ICT competencies for sustainability science teaching in 21st century

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Abstract. ICT competencies for sustainability science teaching in 21st century needs appropriate ICT competencies in order for instructional to effectiveness. The data in this study came from documentary analysis include brainstorming and interview among the science teachers of primary and secondary education service areas under the basic education commission office. ICT competencies for demonstrating knowledge and skills using technology, training the learners use technology by themselves, creating to interactive and discovery learning, technology access of connects and communicates, use ICT skills in developing and presenting of informations, designing in effective learning to experiences and creating to rich learning environments, and using ICT as didactical tool to implements the collaborative learning.

Keywords: ICT competencies, sustainability science teaching, 21st century

1. Introduction

Education is important a foundation to development that mechanisms a developing of competencies and abilities is important to variable in long-term competitiveness [1]. In educational context, teachers are important gardeners for nurturing national future masters of students. Teachers are successful, students will be successful, in term Thai’s national will be continuing the prosperous. Therefore, quality of education can forecast of future. Teachers play a pivot role in practice on educational quality. Teaching should be regarded as professional, the teachers conduct these professional services to the students and the professional is based on teachers’ content knowledge and practice of instructional delivery of the content knowledge [2]. The professional learning community can be information social networks aiming to develop members’ knowledge construction and sharing. Therefore, the professional learning community should be cooperating, sharing practical knowledge.

The 21st century skills for the future to innovative approach a learning that teaches to multitude the strategies critical for success in the 21st century. Students drive their own learning through inquiry, as well as work collaboratively to research and create projects that reflect their knowledge. From gleaning new, viable technology skills, coming proficient communicators and advanced problem solvers, students benefit for approaching the instruction [3]. Challenges through the technology and curriculums to students improve for understanding to both the science of the contents and scientific practices. Educational technologies, knowledge related to the effective use of educational technologies has become widely recognized as important aspect of an educator’s knowledge-base in the 21st century. Educational technology, educators were taught in the technology classes that focused primarily on technology skills independent from pedagogical or a content [4]. Educators soon recognized that technology skills alone did not serve them well because one could know how to
operate a piece of technology without knowing how to use it effectively to promote student learning. The focus then shifted to preparing educators for integrate technology to their teaching.

Technology integration became the phrase that characterized efforts to use technology in an educational context. There have been many technology integration models or frameworks developed to help measure and guide educators in their use of technology. A few of the widely recognized frameworks, the levels of technology Integration scale, apple for learning management to continuum [5]. Technology integration frameworks have to focused using the technology for generalist’s the perspective; they characterize use technology to general pedagogical terms, independent any particular content domain. Most recently of the recognition among educational technologists that the pedagogical uses of technology are strongly influenced by content domains to situated. For example, knowledge required to effectively integrate technology in science classroom ICT competencies for science teaching represents to integration the technology with general pedagogical strategies to characterized of technology integration literature (e.g., how to the management technology-rich classroom, engage students with technology-oriented activities, and create useful presentations, assessments). Represents knowledge of technology tools and representations that are used by practitioners within a content discipline. Finally, which the center of the model, represents the use of technology to support content-specific pedagogical strategies (e.g., use of technology for supporting on inquiry in classroom). ICT competencies for science teaching in the 21st century.

The 21st century competencies, the influential of the subsequent work. The Commission spoke with a wide range of managers and workers: “their message to us was the same across the country and in every kind of job; good jobs depend on people who can put knowledge to work. Individuals in the workplace should be able to productively used to resources, interpersonal skills, information, systems, and technology [1], [15], [16]. Capacity in 21st century competencies for science teaching to change given a rate of the technological innovation, frequency to organizational restructuring, work process knowledge theory argues that the ability of individuals to adapt and innovate to use their technical and generic knowledge and skills to contribute the production of new knowledge.

The research objective aimed to analyze ICT competencies for science teaching in 21st century.

2. The literature review

2.1. ICT Competencies for Promotes Collaboration & Interaction

ICT competencies for science teaching to promotes collaboration and interaction, ICT stimulates interaction by providing a supportive and encouraging communication environment. That ICT offers different and convenient ways of interaction has been mentioned above. The interaction will be examined in two contents were interaction with teachers and interaction between learners. Interaction between teachers and learners plays a crucial role in learning processes. Teachers design curricula, lesson plans, learning materials and learning activities to create a learning environment to the students on interact and make meaning [6]. ICT, the powerful tool for design to interactive learning environment, facilitate learning by answering a question, mentoring, scaffolding, giving feedback and so on. Students can interact, get support from educators through different ways, such as face-to-face, email, chat and forum. Collaboration among learners is also enhanced to provides flexibility in methods of communication. flexible communication, collaboration can be fostered. ICT may provide an interactive learning environment in which students explain and share ideas or hypotheses justify them, argue or negotiate, and build knowledge. In general, learning, internal re-organizing knowledge and constructing understanding in a society, is mediated by tools (e.g. equipment of experiments). ICT, considered to type of meditational means provides learning flexibilities on learning resources, an instructional organization of learning, communication, social organization of learning. Flexibilities, ICT promotes to an interaction and a individuals’ learning activities. Agbatogun [7] delineated three stage for development an initiation stage, teachers start to incubate teaching leadership on implementing stage include teachers starts to share their power, responsibility, focus on students’
achievement, sustaining stage, teachers pervasively involve in school policy formation, decision making processes, implement on practice. The features of professional learning community of a negotiation meaning, preserving, creating knowledge, spreading information, a being for identities. Activities imply of teachers needed the competencies into students for assessment and sufficient time, resource to complete them in a professional learning community [8]. ICT support to individuals learning connects into cognitive constructivism, fostering interaction and collaboration relates to social constructivism. It requires continuing adjustment and refinement to a stable professional learning community.

2.2. Science Teaching of Technological Pedagogical Content Knowledge
Mentioned earlier, to focus on sustainability science teaching in the 21st century which integrates appropriate learning principles the technology of science contexts. Arnseth, H.C., & Hatlevik, O.E. [8] conceptualization of TPCK is conceptualized to situated form of the knowledge deeply rooted in the interactions of subject matter, pedagogy, technology. Situated form knowledge that is required for intelligent uses technology in teaching and learning. Is dynamics, transactional relationship between content, pedagogy, technology. In teaching with technology requires for understanding to mutually reinforcing of relationships development, appropriate, context-specific, the strategies, the representations. Conceptualization goes beyond seeing content, pedagogy and technology as constructs of themselves. Specifically, their approach considers to interactions, a goal of describing each of discussions about nature of knowledge.

2.3. Teachers’ Belief on Technology-based Teaching and Learning
With development of learning technologies in 21st century, education system has changed rapidly. This is due to the capability of technology to provide a proactive, easy access and comprehensive teaching and learning environment. Nowadays, education has provide a lot of facilities and enhance use of advanced technologies for teaching and learning process. A high budget has been placed in order to provide the equipment needed by teachers to improve the education system. Despite all the efforts are facing similar problem. The teachers are not maximizing to usage of technology provided. [9] ICT in teaching and learning process could improve students’ achievement. Affecting teachers’ acceptance of ICT usage in classrooms. It shows that, the major barrier of the implementation was the teachers’ belief as the teachers are the person who implements the change in their teaching and learning process. Moreover, the correlation of teachers’ belief and the use of ICT are high. Teachers’ role is getting more important especially in usage of ICT in pedagogy which could increase the achievement of the students, their creativity and thinking skills.

3. Methodology
ICT competencies for sustainability science teaching in the 21st century in the methodology were followed:

3.1. Data Method
Type of research is a qualitative research both to the participatory action learning by brainstorming and interview aimed to gather an in-depth understanding with science teachers to analyzed ICT competencies for sustainability science teaching in the 21st century to research design of data method.

3.2. Sampling Method
The respondents of the results sampling method that will be used in this study with the science teachers of primary and secondary educational service areas under the basic education commission office throughout Thailand. The total number of participants as 150 persons. They all were multistage random sampling.
3.3. **Collection Method**
The collection method of respondents were asked to respond to the qualitative data. Step 1: Involved synthesizing documentary to study the contents were perceived on influence to challenges of ICT competencies for promotes collaboration and interaction, science teaching in technological pedagogical content knowledge, teachers’ belief on technology-based teaching and learning, for analyzed the elements in data collection. Step 2: Take to important points that can be analyzed follow step 1, for brainstorming, interview with 150 science teachers by the structure interview questionnaire on influence to the challenges at a “key” of 7th elements were demonstrating knowledge and skills using technology, training the learners use technology by themselves, creating to interactive and discovery learning, technology access of connects and communicates, use ICT skills in developing and presenting of information, designing in effective learning to experiences and creating to rich learning environments, and using ICT as didactical tool to implements the collaborative learning, for analyzed on the perspective of the elements in data collection.

3.4. **Inquiry Method**
The collections to instrument study to analyzed ICT competencies for sustainability science teaching in the 21st century. It is a qualitative data employed a review of documentary and interview on the elements of demonstrating knowledge and skills using technology, training the learners use technology by themselves, creating to interactive and discovery learning, technology access of connects and communicates, use ICT skills in developing and presenting of informations, designing in effective learning to experiences and creating to rich learning environments, and using ICT as didactical tool to implements the collaborative learning was analyzed by using three main stages, i.e., data reduction, data organization, data interpretation to conclusion of the data analysis.

4. **Summary**
ICT Competencies for sustainability science teaching in 21st century at a “Key” of elements shown on a figure 1.

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**Figure 1.** A “Key” of 7th elements on ICT competencies for sustainability science teaching in 21st century
1. ICT Demonstrates: Demonstrating knowledge, skills using technology for implementing the concepts, methods, problem solving, developed to innovation instructional media throughout technological process of tools for learning management based on creative innovations of the digital medias for enhancing the new knowledge and skills to consistent with the learning contents of a “key” attribute as, (a) Learning management through the networks and linking of technology literacy and digital citizens by any where and any time to effects of learners for social interaction and learning exchange, searching for knowledge, including participation between the teachers and the learners to crystallization of new knowledge, ability and skills to sustainability, (b) Learning on internet networks to interaction of knowledge sharing, learning exchange and utilization of various learning resource using information and communication technology skills for apply to search data in learning management, (c) Learning process caused by the learners is a self-creator from existing knowledge and experience, by thinking through the process for linking to new things on learning, with previous knowledge and the experience, modification cognitive structure of students.

2. ICT Accessible: Training the learners use technology by themselves through activities that integrate learning, combined with the innovative design process and educational technology of learning by using the problems base, which the learners are the creator of self-knowledge from knowledge and experiences through thinking the process to connects the new things, intellectual structure modification of students a providing opportunities of the students to integrate knowledge and skills was related during for learning, helping the students to developed the skills in 21st century.

3. ICT Interactions: Creating to interactive and discovery learning for instructional through development process shown be approach on teaching and learning for achievement to virtual classroom arrangement through ICT networks and connects learners to information technology can be anywhere, anytime, continuously of instructional such as, (a) creating challenges of learning the solving problems and situation, that the teachers to determines, (b) creating activities that stimulate learning of active learning, and (c) creating situations or problems used in the activities to connection and relationship with the contents and knowledge.

4. ICT Internship: Technology access of connects and communicates to created the learning exchange networks, technology communicates networks to critical thinking, analysis thinking, necessary learning of the 21st century skills.

5. ICT Informations: Use ICT skills in developing and presenting of information for building the knowledge and ability to analyze queries and information processing for applying to create knowledge solving problems to effectively.

6. ICT Environments: Designing in effective learning to experiences and creating to rich learning environments, learning design focuses on students to actions and implementing of knowledge creation is more than a recipient of knowledge transfer from the teachers, for giving students the opportunity to discover by themselves can create knowledge on their own, through Assimilation as bringing new information or knowledge, that has been linked in harmony with existing knowledge structure, and accommodation of thinking, finding various methods to create for understanding until it becomes knowledge of meaning for oneself. Creating a diverse learning environment of development about the ability to recognize and understand in the student. Together with the structure of the contents to be learned in harmony based on the basic of learning management were followed, (a) knowledge is created or molded by experience, (b) students are responsible for learning, (c) students to create meaning from various aspects, (d) Students are in a realistic environment, (e) students are choose their own content and activities, and (f) the content should be created as a whole.

7. ICT Didactical Tools: Using ICT as didactical tools to implements the collaborative learning focuses on students to activities in creating self-knowledge from fusion of previous knowledge to create new knowledge through the use of ICT, and participatory learning on important principles to instructional of the flipped learning with self-directed learning by dividing the learning area, 2th parts were internal classroom and external classroom for learning management of the students to study and research the content of learning by ICT for bring the knowledge to do activities and create work pieces.
5. Discussions

ICT competencies for sustainability science teaching in the 21st century are conceptual action on science teaching of centered learning management to students for learning effectiveness. That to support are students have a role seekers of knowledge, and practice by applying technology as a learning tool, which teachers help and give advice, that to promote learning on resulting in ICT skills to efficiency, learning environment management of technology integration matrix, learning environment management to students use technology tools a working with others, creating knowledge through the works, learning environment management to students use technology tools for the real life in problem solving on meaningfully for themselves. Accordant with Cassim and Obono [10] to mentioned of replacing tools for quality teachers but instead they are considered as an add-on supplements needed for the better teaching and learning. The need for ICT integration in education is crucial, with the help of technology, teaching and learning is not only happening in school environment, also can happen even if teachers and students are physically in distance. However, ICT integration is not a one-step learning process, but it is a continual process of learning that provides proactive teaching-learning environment, to accordant with Chapelle [11], ICT used in various ways where it helps both teachers and students to learn about their respective subject areas.

Technology based teaching and learning offers various interesting ways. Cox and Marshall [12] have identified three main stages for ICT to be highly valued and regarded by teachers; integration, enhancement and complementary. ICT competencies for sustainability science teaching in 21st century on activities imply to teachers need competence in students assessment and sufficient time, and resource to complete them in the professional were to, (a) understanding to students’ in cultural backgrounds, interesting, skills, and abilities as they apply across a range of learning domains and subject areas, understanding students' motivations and their interests in specific class content, clarifying and articulating the performance outcomes expected of pupils, planning instruction for individuals or groups of students, (b) monitoring pupil progress toward instructional goals, identifying gains and difficulties pupils are experiencing in learning and performing, adjusting instruction, giving contingent, specific, and credible praise and feedback, motivating students to learn, judging the extent of pupil attainment of instructional outcomes, (c) describing the extent to which each pupil has attained both short- and long-term instructional goals, communicating strengths and weaknesses based on assessment results to students and parents or guardians, recording and reporting assessment results for school-level analysis, evaluation, decision-making, assessment information, and instructional planning. Competencies of teaching professional on the standards represent a conceptual framework or scaffolding from which specific skills can be derived. It is also expected that experience in the application of these standards should lead to their improvement to further development. The competencies of teaching professional were ability, knowledge, skills and attributes in the teachers to require in job roles for successful and outstanding than others of behavior as learning management [13]. The technology-based teaching and learning can make many changes in school that requires for proper planning. Finger and Trinidad [14] noted that national ICT policies can serve several crucial functions. To provide a rationale, a set of goals, and a vision of how education systems run if ICT is integrated into teaching and learning process, they are beneficial in educational. ICT competencies for sustainability science teaching in the 21st century is integrated into teaching and learning process, are beneficial to students, teachers of effectiveness instruction.

6. Implementation

Sustainability science teaching in the 21st century that integration approach is about implementing right use of ICT in particular subject area that involved complex concepts and skills to improving the students’ achievement and attainment.
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