

Figure-2 illustrated that the architectural system consisted of many databases and engine of data management. The databases were linked to another database, so students were able to access to the database through three channels: student database, instructional database, and CSCL database while teacher was able to access to all databases.

Domain Knowledge

The design of domain knowledge of lessons illustrated as in the figur-3.

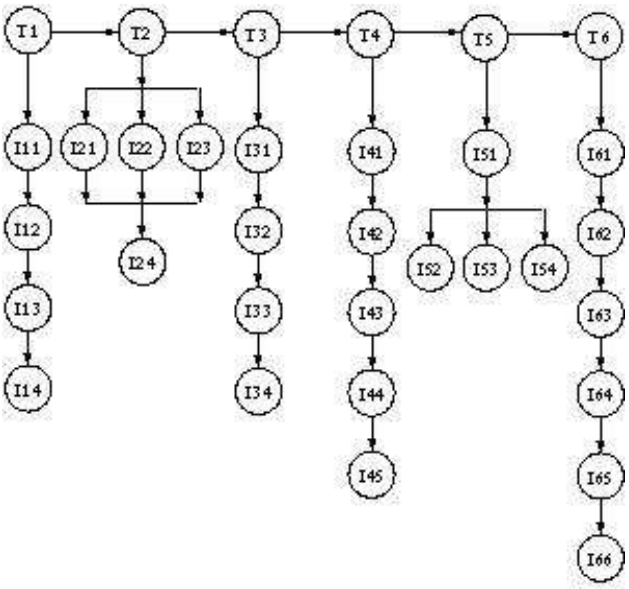


Figure-3 The domain knowledge of lessons

Figure-3 illustrated the lessons of the domain knowledge module which each lesson contained 6 Main topics with sub-topic. Students learned with the learning model respectively (T1 – T2 – T3 etc.)

Presentation

The design of student model was an overlay model. Students had to learn the assigned topic and sub-topic according to the domain knowledge. Dynamic presentation of the contents consisted of three forms: an explanation, an explanation with examples and conclusion. The contents of the lessons were adapted for students using the Confidence Factor (CF). CF value indicates the cognitive level of students. If students get a high value of confidence factor, it indicates that students comprehend the content more precisely and the lessons are presented in a conclusive form. On the other hand, if students get a low value of confidence factor, it indicates that students do not comprehend the content precisely and the lessons are presented in an explanatory form.

Environments

A model of the design of an online learning environment was illustrated as follows: 1) Two forms of communication: a synchronous communication by chat, and an electronic whiteboard for communicating between teacher and student, or student and student. 2) Students were divided into groups of three-four students with different cognitive level. 3) Group management used a numbered head technique; students had their own different number. 4) Collaborative learning method was problem based learning. 5) Evaluation consisted of three sources of scores: work group, exercises and test. And 6) Agent was used to monitor the participation and language use of students.

The Evaluation of the Lessons

The effectiveness of the lessons evaluated by E1/E2 shown as in table-3

Table-3 The effectiveness of the lessons

Lesson	Effectiveness	
	E1	E2
Effectiveness	83.33	82.63

The result indicated that the effectiveness of the lessons model was higher than the criteria. The scores of E1/E2 were 83.33/82.63.

The evaluation of the lessons by the experts shown as in table-4.

Table-4 The opinions of the experts toward the lessons.

Dimensions	Mean	S.D.
Effectiveness of the lessons		
Management system	4.42	0.59
Teacher supporting system	4.47	0.51
Learner supporting system	4.23	0.43
Mean	4.37	0.51
Accuracy of the lessons		
Management system	4.28	0.71
Teacher supporting system	4.23	0.43
2.3 Learner supporting system	4.61	0.58
Mean	4.37	0.57
Accessibility of the lessons		
Management system	4.43	0.57
Teacher supporting system	4.45	0.51
3.3 Learner supporting system	4.46	0.48
Mean	4.44	0.52
Contents	4.14	0.63
Total	4.37	0.54

In regard to the three dimensions of the lesson evaluation, it was found that the average level of the four dimensions was high, effectiveness (Mean = 4.37 S.D. = 0.51), accuracy (Mean = 4.37 S.D. = 0.57), convenience (Mean = 4.44 S.D. = 0.52), and contents. (Mean = 4.14 S.D. = 0.63).

Part-2 : Results of The Research

Achievement

The comparison of post-test scores between E1R and CR by using t-test based on the hypotheses as follows :

H0 : The post-test scores between E1R and CR are not different.
H1 : The post-test scores of E1R are higher than the scores of CR after learning with the lessons.

The calculated post-test scores shown as in table-5.

Table-5 The comparison of post-test scores between E1R and CR.

Group	Number	Average scores	T	Sig.
E1R	30	79.10	15.57	.000
CR	30	62.30		

Value of validity is 95% (α = .05)

The results indicated that the post-test scores of E1R were significantly higher than CR at the 0.05 level.

Degree of Satisfaction

The satisfaction of E1R with the lessons shown as in table-6

Table-6 The satisfaction of E1R with the lessons.

Items	Mean	S.D.	Degree of satisfaction
1. Online lessons	4.73	0.45	Very high
2. Instructional network	4.67	0.55	Very high
3. Model of instructional presentation through network	4.57	0.68	Very high
4. Assignment	4.37	0.61	High
5. Learning activities	4.63	0.56	Very high
6. Learning Performance of members	4.37	0.72	High
7. Collaborative learning activities	4.50	0.68	High
8. Evaluation	4.67	0.66	Very high
9. Participation of members	4.46	0.62	high
Mean	4.55	0.62	Very high

The results indicated that the average degree of the satisfaction of E1R with the lessons was very high (Mean = 4.5 S.D. = 0.62).

Thinking-Skill Process

The comparison of pre-test scores and post-test scores of thinking skill process of E1R by using t-test based on the hypotheses as follows:

H0 : The average scores of pre-test and post-test scores of E1R are not different.

H1 : The post-test scores of E1R are higher than the scores after learning with the lessons.

The calculated pre-test and post-test scores shown as in table-7.

Table-7 The comparison between pre-test and post-test scores of E1R of thinking skill process

Duration	Mean	t	Sig.
Before learning with the lessons	12.40	23.40	.000
After learning with the lessons	28.37		

Value of validity is 95% (α = .05)

The results revealed that the average pre-test and post-test scores of E1R on thinking-skill process were significantly different at .the 0.05 level.

CONCLUSION

The developed CICAI model consisted of 6 modules: expert module, teaching module, domain knowledge module, communication module, student module and CSCL module. According to the evaluation of the experts, it indicated that the average degree of the opinions of the experts toward the CICAI model was high, and it indicated that the level of effectiveness of the developed lessons was high. In regard to the achievement of the students, it indicated that the scores of E1R was significantly higher than CR at 0.05 level. Moreover, the results indicated that E1R had more thinking skill and satisfied more with the lessons.

In conclusion, the findings indicate that the CICAI model is an efficient model, and the effectiveness of the model is a basic standard criteria of the CICAI model. Further study, the CICAI model will be applied to a new different group of students such as level of education, major study, age, sex, etc.

REFERENCES

Damrongwong Kampol. (1997) Development of the model of intelligent computer-assisted instruction for teaching conceptual construction, Bangkok, graduate school Chulalongkorn University.

Jaitip N songklha. (1999) Web based Instruction, Bangkok, Faculty of Education Chulalongkorn University.

Jianhua Zhao and Akahori Kanji. (2000) Web-base Collaborative Learning Methods and Strategies in Hiher Education, Available online at http://www.eecs.kumamoto-u.ac.jp/ITHET01/proc/139.pdf

Jianhua Zhao, and Likedony, and Akahori Kanji.(2001) Modelling and System Design for web Based Collaborative learning, Available online at http:\\www.eecs.kumamoto_u.ac.jp/ITHET01/proc/084.pdf

Joseph Beck and Mia stern, and Erik Haugsjaa.(1996) Applications of AI in Education, Available online at http://www.acm.org/crossroads/xrds3-1/aied.html.

Guo Hong and Sun Jun-ming.(2002) Research and Design of Intelligent Teaching Model and Collaborative Learning Mechanism, The 7th International Conference on 25-27 September, 2002. Page 465-469.

Limance, Teresita C.and Raymund C. Sison.(1998) Agent-Based Collaborative Learning Environment for Intelligent Tutoring System (ITS), Available online at http://www.psi.dlsu.edu.ph/ccs/csp/csp/docs/proceedings/posters/agen%zobase.pdf

Mahling, D. E., Sorrows, B. B., and Skogdeid, I. (1995) A Collaborative Environment for Semi-Structured Medical Problem Based Learning, In Proceedings of CSCL'95.

McConnell, D. (2000) Implementing Computer Supported Cooperative Learning, London:Kogan Page Limited.

Scardamalia, M. (1999) Engaging Students In a Knowledge Society, Paper Presented at the Biannual Conference of the European Association for Research on Learning and Instruction (EARLI). Gothenburg, August 24-28.

Wichuda Rattapian. (1999) Web based Instruction: A new way for educational technology,Bangkok,
Faculty of Education Chulalongkorn University.