INVESTIGATING VIEWS OF STEM PRIMARY TEACHERS ON STEM EDUCATION

Prasart Nuangchalerm
Mahasarakham University (Thailand)

Abstract. STEM education is now widely distributed to educational institutions in Thailand. It is directly forced through policy and instructional practices. The study was an examination of current views of STEM primary teachers on STEM education, integrated learning among Science, Technology, Engineering, and Mathematics. Participants were STEM primary teachers who selected by purposive selection from STEM schools, Nakhonphanom province, located in the northeast of Thailand. One hundred and twenty STEM teachers from 40 STEM education schools were surveyed. The closed and open-ended forms of surveying consisted of 20 research items with 3 point Likert scale. The open-ended question was summarized and recorded for frequency and percentage. Findings indicated that STEM primary teachers had views on STEM education by a variety of school contexts and they also need more comprehension of STEM practices in their school workplace.

Keywords: STEM; teachers; views; school workplace; integrated learning

Introduction

Thailand is now facing with new era of school reform, world is rapidly changed to 21st century learning, adaptation and development in quality of education are required. Schools need to implement creative education through holistic views, arrange learning progress to integrate with prior knowledge. Active learning, problem-based learning, everyday analogy, sequencing of concepts, and creative-problem solving are require to schools and teachers-based pedagogy (Reeve, 2013; Manosuttirit, 2016). Answering school of change or new paradigm in education to Thailand, that is, we need to focused on teacher development and promote them to professional teachers (Prachagool *et.al*., 2016). They have to competence knowledge to solve new problems, and Gen Z learners' characteristics. As it should be, teachers act as if previous knowledge that they impart to students will not be available to solve many and complex problems in the future. We can doubt that the preparation our citizens appeared as terrible failures in education.

The solutions for teacher developments are employed variety of methods. Ministry of Education launched project to engage in-service teachers with innovative classroom. Teacher coupon is the project that novice and expert teachers learn as well as they need, but it cannot answer all of their need to self-development. Then, IPST settled STEM education into curriculum and educational policy. S T E M education is an integrated approach which stands for science, technology, engineering, and mathematics. These disciplines are distinction in our daily lives, helps us to solve the problem by creative thinking based on contents clarification. STEM education is now distributing around the world, and also in Thailand education. IPST engages STEM education to science and mathematics curriculum, initially introduced with creative learning activities, and propagating STEM to school practices at national level. STEM will be effectively done, teachers are key success to promote integrated learning and STEM curriculum into school. This study investigates STEM primary teachers on their views of STEM education. Although, IPST promotes concepts and some activities through national workshop, online-based training, and face to face by STEM experts and school delegates. However, the progress of STEM education is less monitoring the strength and weakness of STEM teachers' views.

STEM is an integration of curriculum and instruction. The concept of curriculum integration is complex to novice teachers and challenging education 4.0. It is derived from science educators' awareness and responsibility to future citizens. Discipline of tomorrow seems to be different and complicated, real world problems are not separated into isolate disciplines that are taught in schools (Beane, 1995; Czerniak *et.al*., 1999; Jacobs, 1989). Holistic view is not new, but necessary approach for sustaining life in balance. The traditional classroom is focused on standard test, passive learning used, recitation in the lesson, and read for test not for implication of knowledge to live. In addition, the nature of learners tends to be changed, ICT and active learning can answer ways of lifelong learning. Students are expected to connect the contents and necessary skills.

Teachers have to competence their ability in teaching and characteristics through professional standards. These standards are regulated by Teacher Council of Thailand (TCT), teachers must show on their competency in teaching and learning management. The 21st century learning skills are introduced and recognized to the concept of integration. The world is now uncertainty due to the development of information technology. Some knowledge can be changed or unchanged based on explicit evidences. Some knowledge may be faked by the progression of computer and internet. Information can be easily accessed through open-access journal services. Students can monitor and investigate of what reliable knowledge. Teachers have to change instructional practices by emphasizing on practical knowledge. STEM education is the approach in which teachers incorporated into their classroom because it needs necessary tools for thinking and doing.

The previous education may be focus on subject matter, learn for testing, learn for high score, but it ignores knowledge for daily lives implication. As it related to PISA competition and O-NET, students play their score with less satisfaction of learning management. These causes is to learning environments that be changed from passive to active learning. STEM education answers interdisciplinary approach, it begins with a problem or an issue leads the content and skills in multiple disciplinary subjects (Beane, 1997). Interdisciplinary approach initiates with real situations that students have to participates and solve problems through active learning. The active learning helps them to encourage of what students should think and do with peers, it also integrates learning experience from prior knowledge to new experiences. They construct knowledge by individuals through active thinking in their life.

STEM education not only needs to focus on content knowledge, but also needs to include thinking skills and 21st century learning skills. The integration of curriculum and instruction with STEM education need teachers to implement their knowledge and teaching strategies as well. So, this research purposes to explore STEM primary teacher views towards STEM education. The information that report will helps us to understand how STEM teachers perceived.

Methods

The aim of this study focused on surveying, then is to exploring views of STEM primary teacher on STEM education. The survey was conducted with in-service teachers who had responsibility to create STEM leaning activities in elementary education. They were selected by supervisors in primary schools from Nakhonphanom primary educational service area 1, Nakhonphanom province, Thailand. Participants were 120 teachers who working for 20 STEM-based schools and 20-STEM education schools in smart trainers' program. Each school was selected three teachers (science, mathematics, and career and technology teachers) to participate in surveying.

Instrument of data consisted of demographic information of participants and to asking rate of views. Demographic information asked sex, age, educational background, and STEM education workshop experience. Views of their sense can be considered into the rate of 20 items for investigating STEM education. The views can be divided into three levels: yes, no, and not sure. Opinion free and no conflict of interests were declared to respondents. Open-ended form in the final part of questionnaire was added.

Data were collected in the workshop on STEM education for primary teachers in Nakhonphanom province, held on 2-day period in July 2017. The questionnaire about views on STEM education was self-administered through the working. All participants completed the questionnaire, recheck the completion

of form of data collection. The researcher was in the workshop room during they response to the items. Questionnaire form was sent to participants; it was returned with completion form by 87 respondents or 72.50% of returning. Then, the data related to the views of science teachers, data were obtained and re-check the completeness. Data were analyzed in terms of percentage, mean and standard deviation.

Findings

The finding revealed that STEM primary teachers are mostly female, 31-40 yrs, hold a bachelor degree, and having experience in STEM workshop (Table 1). They have been working and teaching for primary school, concerning STEM practices as well as educational policy determination and school movements. The Ministry of Education launched STEM education practices to all school, leading students to Thailand 4.0 and 21st century learning learners. STEM primary teachers are engaged to new learning approach which activity and integrated learning are importantly required.

Table 1. Demographic information of STEM teachers

Information		Frequency	%
Sex	Male	29	33.33
	Female	58	66.67
Age	20-30 yrs	15	17.24
	31-40 yrs	33	37.93
	41-50 yrs	18	20.69
	More than 50 yrs	21	24.14
Educational background	Bachelor degree	51	58.62
	Master degree	36	41.38
STEM workshop experience	No	38	43.68
	Yes	49	56.32

STEM teachers who participated in this study are mostly constructive and productive generation. They have ever been trained or experienced in workshop of STEM education and learning activities (56.32%). Due to the Institute for the Promotion of Teaching Science and Technology settled program for teacher development in learning design through STEM practices in both online and face to face. Policy on STEM education is forced to school by educational service area under Ministry of Education. The views of primary teachers on STEM education can be shown in Table 2.

Table 2. Views of primary teachers on STEM education

Item	Respondents (%)		
	Yes	No	Not sure
STEM education is an integrated learning approach which concerns in S-science; T-technology; E-engineering; and M-mathematics only	51(58.62%)	30(34.48%)	6(6.90%)
STEM education is very complex for teachers to manage classroom	25(28.74%)	48(55.17%)	14(16.09%)
STEM education is project-based learning	48(55.17%)	23(26.44%)	16(18.39%)
Objectives of STEM education need students to having 21st century learning skills	79(90.80%)	3(3.44%)	5(5.56%)
Objectives of STEM education emphasize on students' understanding in core subjects and basic education curriculum	56(64.37%)	17(19.54%)	14(16.09%)
Objectives of STEM education require students to have ability in analytical thinking and problem-solving	85(97.70%)	1(1.15%)	1(1.15%)
Objectives of STEM education is an actively engaged to students	79(90.80%)	5(5.56%)	3(3.44%)
STEM education must be occurred only in science hours	9(10.35%)	75(86.21%)	3(3.44%)
STEM education must be conducted in moderate class, more knowledge period	15(17.24%)	60(68.97%)	12(13.79%)
Teachers no need to teach in STEM classroom, just assign work to students	14(16.09%)	64(73.56%)	9(10.35%)
STEM education must be always evidenced in worksheet or production	40(45.98%)	38(43.68%)	9(10.34%)
Team-based teaching is require for STEM education	61(70.10%)	19(21.84%)	7(8.06%)
STEM education must be facilitated students to concentrating in project materials	36(41.38%)	40(45.98%)	11(12.64%)
Instructional strategy of STEM education is less questioning, but action learning is very important	55(63.22%)	21(24.14%)	11(12.64%)
ICT and internet resources are required for STEM education classroom	38(43.68%)	37(42.52%)	12(13.80%)
Portfolios are vital tool for learning assessment in STEM education	29(33.33%)	45(51.73%)	13(14.94%)
STEM education focused on subject matters and learning achievement in the lesson	30(34.48%)	50(57.47%)	7(8.05%)
STEM education must be assessed students' learning in both process and product	80(91.96%)	3(3.44%)	4(4.60%)
STEM education can be considered learning behavior through learning activities	69(79.30%)	7(8.06%)	11(12.64%)
STEM education ignores contents which appear and determine in core curriculum	41(47.13%)	35(40.23%)	11(12.64%)

In response, most of teachers (58.62%) showed their views on STEM education is an integrated learning approach which concerns in S-science; T-technology; E-engineering; and M-mathematics only. STEM is just integration approach which teachers think and do based on multidisciplinary. It is an instructional approach – STEM education is easily managed in classroom (55.17%). Most of them considered STEM education is project-based learning, creative working and innovation, and product designed. It can make students as good thinker, especially analytical thinking and problem-solving (97.70%). However, they believed that STEM education must be always evidenced in worksheet or production (Yes 45.98%; No 43.68%).

Teachers can manipulate as it integrated activities due to STEM education make students success for 21st century learning skills (90.80%). However, they are still understood that 64.37% of STEM education emphasizes students' knowledge concurrent with core subjects and basic education curriculum. It helps students to learn with lively learning or active learning (90.80%). Team-based learning to answer collaboration is an issue which they agree to Yes. But, it is very surprised when they agree to STEM education should be less questioning, giving students to learn in freely by action (63.22%). For the assessment, they considered that students' achievement can measure in both process and product (91.96%). Activities and behavior will be shown during STEM education practices, they agree to assess learning behavior through learning activities (79.30%), consider learning progress of their students based on authentic assessment.

Discussion

Views of STEM primary teachers on STEM education can be understandable how they perceived even though school policy and Ministry of Education launched STEM education campaign. They are key success of integration a whole content knowledge and pedagogy to classroom. The investigation indicated that some of them have some misunderstand in the views to STEM education. STEM education is emerged from 4 subjects; science, technology, engineering, and mathematics, but it can use with others subjects. STEM education is an integration approach to achieve students in knowledge, practices, and higher-ordered thinking. It also provides importance to the development of 21st century skills in every aspect of students' life (Erdogan & Ciftci, 2017). It is an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world situations that challenges students learn science, technology, engineering, and mathematics (Bybee, 2010; 2011).

STEM is an integration approach allowing knowledge and practices into learning activities, making connection between skills, knowledge, thinking, and attributes. These characteristics are good explanation of 21st century

learners. It is actively learning, STEM education is easily managed in classroom by supporting materials and effective management from relevant parties (Manostturit, 2016). However, students need a balance of learning between passive and active learning because they have to bring knowledge to create of what they need to solve problems. STEM education followed mind-on, hands-on, collaborative, effective communication, critical thinking, and creative thinking relevant to designed-based inquiry (Schnittka et.al., 2010; Baran et.al., 2016).

STEM primary teachers considered that STEM education is project-based learning. In fact, STEM education is an integrated learning approach, support students learn science; technology; engineering; and mathematics based on real-life solutions. Bloom's taxonomy (1956) includes the recognition of specific facts, procedural patterns, and concepts that serve in the development of intellectual abilities and skills. Knowledge, comprehension, application, analysis, synthesis, and evaluation are important components which teachers and students should have and gain much more. STEM education make a linkage between each components add on creative activities. However, half of teachers stills perceived that worksheet or production should represent in STEM classroom (Yes 45.98%; No 43.68%). That is, they define STEM education in passive and active learning, traditional classroom and innovative classroom are waiting for adaptation in STEM primary teachers.

Additionally, teachers viewed that STEM education make student's success in 21st century learning skills (90.80%). STEM education is not only integrated approach, but also students-centered teaching approach (Radloff & Guzey, 2016). The curriculum and instruction can take it role to response student-centered approach, helps them to learn with active learning. But, it is very surprised when they agree to STEM education should be less questioning, giving students to learn in freely by action (63.22%). It seems to teachers misunderstand about instructional practices. The misunderstanding can be change by setting STEM workshop for in-service teachers and implementing STEM curriculum to pre-service teachers (Erdogan & Ciftci, 2017). Teachers showed their significant views in the STEM education, learning and teaching approaches, and also the relationship between curriculum and instruction. The finding indicated that assessment is needed to discuss for STEM education. Teachers considered that students' achievement will be measured and evaluated both process and product. Authentic assessment is significant tool for promoting professional teachers in STEM education. With this research, teachers have views to STEM education, some issues need to implement curriculum and instructional practices. Teachers have to had more opportunity learn variety methods of STEM education in their school contexts.

REFERENCES

Baran, E., Bilici, S.C., Mesutoglu, C. & Ocak, C. (2016). Moving STEM beyond schools: sudents' perceptions about an out-of-school STEM education program. *Int, J. Educ. Math., Sci. & Tech.*, *4*, 9 – 19.

Beane, J.A. (1995). Curriculum integration and the disciplines of knowledge. *Phi Delta Kappan*, *76*, 616 – 622.

Beane, J.A. (1997). *Curriculum integration: designing the core of democratic education*. New York: Teachers College Press.

Bloom, B.S. (1956). *Taxonomy of educational objectives, vol. 1: cognitive domain*. New York: Addison-Wesley Longman.

Bybee, R.W. (2010). Advancing STEM education: a 2020 vision. *Tech. & Eng. Teacher*, *70*, 30 – 35.

Bybee, R.W. (2011). Scientific and engineering practices in K-12 classrooms: understanding a framework for K-12 science education. *Sci. Teacher*, *78*(9), 34 – 40.

Czerniak, C.M., Weber Jr., W.B., Sandmann, A. & Ahern, J. (1999). A literature review of science and mathematics integration. *School Sci. & Math.*, *99*, 421 – 430.

Erdogan, I., & Ciftci, A. (2017). Investigating the views of pre-service science teachers on STEM education practices. *Int. J. Environ. & Sci. Educ., 12*, 1055 – 1065.

Jacobs, H. H. (1989). *Interdisciplinary curriculum: design and implementation*. Alexandria: ASCD.

Manosuttirit, A. (2016). A study of teaching STEM education in Thai high school. *Thammasat Int. J. Sci. & Tech., 21*(5), 1 – 6.

Prachagool, V., Nuangchalerm, P., Subramaniam, G. & Dostal, J. (2016). Pedagogical decision making through the lens of teacher preparation program. *J. Educ. Gifted Young Scientists*, *4*(1), 41 – 52.

Radloff, J. & Guzey, S. (2016). Investigating preservice STEM teacher conceptions of STEM education. *J. Sci. Educ. & Tech., 25*, 759 – 774.

Reeve, E.M. (2013). *Implementing science, technology, mathematics, and engineering (STEM) education in Thailand and in ASEAN*. Bangkok: Institute for the Promotion of Teaching Science and Technology.

Schnittka, C., Bell, R. & Richards, L. (2010). Save the penguins: Teaching the science of heat transfer through engineering design. *Sci. Scope*, *34*(3), 82 – 91.

✉ **Prasart Nuangchalerm**
Faculty of Education
Mahasarakham University
44000 Mahasarakham, Thailand
E-mail: prasart.n@msu.ac.th