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Students' critical thinking skills in a Thai ICT schools pilot project

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This study is exploratory, examining to what extent the Thai ICT (information and communication technology) schools have classroom learning environments that are associated with certain teacher characteristics using questionnaires, interview surveys, and computer-based classroom observations in order to collect data from 13 Thai ICT model schools. The data analysis was carried out using statistical analysis techniques as well as using descriptive analysis. It is proposed that students can be assisted to learn critical thinking skills that have particular supportive learning environments. The significant findings offer opportunities to develop and support students' critical thinking skills through co-operation between students and their peers to achieve their student assignments among cooperative classroom learning environments with ICT. In particular, the findings of this study have major implications for teachers and school management where ICT schools are being established and incorporated in Thailand.

Information & Communication Technology (ICT), critical thinking skills,
ICT model schools, ICT-integration into teaching and learning process

INTRODUCTION

One of the intentions of the *National Education Act of B.E. 2542* (1999) ('the *NEA*') in Thailand has been trying to provide principles and guidelines for educational reform. It is hoped that Section 24 in Chapter 4 of the *NEA* will:

(a) provide training in thinking processes, management, how to face various situations and the application of knowledge for obviating and solving problems;

(b) organise activities for learners to draw from authentic experience; drill in practical work for complete mastery; enable learners to think critically and acquire the reading habit; and develop a continuous thirst for knowledge (Office of the National Education Commission, 1999, p.11).

In particular, this statement aims to ensure that the learning process for students starts with curiosity and is followed by planned learning activities. Through teacher-student interaction, it is also expected that students should be assisted to learn critical thinking skills, such as gathering knowledge, comprehension, application, analysis, synthesis, and evaluation in classrooms where supportive learning environments are presented.

Considering the essential role of technology for education in enhancing the competitiveness of Thailand and its people in a knowledge-based economy and society, both the *1997 Constitution of the Kingdom of Thailand* and the *Amended National Education Act 2002* identified the possible importance of computer technology for education (Office of the National Education Commission, 2002).

Sections 40 and 78 of the *1997 Constitution* and Section 63 to 69, in Chapter 9, of the *1999 National Education Act* proposed that major action should be taken to promote the use of technology for education. These actions included: (a) the establishment of an organisation to introduce ICT, (b) the development of ICT policies and plans, (c) the planning of infrastructure and networking systems, (d) the construction of materials and other technologies for education, and (e) the advancement of educational personnel and learners in the use of ICT. Therefore, the introduction and implementation of ICT strategies have become essential for Thai people, in particular, under the educational reform in Thailand.

Recently, Thailand has placed an emphasis on the use of technology in education to facilitate the advancement of teaching and learning processes (Office of the National Education Commission, 2002). It was anticipated that the adoption of new technology would also enhance higher-order thinking skills, critical thinking skills, systematic, and other relevant thinking skills for all students (Office of the National Education Commission, 2003).

In order to investigate the effectiveness of new technology, the Thai Government in 2003 set up the ICT Schools Pilot Project. It was a three-year pilot project (from fiscal year October 2003 to fiscal year October 2006) to be conducted in six primary and six secondary schools, which were the pioneer ICT schools in Bangkok and surrounding suburbs. One year after the project began, in 2004, two new schools applied to participate in this pilot project. One of them was in Chiangmai in the northern area of Thailand. The main objectives of the ICT Schools Pilot Project were to apply and integrate ICT into teaching and learning processes within classroom learning environments with ICT by developing the students' body of knowledge and promoting students' self-learning through the development of learning activities in elementary and secondary model ICT schools under this project (Office of the National Education Commission, 2002). Therefore, the purpose of the project was to provide a model in teaching and learning by integrating ICT through the teaching and learning process into classroom learning environments. The aim was for these model ICT schools to use ICT as a teaching and learning tool. In addition, they would use ICT to facilitate independent self-paced learning for all students.

Thus, this present study aimed to investigate how effectively ICT was being used to support students' critical thinking skills by ICT that was integrated into the teaching and learning in the elementary and secondary schools involved in the ICT Schools Pilot Project in Thailand. This exploratory study sought to examine to what extent these model ICT schools had classroom learning environments that were related to students' critical thinking skills; and to what extent the classroom learning environments were associated with certain teacher characteristics.

PURPOSE OF THE STUDY

In order to achieve the purpose of this investigation, the current study examined relationships among predictor variables at the student level, including student gender, computer experience, academic background, computer usage, and students' perceptions of ICT classroom learning environments and at the class-teacher level students' in classes with different teacher personal backgrounds, different teacher attitudes toward ICT, and different teacher critical thinking skills which might impact on students' critical thinking skills. These relationships are presented in Figure 1.

RESEARCH METHOD

Sample

Both analytical and descriptive research methods were used to investigate relationships in the research model. Data were collected from 13 Thai model ICT schools by means of questionnaires (150 students and 16 teachers from eight ICT schools), interview surveys (30 students and 5 teachers from 10 ICT schools), and computer-based classroom observations in 22 classrooms from all 13 ICT schools.

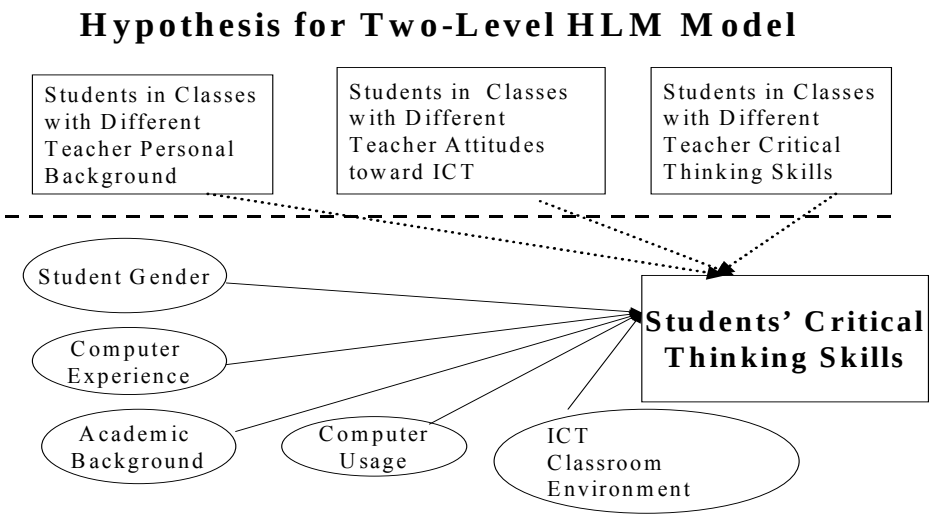

Figure 1. Two-level model of students' critical thinking skills

Variables Used in the Study

Table 1 lists the student level (Level-1) variables as well as the classroom-teacher level (Level-2) variables that are examined in this investigation.

Table 1. List of variables

Variable Name	Description	Value
Student Level		
GENDER	Student Gender	0 = boy student; 1 = girl student
COOP_ENF	Perceptions of the Actual-Preferred Interaction on Scale of Co-Operation	High value means high perception degree of Co-operation
CRI1	Deduction-Assumption Critical Thinking Skills	High value means high degree of deduction-assumption critical thinking skills
Classroom-Teacher Level		
TOTALCT	Total Scores of Teachers' Critical Thinking Skills (Induction, Deduction, Evaluation, Inference, and Analysis)	High value means high degree of total critical thinking skills
COMCLASS	The Use of Computer in the Classroom	High value means high perception degree of attitudes on the use of computer in classroom
COM_EX1	Computer Experience	0 = Teacher who had computer experience equal or less than 3 yrs 1 = Teacher who had computer experience more than 3 years
NET_H1	Use the Internet at Home	0 = accessed the internet at home 1 = Did not access the internet at home

DATA ANALYSIS

Statistical techniques as well as qualitative analysis were used to examine the research propositions that were constructed from the research model. Because of the hierarchical nature of the data, hierarchical linear modelling (HLM) was used to examine the relationships between the student outcome and the independent predictors, which were influenced by teacher factors such as their teachers' individual backgrounds, teachers' critical thinking skills, and teachers' attitudes toward ICT.

As shown in Figure 2, the impact of teachers at the classroom level (class-teacher level or Level-2) on student outcomes (students' critical thinking skills) at the student level (Level-1) is examined. As has also been documented in prior studies (Rowe, 2001), a multilevel statistical modelling technique that was more appropriate in such cases was employed (Bryk &

Raudenbush, 1992; Goldstein, 2003). These techniques are now commonly referred to as applications of hierarchical linear modelling (HLM).

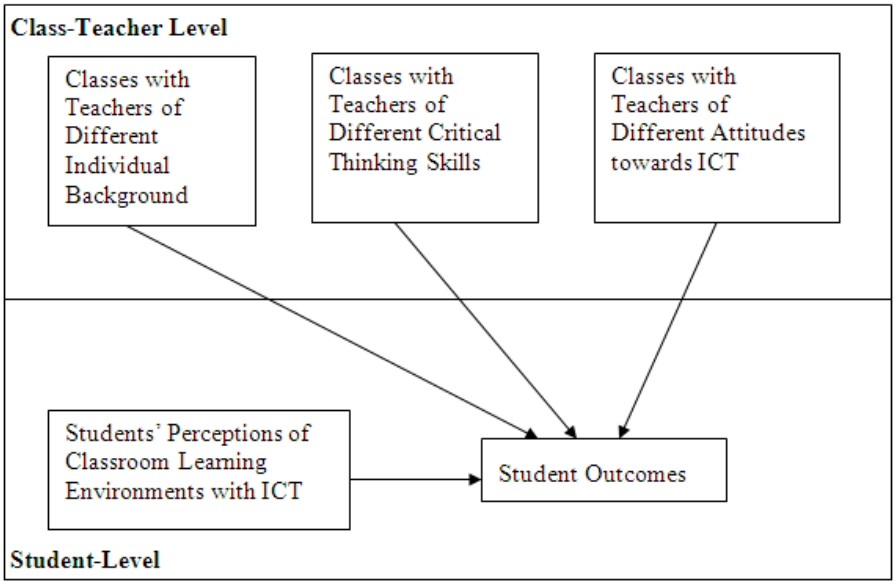

Figure 2. Diagram showing the impact of teachers at class-teacher level on student outcomes at the student level

In this way, the HLM analyses was able to produce better results, with each level estimating the effect of every predictor variable in the model on the student level outcome (students' critical thinking skills). Moreover, the HLM procedures not only provided the direct effects from the various levels but also the cross-level interaction effects between predictor variables and outcome variables at the two levels (student and class-teacher levels).

Therefore, this current study examined various potential relationships among predictor variables at the student level (Level-1) and at the class-teacher level (Level-2) on the students' critical thinking skills as the outcome variable using two-level hierarchical linear modelling (HLM) procedures.

RESULTS

The fixed and interaction effect is presented in Figure 3. Only COOP_ENF was found to be a significant predictor of CRI1 at the student level (Level-1). Two variables at the class level (Level-2), including COM_EX1 and NET_H1 also influenced CRI1 directly. In addition, TOTALCT and COM_CLASS at Level 2 interacted with COOP_ENF at Level 1 influencing CRI1.

The final model for the variable, deduction-assumption critical thinking skills, at student level (Level-1) and class-teacher level (Level-2) can be denoted in Equation 1 and the results are shown in Figure 3.

Level 1 Model

$$\text{Critical Thinking Skills} = \beta_0 + \beta_1 \textbf{\textit{(COOP\_ENF)}} + e$$

Level 2 Model

$$\beta_0 = \gamma_{00} + \gamma_{01}\,(\text{COM\_EX1}) + \gamma_{02}\,(\text{NET\_H1}) + u_0$$

$$\beta_1 = \gamma_{10} + \gamma_{11}\,\textbf{\textit{(TOTALCT)}} + \gamma_{12}\,\textbf{\textit{(COMCLASS)}} + u_1 \qquad \text{(Equation 1}^{[1]}\text{)}$$

[1] Bold Italic: Grand-mean centred

As shown in Figure 3, at the student level, students who had high perceptions of cooperation between themselves and their peers to achieve their assignments (COOP_ENF) had higher scores on students' deduction-assumption critical thinking skills (CRI1). Thus, the deduction-assumption critical thinking skills (CRI1) were positively influenced at the student level by COOP_ENF (γ = 0.20, $p \leq 0.05$). This finding implies that students who had positive perceptions of co-operative classroom learning environments were more likely to have higher scores for the deduction-assumption critical thinking skills.

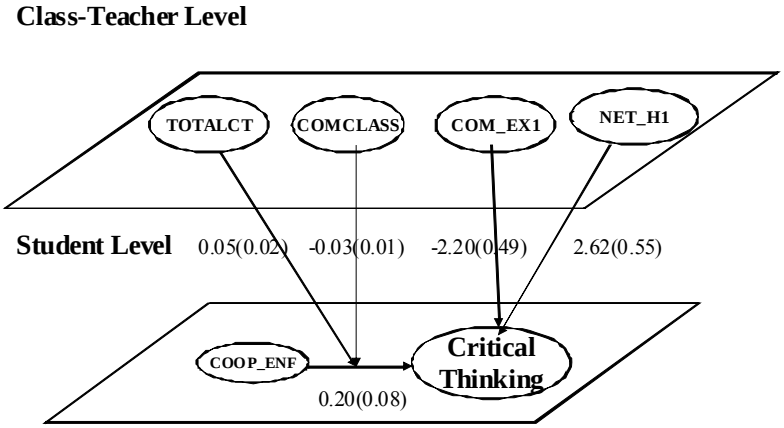

Figure 3. Direct and interaction effects for students' critical thinking skills

Moreover, scores of critical thinking skills are affected negatively by teachers' computer experiences (COM_EX1 γ = -2.20, $p \leq 0.05$) and positively by teachers' internet accessibility at their homes (NET_H1 γ = 2.02, $p \leq 0.05$). The negative effect of the differences in the length of teachers' computer experiences indicated that students in classes with teachers who had less computer experience performed at a higher level in deduction-assumption thinking skills. It may be that students in classes with teachers who had shorter periods of computer experience had more opportunity to share learning experiences and worked together with the students, using their own limited technological knowledge and skills to develop students' critical thinking skills. They perhaps were more likely to share instructing and learning resources and computer experiences with one other in their classroom, by using other ICT material such as television, video, camera, and multimedia equipment. In addition, NET_H1 shows a positive effect on students' deduction-assumption thinking skills (CRI1). It is possible that students in classes with teachers who did not access the internet at their home generated learning and instructing material resources, together with their own students, through accessing the internet during class hours. It seemed that students were more likely to develop and improve their deduction-assumption thinking skills by searching for information or knowledge together with their teachers to complete class assignments.

According to participant students' views, the ideal teacher to develop students' critical thinking skills needs to have a high understanding of the skills and knowledge necessary to teach their students, to search effectively for new information from any sources such as the internet, books, articles, and other material resources, and to provide attractive lesson materials to apply this modern technology in their classroom. In particular, there is a need for teachers to develop students' critical thinking skills through the use of the internet in classroom environments in all subjects. This is consistent with prior research. Admiraal et al.'s (1998) research similarly found that the use of technology in the classroom through computer conferencing, in particular the use of the internet, could support and develop cooperative learning between students and between students and teachers. Moreover, the teachers' constructive understanding of skills and knowledge enabled their students to have a high quality learning outcomes, such as the students' achievement of critical thinking skills.

In addition, at the class-teacher level, there are two cross-level interaction effects. Teachers' critical thinking skills (TOTALCT γ = 0.05, $p \leq 0.05$) and teachers' attitudes towards the use of

computers in the classroom (COM_CLASS γ = -0.03, $p \leq 0.05$) interacted with students' perceptions of cooperation between students and their peers (COOP_ENF) in influencing students' deduction-assumption thinking skills (CRI1).

Figure 4 shows the positive interaction effect between cooperation among students and their peers to achieve their assignments (COOP_ENF) and teachers' critical thinking skills (TOTALCT) on students' deduction-assumption thinking skills (CRI1). The effects of students' perceptions of the actual-preferred interaction on the scale of Co-Operation (COOP_ENF) on deduction-assumption thinking skills (CRI1) had a greater impact in classes with teachers who had high scores for overall critical thinking skills (high TOTALCT). The results indicated that it would be more beneficial for students with high COOP_ENF to be in classes with teachers who had high overall scores for critical thinking skills. That is, teachers with high TOTALCT appeared to facilitate the participation between students and teachers or between students and their peers through class discussion, student tasks and class activities, in using ICT instructional material in their classroom environments.

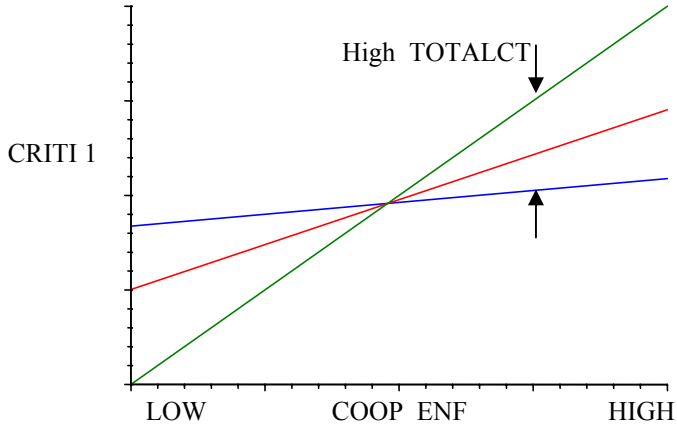

Figure 4. Effect of teachers' critical thinking skills on cooperation between students and peers to achieve their assignments

Figure 5 shows the positive impact of COOP on students' critical thinking skills is lessened when the students were in classes where teachers were perceived to be high in the use of the computer in their classrooms. In addition, the negative interaction effect for COOP_ENF and COMCLASS on the deduction-assumption thinking skills (CRI1) implied that where students were taught by teachers who were less interested in using computers in their classrooms, they could share learning resources and work together through individual or group activities and student tasks, using a computer outside their classroom, such as the school library or the school computing room. Another possible explanation is that students with teachers who were more interested in using other instructional ICT equipment, such as television, video, camera, slides, and multimedia in their classroom with ICT, may have developed higher deduction-assumption thinking skills through the use of equipment other than computers in the classroom. They further expressed the opinion that the best teacher, in their students' eyes, to develop critical thinking skills in their students, needs to have high technological skills and knowledge to teach their students in an active way. In particular, there is a need for teachers to develop technological literacy, including basic computer operation, professional use of technology, and the applications of technology in instruction. They strongly agreed that the most important factor is that all teachers ought to try to teach their students through the use of a variety of teaching procedures and skills. These teaching skills could change from complex content to simple lessons that would develop fully and clearly students' understanding of ideas with or without the ICT environment.

DISCUSSION

Findings of the study assist to establish and enable the successful implementation of ICT integration in primary and secondary schools in Thailand. On the basis of the main research findings, recommendations are made for teaching roles to advance students' learning and school management.

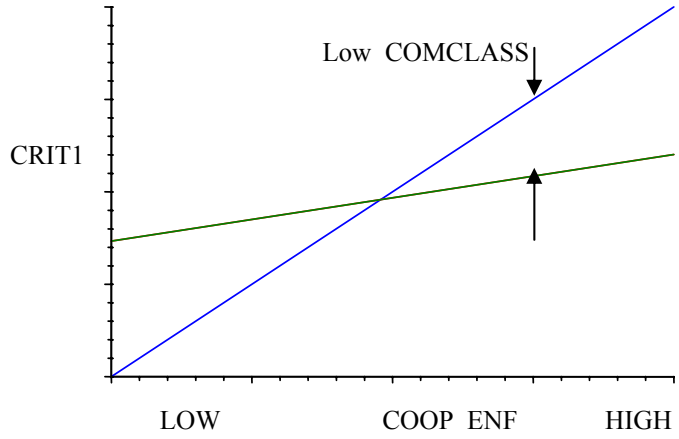

Figure 5. Effect of teachers' attitudes toward the use of computer in the classroom on cooperation between students and peers to achieve their assignments

The study's findings have several important implications for school teachers through their teaching roles, (namely, to promote active and autonomous learning, increase more cooperative learning and assignments, and assist students to construct their own knowledge and share it with other students). Recommendations that can be made include:

Teachers' efforts ought to try to promote an active and autonomous learning among students through ICT-integration into teaching and learning processes. School teachers need to transform their teaching roles from information delivery specialists to guides and facilitators of learning. This means that teacher roles must be changed from lecturer to consultants, guide, and resource providers. Moreover, teachers should make a large effort to assist their students by supporting their ideas or creating projects, such as an ICT club or an ICT camp rather than controlling or limiting the scope of their imagination or, creative learning activities.

Teachers need to try to increase more cooperative learning among students. This is achieved by supporting students working as group members, group interaction, and teamwork, because the findings showed that students who lacked computer experience would prefer more student involvement with each other to complete their assignments. In this way students would understand better what they had learned through sharing and exchanging their computer experiences with others.

Teachers ought to try to assist students to construct their own knowledge and share it with other students. Therefore subject teachers and students should work together to generate the 'Reading Circulation' or the 'Website for Learning' where they could search for new information in any learning sources and spend time on discussion through online communication tools, such as email or web board.

Importantly, the results of the present study suggest that the success of incorporating ICT into teaching and learning is fundamentally dependent on teaching roles and school management which were comprised of the allocation of school budgets for ICT, the use of classrooms' ICT infrastructure, and the establishment of schools' organisational structures. From these findings, further recommendations can be made.

School principals or school administrators need to allocate a budget or distribute money for introducing, setting up, or using ICT as a teaching and learning process in classroom environments.

School administrators, particularly principals need to support subject teachers to set or manage their classrooms' ICT infrastructure. These classrooms' ICT infrastructure needs to include the hardware, software, internet servers, networking and connectivity requirements that are necessary for the teaching and learning process. So some subject teachers developed their classroom environments by incorporating flexibility of ICT into teaching and learning in a range of subject areas by choosing portable computer, computer laptop, or wireless technologies, as they are convenient tools for the job.

Principals should establish their schools' organisational structure to build effective school environments. The roles of school principals involves the ability to bring the appropriate types of school staff, such as curriculum coordinator, teacher-librarians, technological support officers to assist other subject teachers or ICT teachers to provide the necessary balance of teachers' technological knowledge, skills, and capabilities with ICT and to incorporate ICT into the teaching and learning processes. Another interesting and important issue which was found from the findings of this study is there were some students who could not access the computer or the internet in their homes, due to budget constraints or the limitation of family support. Therefore, school principals need to focus on the importance of ensuring equity of access to computing equipment at school.

CONCLUSIONS

The overall findings showed that students could be assisted to learn critical thinking skills through integrating ICT into teaching and learning processes under the Thai ICT Schools Pilot Project. The present study concluded that successfully incorporating ICT into teaching and learning is fundamentally dependent on teaching roles (i.e., to promote active and autonomous learning, increase more cooperative learning and assignments, and assist students to construct their own knowledge and share it with other students) and school management, regarding the allocation of school budgets for ICT, the use of classrooms' ICT infrastructure, and the establishment of effective school organisational structures.

In particular, the improvement of classroom learning environments with ICT involves the potential ways of providing effective and efficient instruction through both teachers' and students' integration of ICT into overall teaching and learning processes in the school classroom environments.

It is hoped that the findings of this study can stimulate future development and guide further improvements of classroom learning environments with ICT to enhance effective and efficient instruction that combines the roles of teachers' and students' learning into teaching and learning processes through the use of ICT.

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