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## The Development of Thai Learners' Key Competencies by Project-based Learning Using ICT

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### Abstract

This research aimed to study the use of Project-based Learning using ICT (PBL using ICT) to develop learners' five key competencies based on Thai Basic Education Curriculum 2008, which consists of 1) communication capability 2) thinking capability 3) problem solving capability 4) capability in applying life skills and 5) capability in technological application. The subjects were 212 students from 4 schools in Kanchanaburi, Chiang Mai, Mae Hong Son, and Si-Saked provinces that were enrolled in the 2010 academic year. The PBL using ICT approach was used as the research tool. The data collecting instruments were lesson plans, students' journals, semi-structured interviews, and social networking where students' learning artifacts and products were collected (nectecpbl.ning.com). Content analysis and triangulation methods were used to analyze the data. The results showed that students were able to perform five key competencies in communication capability, thinking capability, problem solving capability, capability in applying life skills, and capability in technological application. Moreover, the students learned the content in the learning areas of Science, Mathematics, Foreign Languages, Health and Physical Education, and Occupations and Technology. The research findings revealed that the use of PBL using ICT can help to develop students' abilities to communicate ideas, problem solving, life skills, and abilities to use technology, as well as their learning in content of the subject area.

**Key words:** Project-based learning; Project-based learning using ICT; Learners' key competencies

### Introduction

There is a need to develop learners' competencies for Thais in order to support the change of global competition and workplace of technology in the digital world. The learners' key competencies are analyzed to identify habits of the learners to become effective as 21st Century Citizens by the Ministry of Education (MoE) of Thailand. There are five key competencies: 1) communication capability 2) thinking capability 3) problem solving capability 4) capability in applying life skills and 5) capability in technological application in the Basic Education Curriculum B.E. 2551 (A.D. 2008) of Thailand. These competencies are the results of the research findings and the statement on the Tenth National Economic and Social Development (A.D. 2007-2011) which focuses on learner development for the future (MoE, 2008). To support the learners' development of key competencies, learning tools and teaching pedagogy are needed. The Project-based Learning (PBL) using ICT is an alternative way to support the learners in the digital age which everybody can learn and share anywhere and anytime.

The Project-based Learning (PBL) is an approach that emphasizes meaningful learning activities that are long-term, interdisciplinary, and student-centered. The learning activities are designed to provide students with real world relevance, complex tasks, and creative outcomes. The students have chances to learn course content, master course objectives, choose their own topics, activities, or learning tools (Grant, 2002). In the words of Papert (2011), "creating is learning" which means the way to use knowledge is the way to get more knowledge. This can happen by creating projects such as movies, robots, inventions, multimedia, digital storytelling, etc. in the classroom environment.

According to Redecker (2008), ICT can enhance learning outcome by supporting different senses; supporting collaborations with new online production, commuting and networking tools; supporting differentiation and diversity; and empowering learners to personalize their learning process. Therefore, the PBL using ICT should be introduced to the classroom in order to support students to create their own knowledge. In this case, using ICT as content based learning is not enough for supporting the learners' development of key competencies. In

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the age of global network, computer and internet access should be used more than data searching, emailing, or chatting. The way to use computers for supporting students' learning should be focused on creating intelligence on content knowledge and competencies.

The report of Empower ICT project (Vrasidas, Laohajratsang & Suwannatachote, 2005) has found that most of the teachers lacked skills in using ICT. Consequently, they could not design lesson plans by integrating ICT as learning tools. Therefore, there is a need to instruct teachers to be able to use ICT, and be able to integrate ICT as learning tools in their classroom. The project of Her Royal Highness Princess Maha Chakri Sirindhorn: Royal IT Projects (2010) is the project that has developed teachers' abilities to use ICT in their classroom during 2008 – 2013. The researchers worked with the teachers who have participated in the project of Her Royal Highness Princess Maha Chakri Sirindhorn and learners in their classrooms. This research aimed to study learners' development of the five key competencies during the 2010 academic year.

## **Theoretical Framework**

### **The Development of the Learners' Key Competencies through PBL using ICT**

Project-based learning (PBL) is an instructional method which does not focus on rigid lesson plans. PBL allows learners to investigate more about the topic through constructing the meaningful artifact (Harris & Katz, 2001). While creating artifacts such as plays, poems, pie charts, or toothpick bridges, they engage in learning by sharing and reflecting on their artifacts with others (Grant, 2002).

PBL is based on constructivism and constructionism. Constructivism explains that learners can construct their own knowledge through interactions with their environment. The learners are different and each individual learner can construct new knowledge by building from the current knowledge (Piaget, 1969; Vygotsky, 1978; Perkins, 1991). Constructionism explains that learners learn when they construct the artifact or project (Harel & Papert, 1991; Kafai & Resnick, 1996). To create a project, the learners have to start with thinking about designing their work processes. This includes how the artifacts will look like, what technology, media, and materials should be used. These will communicate to others how to understand their projects. Therefore, today, communication is needed more than reading and writing. The more learners have experience to create things through intermediate media, the more they will understand and insight the important of media analysis from all around the world (Richards, 2005).

While creating projects, there were many problems. When trying to solve one problem, new problems always occurred. The learners had to pay attention, think, and work on the problems, use reasoning and systematic thinking to support their answers in the context of their work. After the students experienced problems and problem solving, they created more meaningful projects. The learners got some creative answers which derived from unexpected problems. Therefore, it can be implied that problem-based learning is support creative thinking which is important for the rapid changes of the world. Moreover, the problem is the important factor for building interaction between learners and surroundings. This interaction will support the cooperative working, sharing, and respecting to the ability of others. The learners are not only learning to solve problems, but they are also prepared to face their new challenge problems. This is a kind of inner motivation that they try to overcome challenges and frustration facing from creating projects (Richards, 2005; edUTOPIA, 2011).

The project-based learning is an effective way for learners to develop and integrate skills during their small group cooperation, because they are learning while they are using their knowledge through their work. The more they use and share in group, the more inspiration for them to know deeper on what they are studying. The assessment which is designed to measure on the project will give meaningful feedback to the learners for connecting what they learned and real life (Bautista & Escofet, 2009; Richards, 2005; edUTOPIA, 2011).

The advancement of technology in the present can support the web learning tools for classroom. These learning tools can be accessed by everybody. Learners can use and share in their real lives. Now a days, the web learning tools are not distinguished from education anymore. Learners should have chance to learn on the age which is too different from adult age in the past (Jonassen, Howland, Moore & Marra, 2003; Richards, 2005). Focusing on the understanding of Project-based learning, there is still different understanding among teachers. Many teachers are familiar with designing a science project. To do a science project, a student must begin with questions and processed through the scientific method for seeking the answers which might or might not be artifacts or products at the end of solution. However, the project-based learning is focused on the "products" as the aim (Tunhikorn, 2008).

**The Framework for 21<sup>st</sup> Century Skills**

According to the Framework of Education Model in the 21<sup>st</sup> century (The Partnership for 21<sup>st</sup> Century Skills, 2007), there is a different idea of the education model between 20<sup>th</sup> and 21<sup>st</sup> Century. The education model in the 20<sup>th</sup> century focused on the learning of the core subjects and assessing for learning outcome. While the education model in the 21<sup>st</sup> century focuses on learning among the core subjects, 21<sup>st</sup> century content, life skills, learning and thinking skills, and ICT literacy which are known as 21<sup>st</sup> Century Skills (The Partnership for 21<sup>st</sup> Century Skills , 2007). This idea also covered the focus points of the Basic Education Curriculum B.E. 2551 (2008) of Thailand about content learning standards and the learners’ key competencies. These related points are shown in Table 1.

Table 1. The relationship between the learners’ key competencies of Thailand in the Basic Education Curriculum B.E. 2551 (A.D. 2008) and the framework of the education model in the 21<sup>st</sup> century (The Partnership for 21<sup>st</sup> Century Skills, 2007)

The Basic Education Curriculum B.E. 2551 (A.D. 2008) of Thailand	The Framework of Education Model in the 21 <sup>st</sup> Century	
Outcomes/Skills	Sub-skills	
Learning Standards: Thai Language/ Mathematics/ Science/ Social Studies, Religion and Culture/ Health and Physical Education/ Arts/ Occupations and Technology/ Foreign Languages	Core subjects: English, Reading or Language Arts/ World languages/ Arts/ Mathematics/ Economics/ Science/ Geography/ History/ Government and Civics	
	21 <sup>st</sup> century themes: Global Awareness/ Finances, Economic, Business and Entrepreneurial Literacy/ Civic Literacy/ Health Literacy/ Environment Literacy	
Communication Capacity Thinking Capacity Problem-Solving Capacity	Learning and Innovation Skills	Communication and Collaboration Creativity and Innovation Critical Thinking and Problem Solving
Capacity for Technological Application	Information, Media, and Technology Skills	Information Literacy Media Literacy ICT Literacy
Capacity for Applying Life Skills	Life and Career Skills	Flexibility and Adaptability Initiative and Self-Direction Social and Cross-cultural Skills Productivity and Accountability Leadership and Responsibility

Many researches explained that learning in the 21st century needs higher order thinking skills related to sophisticated cognition such as inquiry process, formulating explanations, and communicating understanding. These skills are difficult to measure with multiple choice or paper-and-pencil tests (Resnick & Resnick, 1992; Quellmalz & Haertel, 2004; National Research Council, 2006). In order to support Thai new generation citizen to have the learners’ key competencies which concordant with the skills in 21st century is needed the effective learning management to support both of learning outcomes and skills. Also the alternative assessment is needed for both summative and formative assessment to support the new way of learning.

## **Method**

### **Subject of the Study**

The subjects of this research were 212 students in the classes of eight teachers from four schools. These schools were located in Karnchanaburi, Cheing-Mai, Mae-Hongsorn, and Sri-Saked provinces. The PBL was introduced to the classroom by integrating with the lessons taught by eight teachers. These teachers had worked collaboratively with the researchers to design their own lesson plans by integrating PBL using the ICT approach.

### **Research Procedure**

This research was based on qualitative research using participatory action research between the researchers and teachers working cooperatively. The participatory action research attempts to present people as researchers themselves to the questions of their daily struggle and survival (Tandon, 1998). In this research, teachers were teamed with the researchers. They understood the research objectives and created the best practice for PBL using ICT in real classrooms. Moreover, they acted as researchers in collecting data of the learners' five key competencies from their students.

The research procedures were conducted in 3 steps: instruction, cooperative working, and follow up. The details are shown below:

#### **1. Instruction**

In this procedure, the 19 teachers had participated in 3 workshops of the project of Her Royal Highness Princess Maha Chakri Sirindhorn: Royal IT Projects during 2010-2011(the 2010 academic year).The aim of the workshops was to prepare the teachers to design lesson plans by using PBL using ICT approach.

#### **2. Cooperative working**

The teachers and researchers were joined in teams to design the PBL using ICT lesson plans. We connected through social networking through the website <http://nectecpbl.ning.com>. Teachers shared their lesson plans for research teams to critique. They posted and shared questions and interesting topics about PBL and ICT for others to reflect on. Teachers also wrote their weekly journals on the website. The research team was working collaboratively to provide feedback on teachers' lesson plans and data collection tools.

#### **3. Follow up**

At the end of the first semester of the 2010 academic year, the researchers followed up on the teachers who were able to design the PBL using ICT lesson plans for the second semester of 2010 academic year. The researchers observed each teacher's classrooms twice, and did group reflection after each class. The learners' five key competencies from learning through PBL using ICT were collected during the class and also through the social network.

## **Research Tools**

### **The PBL Approach**

The PBL approach was used as a tool to determine the development of learners' five key competencies. The PBL approach was designed to focus on the roles of learners and teachers in the classroom.

The learners' roles were to create the artifacts or products in the projects within the social context. The students in each group mainly rotated their own acts of planning, creating, reflecting, and publishing within the cycle and could be related to each step as shown in Figure 1.

- 1) Planning (P); the learners had to think collaboratively to set their group goals, plan and design the tasks to meet their goals.
- 2) Creating (C); the learners followed the plan by using appropriate media and technology. When learners encountered the problems in this step and tried to solve the problems, this led them to make a new plan.
- 3) Reflecting (R); this was a very important step that learners used for talking about and critiquing their own or others' tasks for improvement.
- 4) Publishing (P); learners used this step to present their ideas, artifacts, or products.

### Learners' roles on PBL

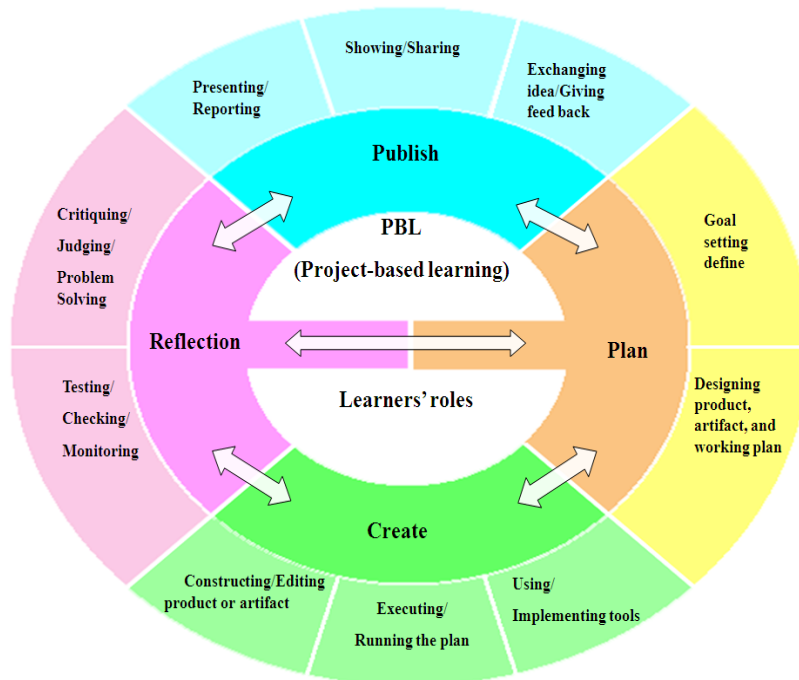


Figure 1. The learners' roles of learning through doing projects within the social context

The teacher's role included knowing, facilitating, context providing, and assessing as shown in Figure 2.

- 1) Knowing (K); teachers became informants for the learners. Therefore he/she should have knowledge not only to provide, but also help learners construct their own knowledge.
- 2) Facilitating (F); teacher became facilitators and supporters for learners' needs.
- 3) Context Providing (C); teachers provided appropriate classroom settings which contained learning resources, learning tools and media, and social context for learners to work collaboratively.
- 4) Assessing (A); teachers prepared the assessment tools which reflected for the performance assessments and followed up on learners' progress.

### Teacher's role on PBL

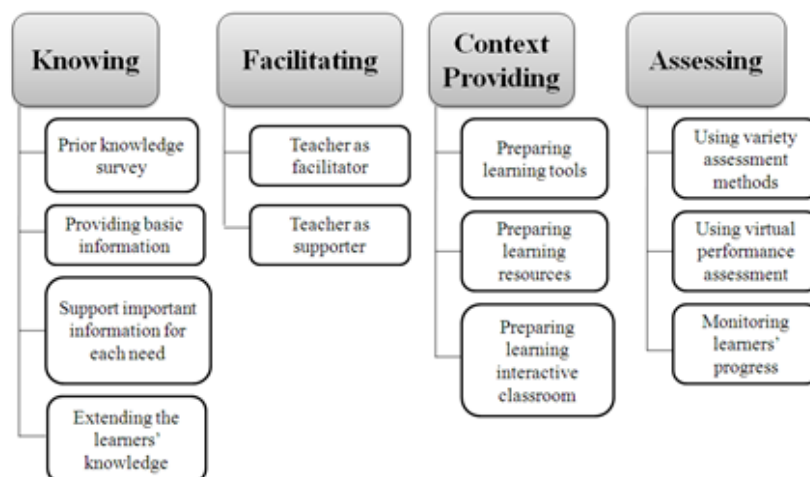


Figure 2. The teachers' roles in PBL

### The Data Collecting Tools

Data collecting tools consisted of four tools shown in table 2. These tools were 1) the teachers' lesson plans, 2) the learners' journals, 3) the learner interviews, and 4) the website nectecpbl.ning.com

Table 2. Tools for data collection

Research tools	Informants	Objectives
1) Lesson plans	Teachers	To study teachers' and learners' roles in PBL and level of integration ICT as the learning tools
2) Learners' Journals	Learners	To study the results of PBL using ICT in the classroom (at the end of every classes)
3) Learners' Interviews	Learners	To study the results of PBL using ICT in the classroom (at the end of course)
4) Social network ( <a href="http://nectcpbl.ning.com">http://nectcpbl.ning.com</a> )	Learners	To study the learners' competencies from learning artifacts or products

The lesson plans that were designed by teachers aimed to study teachers' and learners' roles in PBL and level of integration ICT as the learning tools in the classroom. The data from three other tools was collected from the learners to provide the learners' five key competencies resulted from PBL using ICT in the classrooms.

### Data Collection and Analysis

The data collection was processed during the 2010 academic year through the four research tools. After gathering the data, the researchers used content analysis method to find out the learners' five keys competencies from learning through PBL using ICT. The data triangulation method was used to confirm the validity of data analysis by analyzing data among learners within different abilities. The learners' abilities were justified from their previous learning outcome; students that scores 80-100 percent were labeled as high ability learners, students that scores 60-79 percent were labeled as medium ability learners, and students that scores under 60 percent were labeled as lower ability learners.

### Results and Discussion

The research was conducted through the participatory action research among the researchers and teachers working cooperatively. Teachers designed lesson plans and implemented in their classrooms, while the researchers were facilitators in designing lesson plans and following up. The results of working collaboratively showed that 8 out of 19 teachers who could design and implement the PBL using ICT in their classrooms within one year. During implementation in classrooms, the data of learners' competencies were collected from students' journals, interviews, and social networking. The results of using the PBL using ICT presented the impact on developing both of five key competencies and content learning outcomes. According to teachers' designed lesson plans, it showed that teachers could integrate PBL using ICT in their lesson plans as shown in Table 3.

Table 3. Learners' artifacts/products

Artifacts/Products	ICT tools	Subject
Digital Report	Microsoft PowerPoint	- Science in grades 9, 11 - Health Education in grade 9 - Occupations and Technology in grade 4
Digital Storytelling	Microsoft Powerpoint	- Math in grade 7 - Science in grade 9
Mind Mapping	EDraw Mindmap	- Science in grades 11, 12
Electronic Crafts	Glogster	- Science in grades 11, 12
- Cards	PhotoPeach	- English in grades 11, 12
- Poster	Tattoons	- Occupations and Technology in grade 4
- Slide Show	FlipAlbum Paintbrush	
VDO Role Playing	Windows Movie Maker	- Science in grade 12
	Ulead	- English in grade 11
	YouTube	
Website	Google Sites	- Science in grades 11, 12 - English in grade 12

The results showed that the learners developed five key competencies which included: 1) Communication Capacity, 2) Thinking Capacity, 3) Problem-Solving Capacity, 4) Capacity for Applying Life Skills, and 5) Capacity for Technological Application. The details of their development showed below:

### **Communication Capacity**

The learners developed their communication capacities during the whole process of working; planning, creating, reflecting, and publishing their artifacts. The results of the study showed that the learners developed communication capacity in three ways;

- 1) Perceiving and analyzing the information beyond the classroom
- 2) Choosing the information and media to fit the tasks
- 3) Using a variety of ways of communication

The learners learned how to choose, create, manage, and use different types of media such as text, picture, sound, and movies to create their tasks. In order to communicate their tasks to others, they needed more than reading and writing skills. Learners had to analyze their final products to determine whether it fit the purpose of their tasks. It showed that the learners not only created the tasks, but also communicated their tasks interestingly. From this process learners experienced perceiving and analyzing the information.

### **Thinking Capacity**

The learners developed thinking capacity during the whole process of working; planning, creating, reflecting, and publishing their tasks. The results of the study showed that the learners developed the higher order thinking of:

- 1) Creative thinking
- 2) Analytical thinking
- 3) Reasoning and systematic thinking
- 4) Synthesis thinking
- 5) Critical and reflective thinking

From learning through PBL using ICT, learners could create creative artifacts. Moreover, the evidence of learners' learning showed that doing projects helped them pay more attention to provide reasons and use systematic thinking. In order to complete the tasks, they had to interact with teachers, peers, and everything around them. In these situations, it allowed them to think analytically to distinguish all problems and factors impacts to their work success, to plan and choose media such as texts, pictures, sounds, and movies involving in content. Moreover, they thought critically and reflectively on the weak points to improve their tasks. When they tried to explain their tasks, they used synthesis thinking. It helped them connect all working processes to set their own working system. These direct experiences on designing and creating helped the learners develop a variety of ways of thinking.

### **Problem-Solving Capacity**

The process of working; planning, creating, reflecting, and publishing their tasks supported the learners to discover and solve problems from their own context. The results of the study showed that the learners developed the problem-solving capacity in three ways:

- 1) Solving problems in a reasonable way
- 2) Inquiry for solving the problems
- 3) Effective Decision Making

The learners used analytical and critical thinking to solve many problems while doing projects. Each learner had a different way of doing projects. Some were well organized and were good planners, and some were not. Whatever type of planner, they were all involved in solving problems.

### **Capacity for Applying Life Skills**

During the process of working on the project, difficulties and problems were challenges for learners. In this situation, the learners collaborated and supported each other. They not only shared idea to others, but also



shared their own potential to make things successful. The results of the study showed that the learners developed the capacity for applying life skills in five ways:

- 1) Collaborative Learning
- 2) Creating potential to overcome difficulties
- 3) Learning to set the goal for success
- 4) Creating self-confidence
- 5) Lifelong learners

These were the intrinsic motivations of learners developed to overcome challenges and disappointment when they faced difficulties.

### Capacity for Technological Application

The learners developed the capacity for technology during the whole process of working; planning, creating, reflecting, and publishing their tasks. The results of the study showed that the learners developed in three ways:

- 1) Choose and use technologies appropriately to the task
- 2) Choose and use technologies as the learning tools
- 3) Choose and use technologies in a moral way

The learners chose and used many kinds of technology to search for information, communication, design, create and present their own tasks or projects. Moreover, they used social networking to publish and share their ideas and works by concerning morality such as using polite words, being aware of and respectful for copy rights, and thinking critically about reliable information.

### Learning Outcomes

The result of the study also showed that learning through the PBL using ICT enhanced the learners to understand on the contents. Moreover, many learners thought that they enjoyed doing project and it helped them learned in deeper content. The evidence is shown below.

*"I learned on the content about the definition of energy. I can also divide energy into 2 types. The first is ran out energy and the second is the renewable energy. I could give examples of energy for each type of those. I knew more about the advantage and disadvantage which it was valuable to use in my everyday life."*(Learner's journal writing)



<https://sites.google.com/site/phlanggannichiwitpracawan/home>

Figure 3. A Learner's Website about energy in daily life using Google site from Ms. Pan's classroom in science grade 11

*"This house is designed to use the roof in the dark blue color to prevent heat. The wall is white cream color, because it's not an endothermic wall. There are some windows to help air flow..."* (Learner's journal writing)



Figure 4. The learner's artifact "The Energy Saving Home" designed on PowerPoint from Ms. Cha's classroom in science grade 9

The researchers found that the PBL using ICT enhanced the learners' five key competencies and learning outcomes. The results of the study revealed that the learners were developed in key competencies:

- 1) Communication Capacity: The learners compiled the substance of the speech, writing, analytical sharing knowledge and ideas and communicated to others. They had abilities in perceiving and analyzing information from all around the world, choosing the media fit to the tasks, and creating a variety of ways of communication.
- 2) Thinking Capacity: The learners had abilities in analytical thinking, reasoning and systematic thinking, synthesis thinking, thinking critically and thinking reflectively.
- 3) Problem-Solving Capacity: The learners had abilities to identify problems and find reasonable solutions, inquiry for solving the problems, and effective decision making.
- 4) Capacity for Applying Life Skills: The learners were able to work well with others, and also had social harmony through the strengthening of good interpersonal relationships. They had abilities in collaborative learning, creating potential to overcome difficulties, learning to set the goals for success, creating self-confidence, and lifelong learning.
- 5) Capacity for Technological Application: The learners chose and used appropriate technologies for the task, chose and used technologies as learning tools, and chose and used technologies in a moral way. They used technology to communicate, share and learn, create and publish their knowledge.

As above, the PBL using ICT supported the expectation of Thai new generation to succeed the 21<sup>st</sup> Century skills which corresponded to the aim of the present curriculum "Basic Education Curriculum B.E. 2551 (2008)"

## Conclusion

The research results showed that the learners who participated in the PBL using ICT in the different subjects developed both learning outcomes and key competencies. The learning outcomes were present in Science, English, Mathematics, Health Education, and Occupations and Technology. The key competencies were Communication Capacity, Thinking Capacity, Problem-Solving Capacity, Capacity for Applying Life skills, and Capacity for Technological Application which could be discussed as the following:

Communication capacity of learners was developed by using technological as learning tools. These capacities are perceiving and analyzing the information beyond the classroom, choosing the media fit to the tasks and presenting a variety of ways of communication. These tools supported learners to communicate their ideas through various forms of media from their tasks which was presented in text, sound, picture, movies, etc. According to Rusk, Resnick & Maloney (2009) the present efficient communication should be more than reading and writing. When producing tasks, the learners participated in using, managing, and integrating a variety of media in order to express their creativity.

Thinking capacity of learners was developed in thinking analytically, reasoningly and systematically, synthesis, critically and reflectively. Creating is at the top of the revised Bloom's Taxonomy (Anderson & Krathwohl, 2001). These are the higher order thinking which was developed by creating tasks (Rusk, Resnick & Maloney, 2009). During this process, the learners were interacting to their surroundings and facing the problems. These made them concentrate to complete their tasks.

Problem-Solving Capacity of learners was developed in solving problems in reasonable ways, inquiry for solving the problems, and effective decision making. This result is congruent with Rusk, Resnick & Maloney (2009). They described that to create a project is the way for learners to discover and solve the problems within the context of meaningfully design. The learner is the thinkerable which they can test and edit their work throughout the process of creating the project.

Capacity for Applying Life Skills of learners was developed in collaborative learning, creating potential to overcome difficulties, learning to set goals for success, create self-confidence, and lifelong learning. The learners have opportunities to work with others such as friends, teachers, and the community. This interaction allowed them to learn about adaptation and responsibility to work and live with others. It also supported learners to endeavor for success. This kind of thinking brought their inspiration to overcome all challenges and disappointment from the process of designing and problem solving (Rusk, Resnick & Maloney, 2009).

Capacity for Technological Application of learners was developed in choosing and using technologies appropriately for the task, choose and to use technologies as learning tools and choose and use technologies in a moral way. The learners chose ICT tools for creating, publishing, and sharing ideas. Most of them created projects by integrating ICT; therefore, it also had the variety of using ICT which supported the learners' abilities in ICT. Rusk, Resnick and Maloney (2009) described that using ICT in projects supported the learners to choose, create, and manage the variety of media which are text, picture, movies, and sound.

According to those results, it could be concluded that the PBL using ICT in the different subjects developed the learning key competencies. Moreover, it is related to the expected learning outcomes of Thai citizens that are eager to learn, learning on their own, acquiring knowledge continuously throughout life, the ability to communicate, analytical thinking, creative thinking, problem solving, having a public mind, having discipline, regarding to the common good, working in groups with good will, being morally consciousness, having moral values, and pride in being Thai (Office of the Educational Council ,2009).

## **Recommendations**

### **Suggestions from the Study**

From the study, there were some suggestions as follows:

- 1) Most of the tasks from students' projects were small tasks and did not integrate much higher technologies. This is because most teachers were beginners at integrating the PBL using ICT in their classrooms. So, they designed their lessons by letting the students create small tasks in each lesson. The suggestion drawn from this result is that teachers should plan a big picture of the whole project by designing their lessons for students to create small tasks in each week and then combine them as a big project.
- 2) The teachers and students faced many problems about using computers to complete their tasks. The examples of these problems were: 1) the bandwidth of the connected internet was too low; 2) there were not enough computers and 3) the time to do the tasks were not sufficient. Many teachers solved the problems by asking students to complete their task on paper instead of using computer programs. However, this is not much developing the students on students' capacity for technological application. Therefore, the integration of subjects would be one of the ways out to solve these problems.
- 3) From the results, it was reflected that learners who have developed on collaborative working and capacity for applying life skills were the low ability learners, while the high ability learners reflected most of their development on problem-solving capacity. These reflections could be implied that the learners who worked collaboratively in groups with mixed abilities shared their experiences. The high ability learners were often the leaders to solve problems when the group faced problems. The low ability learners had to learn to help the members to overcome the troubles. Therefore, the project-based learning using ICT should proceed under the social context which could support all students to develop themselves and others.

### **Suggestions for Further Study**

In order to support the PBL using ICT in the classroom, it is important to develop teachers to be more knowledgeable on the paradigm of learning based on both constructivism and constructionism. At the same

time, the administrators should provide the facilities and solve problems related to computers and internet network connections for all students to create artifacts by using ICT.

The further studies on the issues of PBL using ICT might be; the learning paradigm shift, the use of computer and network for project-based learning using ICT, the classroom setting for project-based learning using ICT, and the process to support and monitor for project-based learning using ICT.

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