The advantages of Information and Communications and Technology (ICT) in Science Education

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Abstract

Nowadays, the digital technology is a wildly use in education. There are many educational proposes from ICT such as teaching, learning, assessment and evaluating. Science is one of the problematic knowledge about nature, phenomena, substance, theory, and law. Also, it concerns in science process skill practice and attitude toward science. This study is to analyze what is the properly ICT using in the science classroom. The main ideas of how to apply ICT at any stage of teaching explain in term of technology and pedagogical content knowledge for teachers and the learning process for students. The summaries are help the facilitator to categorize ICT and choose the right one to implement in all aspect of the classroom.

Keywords: ICT, Science education

1 Introduction

In past decade, information communication technology (ICT) has been introducing to a classroom. It is friendly user and environment to the teachers and students. ICT is the most powerful tools and promoting knowledge understanding, and it has the variety of feature and function. The teacher should study and try to use it adequately learning purpose. Many research and experiences that claim why education should concern in ICT for example. Roger (2013) had developed and implemented the ICT for Innovative Science Teachers Project with the five partners in Europe. The training packages had created in many ways to access the knowledge using the two groups of ICT feather which are data processing, modeling, simulation, data-logging and video capture for processing information and understanding. Moreover, another one is internet multimedia, visualization, instruction and tutorial for presenting information. This project helps a teacher who had low to high ICT skills to come up with the ICT experiences that made the active learner and classroom.

In the science classroom nowadays, it is not just learning in content and practical work by the only lecture or doing laboratory but it also adds up the digital world of multimedia instruction to reach the science concept understanding. The active classroom could provide the foundation of web-based application or software in many devices such as Google and its feathers, Microsoft Office for Android and Number, Page, Keynote for OS. It also combines the real situation in the real with the visual objects using augmented reality (AR) technology. It can be view in quick response (QR) codes and marker through their camera in any computer and other devices under Android and OS platform, digital information and 3D animations which can be attached to images on paper, cards, or other surfaces.

2 Background

2.1 TPACK for Science Teacher

Technological Pedagogical Content Knowledge TPACK is the unique and famous framework for teacher learning management in this digital era. It has a boundary between Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK). The three parts can be visual as the figure 1.

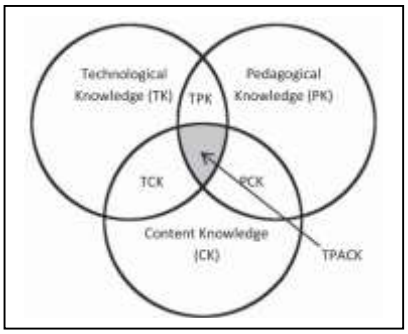

Figure 1. TPACK framework (Koehler et al., 2014)

The PCK component is "the ways of the representing and formulating the subject that make it comprehensible to others" (Shulman, 1986). Technological Pedagogical Knowledge (TPK) is the understanding of how to apply and combine ICT or technology in the learning activity. Technological Content Knowledge (TCK) is about how to represent content or to use an effective way of technology (Rogers L & Twidle J,2013). Teacher has to construct the technology knowledge and generate the idea that merges to the subject matter and teaching approach. It helps them to interact with a clear communication, quick response and getting the point. Also, Jimoyiannis (2010) propose a new model of the science context with the Technological Pedagogical Science Knowledge called the TPASK. It was implemented in curriculum for teacher training ICT integration in science classroom practice. All the frameworks are clearly determined that the knowledge of science and technology are necessary to point out the outcome of learning in a core concept. The way of transfer the concept should be concerned with learning approach, method and techniques. Moreover, the ICT knowledge had changed and available in a short period. The teacher has to learn and practice the new kind of technology and feathers so they should follow and update it even on the devices that let the student practice on the interactive media.

2.2 ICT for Science Education: Teacher Training Program

At present, the country development progress in all dimensions is depended on scientific and technology knowledge to change the world. The influx of information makes people in the society more aware of the choice. Trust, until the decision is correct and meets the situation or needs of the community. The economy, politics and youth are the groups that should be cultivated essential features from the family and the schools. Teachers need to be aware of their learning development in a society based on scientific knowledge and advanced thinking is an intellectual weapon. So the process of learning can encourage and develop learners reach the full potential. Also, The Basic Education Core Curriculum 2008 in Thailand has set at inculcating among learners the following five key competencies:

" 1) Communication Capacity
Capacity to receive and transmit information; linguistic ability and skills in expressing one's thoughts, knowledge and understanding, feelings and opinions for exchanging information and experience, which will be beneficial to oneself and society; negotiation for solving or reducing problems and conflicts; ability to distinguish and choose whether to receive or avoid information through proper reasoning and sound judgement; and ability to choose efficient methods of communication, bearing in mind possible negative effects on oneself and society.
2) Thinking Capacity
Capacity for analytical, synthetic, constructive, critical and systematic thinking, leading to creation of bodies of knowledge or information for judicious decision-making regarding oneself and society.
3) Problem–Solving Capacity
Capacity to properly eliminate problems and obstacles, based on sound reasoning, moral principles and accurate information; appreciation of relationships and changes in various social situations; ability to seek and apply knowledge to prevent and solve problems; and ability for judicious decision-making, bearing in mind possible negative effects on oneself, society and the environment.
4) Capacity for Applying Life Skills
Capacity for applying various processes in daily life; self-learning; continuous learning; working; and social harmony through strengthening of happy interpersonal relationships; elimination of problems and conflicts through proper means; ability for self-adjustment to keep pace with social and environmental changes; and capacity for avoiding undesirable behavior with adverse effects on oneself and others.
5) Capacity for Technological Application
Ability to choose and apply different technologies; skills in application of technological processes for development of oneself and society regarding learning, communication, working, and problem-solving through constructive, proper, appropriate and ethical means." (Ministry of Education, 2008. p6)

The using of ICT in science education had many chances to change the classroom from general teaching to active and interactive learning under the responsibility of pre-service and in-service teacher in the school. Our staff in science

education program at Teacher Education Department, Faculty of education and development science, Kasetsart University, Kamphaeng Saen Campus has many experiences in producing science teacher. We try to emphasize ICT based teaching into all courses in the program. We can improve our teacher students to reach the foundation of using ICT. They can implement the ICT environment through their classroom. In the other projects, the teacher training process has been running through the university and another institute where take the responsibility to the local educational zones for producing teacher from last three years in Thailand called "Teacher Training Coupon". This project is the one of Thai teacher can make the benefit of the new knowledge, connection and learning community. So we launch a science teacher training program (STP), with TPACK framework. This program is aimed to promote secondary science teachers to be ready for teaching activities that emphasize the development of thinking via ICT and communication skills for active learning in science. All teachers can gain their perspective ICT view, play and learn from the real situation. The STP was designed to build science thinking and communication by using active learning, socio-scientific issues, problem and project-based-learning. Thinking and communication skills are one of the characteristics of a global citizen that is defined for self-improvement. Economic and social have been changing with science and technology. The youth should enhance in exploring scientific knowledge about real life. So far, it is the basis for compromising and deciding on social issues related to science.

The program content and the workshop included the introduction of scientific thinking skills, science process skills, necessary application and ICT in science education, activity designing. The program took 20 hours and implemented in the classroom for 2-6 hours. A mentor in the program would take the response and advise the teacher for getting the right ICT in any lesson plans. We had 105 teachers from all over Thailand to attend this program. The schedule of the program is as follow.

Day 1: 1) learning in scientific thinking and reasoning theory and practicing in higher order thinking (critical thinking, creative thinking and problem-solving skill).
2) Learning in authentic assessment and evaluation in higher order thinking.
Day 2: Lesson learned and reflect from a science classroom enhancing thinking skills.
Day 3: Using ICT in appropriate science learning and communication, learning in science application and design science communication using Youtube, infographic and related social media.

2.3 Application (App)

The chosen Apps can be provided on the web-based platform and compatible with any device such as a smartphone, tablet, laptop and personal computer. Those apps can create categories into four roles of the teaching process.1) Cognitive App has pulled content understanding with simulation, data-logging and such data resources. 2) Practical App let the learner processing their thinking and gain their science process skill. 3) Attitude App is bringing the cartoon, graphic, problem and project into their mind. Students have fun and feel good to use this App inappropriate teaching. 4) Assessment Apps is a tool providing any kinds of the test from and reflection from the learner. It shows the score and comment immediately. However, there are some Apps which have compatible more than one role. Every App can use in a single register via email, Facebook and Google account. It is also easy to use in a click and free of charge. So the teacher should take a tour or play it before design their lesson for the student. PHET, phet.colorado.edu/th, is the interactive simulation plus data logging based-on law and theory for science and mathematics. It is created and developed by the University of Colorado. PHET had including experiment, investigation, measurement to understanding science concept. Gizmos, www.explorelearning.com, is the online simulation that focuses on experiment and inquiry understanding. It can change variable to follow the result after simulating in speed time setting in a second. The data collection can show in table and graph. ChemCollective, chemcollective.org, is a virtual laboratory online simulation for chemistry. It is a project in the National Science Digital Library (NSDL). The lab allows a learner practice by scenario-based learning activities. It is designed to provide interactive, engaging materials that link chemistry concepts. Plicker, Kahoot and Quizless are the tools for assessment.

It provides interactive test and questions that easy access by QR code card and register number via smartphone. The most popular is multiple choice test, true or false quiz and short answer test. Science e-book for the student in Thailand was created to fill AR in some topic as the picture below (Ipst, 2018). For the Piktochart.com, it can help the learners design and create their own infographic to reflect the concept, law theory and information of scientific understanding.

Figure 2. AR in science e-book

Table 1. The Application Highlight for Science Education Example

Apps' List	Cognitive	Practical	Attitude	Assessment
PHET	✓	✓	✓	✓
Gizmos		✓	✓	✓
ChemCollective	✓	✓	✓	✓
Plicker				✓
Kahoot				✓
Quizless				✓
Data nugget	✓		✓	
MOOC (Coursera, Edx,Khan	✓		✓	✓
AR	✓	✓	✓	
Piktochart	✓	✓		

2.4 Learning management and outcomes in the classroom

After the course finish, all the teachers had to design a lesson plan which enhances student's high order thinking and the science communication by infographics (information graphics) pattern. Most of the infographics had presented the variety of the concept, law, theory and information integrate picture, graphical representations, and table at the same time. Infographics are efficiently presented to understand complex information (Davidson, 2014). The teacher let the students practice in Piktochart.com and design infographics after they had learned and done the experiment in the classroom. It can be reflected and evaluate the effectiveness of student's learning. The students also can communicate the science concept on Youtube channel. They can create a script and arrange the storyline steps, make a short video clip with capture photos. The Youtube channel can be used in creative studio features which can be uploaded the video clip, count the view number and let the people subscribe to be a member.

Figure 3. The Infographic Example of the Teachers and Students

The lesson plans had developed based on problem- based-learning, 5E model, project-based-learning, situation-based-learning and active learning. The use of ICT and the science contents can summarize as follow.

a. Physic is about;
   Work, force and motion, energy, electricity.
b. Biology is about;
   Cell, DNA, plant, animal, food and nutrient genetic transmission, the evolution of living things, the biodiversity, the application of biotechnology, the eco-system and natural resources.
c. Chemistry is about;
   Acid-base, the properties of substances, materials, element and compound, structures and binding forces between particles, the solution formation and the chemical reaction.
d. Earth science is about;
   Astronomy, earth surface and the interior, topography and form of the earth phenomena in the world.
e. Environmental science is about;
   Energy, earth body, substant cycle, climate change**.**

The lesson plan can analyze into three parts. The first part is about the engagement phase. This step, most teacher selected the video clip to show students and ask the questions before and change the general questions to a scientific question. They could pose the hypothesis and variable to experiment. The second phase, the teachers plan to explore the knowledge by experiment, information on the website (Coursera, Edx, Khan) and demonstration. For the science process skills, they almost used PHET and Gizmos. They also used e-book from IPST (http://www.ipst.ac.th) to show the correct science concept and information. For the last phase, all teacher feel comfortable to use Kahoot, Plicker and Quizless for assessment. They also use formative assessment probe techniques for science concept (Keeley, 2015). All lesson plan insert the situation in daily life such as renewable energy, climate change, flash flooding, electronic waste, surgery, health and medicine to engage and solve the problems and think critically.

3 Conclusions

The three perspective views of the science teacher should attend before managing the classroom with ICT as follow1) They have to understand the central science concept of thinking and practice.2) They need to choose the right ICT tools to match in content, context and practice. 3) They should scaffold student to build and reflect their science concept. By the way, the perfect combine ICT tools or application are that the teacher could try and error in any Apps to make sure it can be usable on leaning concept and achievement learning indicator. The teacher could act like the excellent user more than the programmer. They need to know how the apps can be used with a variety of science concept. Even the apps have designed for the more friendly user the more tryout before lesson plan development. Some of the web-based apps have limited features and could work well in personal computer and laptop but not appropriate on smartphone or tablet. The use of ICT in a science classroom in Thailand has been increasing in the learning process. The new trend of communication and application today can help the student understand science concept and advantages.

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