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Using a Blended Mobile Learning Model for Learning on Tablets through Local Science Learning Stations in SaKaeo Province, Thailand

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Abstract. With the cooperation between the Science Education Center, Srinakharinwirot University (SWU), Thailand, and the Graduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology (NTUST), Taiwan, this academic service project about using a Blended Mobile Learning model for learning on tablets was provided to science and technology teachers in Sa Kaeo, a border province in the east of Thailand. This project was developed through the integration of scientific concepts and local wisdom using science learning stations at the College of Bodhi Vijjalaya, SWU, Sa Kaeo campus, composed of five learning stations; 1) Adobe clay house, 2) Charcoal, 3) Bio-extraction, 4) Alternative energy and 5) Community forest. This project was conducted as a research. The one-group pretest-posttest design was applied. The project was divided into two phases; 1) the development of online science learning resource integrated with the local wisdom and research tools and 2) the project implementation. The participants were 38 science and technology teachers (male = 20, female = 18) in primary and secondary school levels. Data were analyzed statistically using frequency, mean, standard deviation, and nonparametric Wilcoxon matched-pairs signed rank test. The results revealed that teachers' conceptual understanding of three aspects; 1) how to use tablets as a tool of learning, 2) scientific concepts of learning stations and 3) the mobile learning model and approaches, were all significantly increased ($p<.05$). Moreover, the teachers were satisfied with the project and some of them were applied the knowledge from the project to their teaching.

Keywords: blended mobile learning, local science learning stations, learning on tablets

Introduction

The development of science and technology is one index presenting the progress of a country. A wide variety of the electronic devices, equipment and information technology which, nowadays, are continually created through the process of creativity also have greatly influenced people's lives. In the modern era, if we look around, we will be familiar with people whose lifestyle use electronic devices such as tablets and smart mobile phone all over every place we visit. These devices can be used efficiently in various dimensions including the educational dimension. Applying electronic devices to the learning process and educational activities can contribute to the quality of education and also reduce inequality in education as well. Learning activities that rely on digital systems not only promote learning in the form of mobile learning but also make learning close to the real life of learners (Shih et al., 2010; Sung et al., 2016; Basak et al., 2018). It seems that technology can make differences in the classroom in dynamic and positive ways. Additionally, technology can also unravel the problem about teaching with lecturing strategy (Benlloch-Dualde et al., 2010; Arifin & Sukmawidjaya, 2020; Sprenger & Schwaninger, 2021). The key to success in integrating technology into the teaching and learning processes or classroom is related to the method of integration. The integration between teaching and technology should be homogeneous and meet the needs of learners (Adams & Hayes, 2009; Hartman et al., 2019)

In Thailand, between 2012 and 2014, the government recognized the importance of using technology in education. The Thai government, during that time, identified an urgent policy item 1.15 in education involved with providing "Tablet PCs" to the schools across the country under the One Tablet Per Child project (OTPC project) (One Tablet Per Child project, 2012).This was consistent with the second strategy of the Eleventh National Economic and Social Development Plan (2012-2016) which focuses on "human development toward a sustainable lifelong learning society" and also the first stratefy of the Twelfth National Economic and Social Development Plan (2017-2021) which focuses on "strengthening and realizing the potential of human capital". Preparing electronic learning media that can be used via electronic devices for all groups of people to be able to easily and conveniently access anywhere and anytime is one of the development guidelines (Office of the National Economic and Social Development Board, 2011 & 2016). In addition, in the process of developing the country, Thailand needs to emphasize improving the quality of education in order to be recognized at the international level, meet the needs of the country and also create the opportunity for entering to the good quality of education system rightfully. Online learning resources are a way to create opportunities for not only educational personnel, teachers or students but also available for people in general to access information easily, quickly and universally which can promote learning anywhere and anytime.

Srinakharinwirot University (SWU), Thailand, has an area-based academic service in Sa Kaeo province. On behalf of the Science Education Center, SWU, in cooperation with the College of Bodhi Vijjalaya, SWU, Sa Kaeo campus, we have developed five science learning stations. These integrated scientific concepts and local wisdom, and consisted of; 1) adobe clay house, 2) charcoal, 3) bio-extraction, 4) alternative energy and 5) community forest. These science learning stations are served as an important learning resource in Sa Kaeo. The project has received positive feedback from teachers, students, local scholars, people in the community and others involved as well.

However, expanding this knowledge from on-site learning to pervasive learning through an online learning resource needs to be considered. This way of learning is useful to disseminate information, to promote both in-class and out of the classroom learning to encourage ubiquitous learning and to engage students and others who are

interested in this way of learning. Moreover, it also motivates learners to learn and keep up with technology. Learning this way helps to reduce the inequality in education and to preserve local wisdom and knowledge of the community. In the process of learning, students will have opportunities to gain in-depth knowledge, and to observe things that their teacher mentioned in the classroom. Students will be able to apply the knowledge they have gained to real life and become aware of the value of local knowledge. Moreover, this way of learning is not only useful for them individually but will also help students to discuss and exchange their ideas with peers as well (Shih et al., 2010; Iyamuremye et al., 2022). Considering science learning stations integrated to local wisdom in Sa Kaeo province, it clearly seems to be a good and important starting point for encouraging teachers, students and community members to understand science in a familiar context. Besides, these science learning stations will encourage people in the community to appreciate and take pride in their own wisdom, which leads to sustainable learning.

With cooperation between the Science Education Center, SWU, and the Graduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology (NTUST), Taiwan, which both specialize in science education, ubiquitous learning and blended mobile learning, this project was interested in providing academic service in order to develop online science learning resource integrated with the local wisdom of Sa Kaeo province. This project aims to promote teachers' understandings of concepts of using tablets as tools of learning, scientific concepts of learning stations and the mobile learning model and approaches. This academic service was implemented in the form of a two-day workshop. The main staff of the workshop was composed of first year doctoral students and faculty staffs from the Science Education Center, SWU, along with doctoral students and expert from NTUST. Additionally, regarding the project, SWU doctoral students applied their knowledge from the course related to developing innovative science learning.

Blended mobile learning

As a result of the advancement of technology and the internet system, digital learning has changed from the classic model of learning such as computer-assisted learning to web-based learning, mobile learning and ubiquitous learning (Hwang & Tsai, 2011; Basak et al., 2018; Iyamuremye et al., 2022). "Mobile Learning" or "M-learning" was created in order to provide opportunities for people in general for easy access to educational resources. Mobile learning can be used in both formal and informal learning (Shuler et al., 2013; Basak et al., 2018; Matzavela & Alepis, 2021). However, it is necessary to link formal and informal learning, such as learning in museums, to focus specifically on content and skills that correspond to school curricula as well (Cahill et al., 2011).Tatar, Roschelle, Vahey,& Penuel (2003) pointed out the benefits of learning in the form of mobile learning through electronic devices. Mobile learning is able to help students to construct their own knowledge while doing activities. Mobile learning is also able to encourage students to share information with classmates. Moreover, mobile devices are portable and help give students access to data and information instantly. This way of learning can enhance students' interpersonal communication and motivation to learn as well (Huang et al., 2008; Hwang et al., 2009; Galligan et al., 2010; Goodwin, 2012; Matzavela & Alepis, 2021). In other words, the use of mobile and wireless communication technologies can help unite the world of learning, especially the natural sciences, to the digital learning resources, effectively (Chu et al., 2010; Crompton et al., 2016).

The United Nations Educational, Scientific and Cultural Organization (UNESCO) has proposed three focus points of M-learning, which are; 1) *distance education,* such as learning in museums or other resources,2) *authentic learning,* which encourages students to investigate and explore the complex problems through working with peers under the guidance of the experts and teachers and 3) *assessment method,* which has to emphasized self- assessment, evaluation and reflection (Shuler et al., 2013).

Much related research has been involved with different mobile learning models. A blended mobile learning model is one learning model which is outstanding in the way it links in-class and outdoor learning. The blended mobile learning model is mainly composed of three components, which are traditional instruction, indoor mobile learning, and outdoor mobile learning. Learning via this model, each student is required to use a smart mobile phone or tablet and learn in the environment using wireless communication. Students should be able to access the internet anywhere and anytime. Using the blended mobile learning model in both in-class and outdoor learning will help students to connect what they have learned from the classroom to online learning resources and learning through actual situations outside the classroom. This way of learning allows students to learn in a meaningful way (Hwang, 2014). Corresponding to the study of Shih et al. (2010), the research found that teaching with this model not only helps students to realize the relationship of learning with real contexts but also helps students to construct concepts links between real situations and textbooks. Besides, it is a tool that helps students to reflect and record their own learning processes with meaningful learning experiences (Vavoula & Sharples, 2002; Wong & Looi, 2011). Students become active learners and more interactive in learning (Huang et al., 2008) which not only enhances learning but also improves students' learning potential as well (Chanet al., 2006; Crompton et al., 2016).

Research objectives

1. To develop online science learning resource integrated with the local wisdom of Sa Kaeo province.
2. To investigate the results from using online science learning resource integrated with the local wisdom of Sa Kaeo province as follows;

2.1 Participants' understandings toward concepts of using tablet as a tool of learning, scientific concept of learning stations and mobile learning model and approaches.

2.2 Participants' satisfactions toward online science learning resource and the project

Participants

The participants in this study were 38 science and technology teachers who taught in primary and lower secondary levels from 4 schools in Watthana Nakhondistrict, Sa Kaeo province, Thailand.

Methodology

This project was conducted and concurrently merged to the research. The one-group pretest-posttest design was applied. The project was divided into two phases; 1) the development of online science learning resource integrated with the local wisdom and research tools and 2) the project implementation.

Phase 1: The development of online science learning resource integrated with the local wisdom and research tools

1. Researchers set a meeting with working staff, SWU doctoral students, faculty staffs from of Science Education Center, SWU, along with doctoral students and expert from NTUST, and planned to develop online science learning resource

integrated with the local wisdom based on five science learning stations including 1) adobe clay house, 2) charcoal, 3) bio-extraction, 4) alternative energy and 5) community forest at College of Bodhi Vijjalaya, SWU, in Sa Kaeo campus.

2. The working staff and expert went to Sa Kaeo province to explore the area of learning stations and talked collaboratively with teachers in the area about the academic service project.
3. SWU doctoral students designed website, learning materials, worksheets and knowledge documents preparing for the development of online science learning resource through the advisement of SWU instructors and the expert from NTUST.
4. According to the documents from 3, working staffs developed online science learning resource integrated with the local wisdom in the form of website.
5. The research tools were developed including workshop concept test, satisfaction toward project questionnaire and follow-up questionnaire.
   5.1 The workshop concept test composed of 15 multiple-choice items in these three following concepts.
      - Concept of using tablets as a tool of learning (5 items)
      - Scientific concept of 5 learning stations (5 items)
      - Concept of blended mobile learning model and approaches (5 items)
   5.2 The satisfaction toward project questionnaire composed of 14 Likert scale items asking about the participants' level of satisfaction toward the project location, duration, services, speakers and activities.
   5.3 The follow-up questionnaire composed of 3 questions as follows.
      - Question 1: Have you applied the knowledge about "using tablets as a tool of learning in iOS and Android systems" in your teaching? And why? Please explain your results or reasons.
      - Question 2: Have you applied the knowledge about "scientific concept of learning stations" in your teaching? And why? Please explain your results or reasons
      - Question 3: Have you applied the knowledge about "blended mobile learning model and approaches" in your teaching? And why? Please explain your results or reasons.
6. The expert checked the quality of the website and research tools. Then, working staffs improved the website and research tools based on expert's suggestions and recommendations.
7. The working staff tried out the website and online learning materials with a small group of students.
8. The working staffs improved the website again after trying out.

Phase 2: The project implementation

1. This academic service was implemented in the form of a two-day workshop with 38 science and technology teachers who taught in primary and lower secondary levels from 4 schools in Watthana Nakhondistrict, Sa Kaeo province.
2. The content used in the workshop composed of;
   2.1 Introducing the concept of using tablets as a tool of learning
   2.2 Introducing the 5 learning stations applying the concept of blended mobile learning model and approaches
   2.3 Creating lesson plans to promote science learning on tablet.
3. The follow-up process was provided after two months of the workshop. The project methodology can be seen in Figure 1.

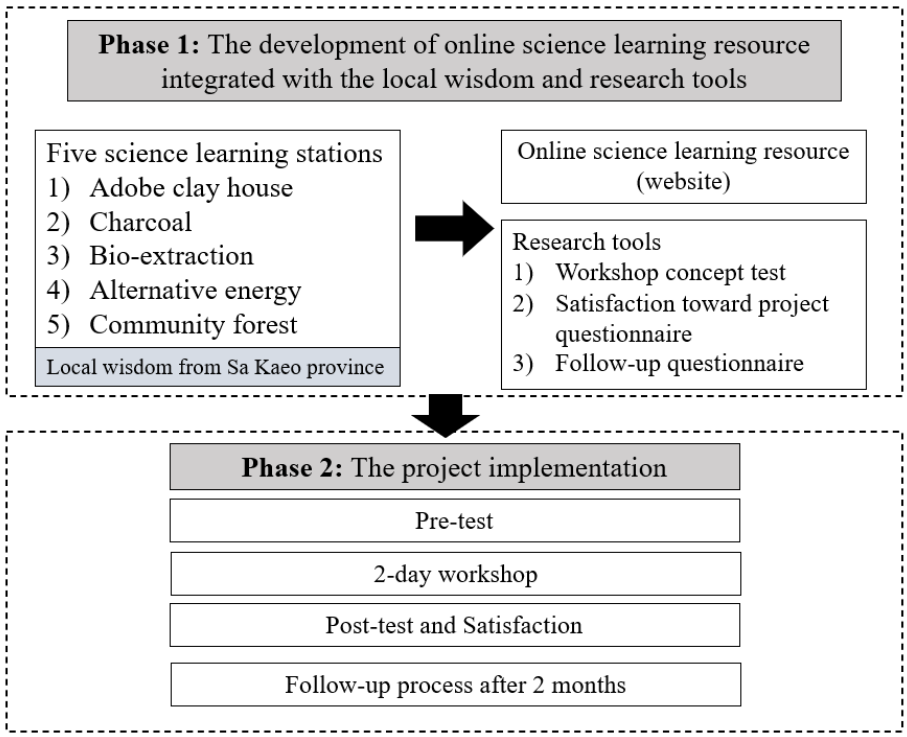

Figure 1: The summary of the project methodology

Data collection and analysis

1. The quantitative were collected from workshop concept test and satisfaction toward project questionnaire.
2. The data from the workshop concept test were analyzed using Wilcoxon matched-pairs signed rank test.
3. The data from the satisfaction toward project questionnaire were analyzed using the criterion presenting the level of satisfaction as follows.
   4.50 - 5.00 strongly satisfied with this statement or highest level of understanding
   3.50 - 4.49 satisfied with this statement or high level of understanding
   2.50 - 3.49 neither satisfied nor dissatisfied or moderate level of understanding
   1.50 - 2.49 dissatisfied with this statement or low level of understanding
   1.00 - 1.49 strongly dissatisfied with this statement or lowest level of understanding
4. The follow-up process was provided after two months of the workshop to participants using a follow-up questionnaire. The data from the follow-up questionnaire were qualitatively analyzed using content analysis (Krippendorff, 2013).

Results

Science Education Center, SWU, has developed online science learning resource integrated with the local wisdom based on five science learning stations at College of Bodhi Vijjalaya, SWU, in Sa Kaeo campus. The results are divided into three parts including the feature of the development of online science learning resource integrated with the local wisdom, understandings toward concepts of using tablet, and evaluation on the project.

Feature of the development of online science learning resource integrated with the local wisdom

Science learning stations are composed of 1) adobe clay house, 2) charcoal, 3) bio-extraction, 4) alternative energy and 5) community forest. In order to develop the website, we have integrated this project with the subject related to innovative science learning course for first year doctoral students of Science Education Center. The students are involved in designing the website, creating learning activities, worksheets and important information under the suggestions of the course instructors and expert. The website can be seen in Figure 2.

Figure2: Online science learning resource integrated with the local wisdom

Understandings toward concepts of using tablet

The data from workshop concept test were analyzed using Wilcoxon matched-pairs signed rank test. The results found that participants' understandings scores toward all concepts after attending the workshop were significantly increased at .05 level of statistical significance level ($z = -5.364$, $p = .000$). Considering separately to each concept of the workshop, the results revealed that teachers' understanding were significantly increased at .05 level of statistical significance of three concepts; 1) concept of using tablets as a tool of learning ($z = -5.356$, $p = .000$), 2) scientific concept of 5 learning stations ($z = -3.341$, $p = .001$), and 3) concept of blended mobile learning model and approaches ($z = -4.344$, $p = .000$) as shown in Table 1.

Table 1: Participants' understanding scores

Concepts		n	Total cores	M	S.D.	z	p
Concept of using tablets as a tool of learning	Before	38	5	1.11	0.92	-5.356*	.000
	After	38	5	4.00	0.84		
Scientific concept of 5 learning stations	Before	38	5	1.50	1.06	-3.341*	.001
	After	38	5	2.37	0.82		
Concept of blended mobile learning model and approaches	Before	38	5	2.66	1.19	-4.344*	.000
	After	38	5	4.00	1.04		
Understanding scores toward all concepts	Before	38	15	5.26	2.00	-5.364*	.000
	After	38	15	10.37	1.60		

*p< .05

Evaluation of the project

The results of the project come from a two-day workshop for training 38 science and technology teachers who teach in primary and secondary level in Sa Kaeo province.

Participants' satisfactions toward project were collected using project satisfaction questionnaire. The data were analyzed from the responses of 35 science and technology teachers who teach in primary and lower secondary levels out of 38 teachers (92.10%) from four schools in Watthana Nakhondistrict, Sa Kaeo province, Thailand. The participants' general information was presented in Table 2.

Table 2: Participants' general information

Gender	Number of participants	Percentage
Male	16	45.7
Female	19	54.3
Total	35	100

The participants' satisfactions toward project frequency and mean scores presented that the project achieved the desired objectives asshown in Table 3.

Table 3: Participants' satisfactions toward the project

No	Statement items	Level of satisfaction					M	S.D.	Data interpretation
		5	4	3	2	1			
1	Workshop/ project location	18	16	1	-	-	4.49	0.56	Satisfied
2	Project duration	10	19	6	-	-	4.11	0.68	Satisfied
3	Services from working staffs	20	11	4	-	-	4.46	0.70	Satisfied
4	Transferring of knowledge from speakers and expert	18	15	2	-	-	4.46	0.61	Satisfied
5	Speakers' responding to the participants' questions	21	12	2	-	-	4.54	0.61	Strongly satisfied
6	Understanding in using tablet in iOS and Android systems before attending the workshop	4	7	9	11	4	2.89	1.21	Moderate

Table 3 (Cont')

No	Statement items	Level of satisfaction					M	S.D.	Data interpretation
		5	4	3	2	1			
7	Understanding in using tablet in iOS and Android systems after attending the workshop	5	20	9	1	-	3.83	0.71	High
8	Understanding in science learning station integrated to local wisdom before attending the workshop	1	10	14	7	3	2.97	0.98	Moderate
9	Understanding in science learning station integrated to local wisdom after attending the workshop	6	23	6	-	-	4.00	0.59	High
10	Understanding in blended mobile learning model and approaches before attending to the workshop	4	8	9	11	3	2.97	1.18	Moderate
11	Understanding in blended mobile learning model and approaches after attending to the workshop	10	18	6	1	-	4.06	0.76	High
12	Writing lesson plan using tablet and blended mobile learning model	6	22	5	2		3.91	0.74	High
13	Benefits gained from the project	14	15	3	3		4.14	0.91	High
14	Satisfactions toward overall project	13	16	3	2	1	4.09	0.98	Satisfied

Besides, the participants have responded to an open-ended question in the project satisfaction questionnaire. The content analysis was used to analyze their responses. The participants' responses are as follows;

Question: How will you apply the knowledge from the project to your teaching? The results are grouped into five groups of response in the following.

1) Writing lesson plans.
2) Providing new technology into the process of teaching and learning.
3) Applying this knowledge to learning activities.
4) Using this knowledge to develop their teaching capabilities.
5) Using this knowledge as teaching media and materials.

All participants thought that this project was useful for teachers and students, as one of teachers stated that "*this is a good project and is useful for teachers and students. The expert and speakers are good and have tuneful voices. The staffs are friendly and have a good service mind. This project makes me realize the important of using technology in teaching."*

The follow-up results about teachers' applying the knowledge from the project in science classroom two months after completing the workshop.

The working staff carried out the follow-up process using questionnaire sending to 38 teachers and received the questionnaires back from 23 teachers (60.53%). Teachers' opinions and reasons are presented orderly depending on the questions as follows;

Question 1: Have you applied the knowledge about "using tablets as a tool of learning in iOS and Android systems" in your teaching? And why? Please explain your results or reasons. Teachers' responses can be seen in Table 4.

Table 4: Teachers' responses toward question 1

Items	Frequency (%)	Results or reasons
Have applied	7 (30.43)	• Using this way of teaching is good for students but the school internet system needs to be ready. • Tablets help students a lot during searching for their science project information. • Using tablets in the classroom can promote students' interests in science learning. • Students have learned by doing and gained more knowledge. • Tablet is a good teaching material.
Have not applied	13 (56.52)	• Schools have not enough tablets and teaching materials compare to the number of students. • The school internet system is not ready. • Primary students are too young to learn this way. • Students and teachers have not enough knowledge about using tablets. • Teachers have not enough time to teach based on their school workloads.
Will apply in the future	3 (13.04)	• Schools will completely have tablets for all students in the future. • Teachers will apply the knowledge in ICT subject.

Question 2: Have you applied the knowledge about "scientific concept of learning stations" in your teaching? And why? Please explain your results or reasons. Teachers' responses can be seen in Table 5.

Table 5 Teachers 'responses toward question 2

Items	Frequency (%)	Results or reasons
Have applied	10 (43.47)	• Students can search the scientific concepts from science learning stations website. • Students can answer the question from activities in the website. • The concept "bio-extraction" can be used corresponding to students' real-life situation in school.

Table 5 (Cont')

Items	Frequency (%)	Results or reasons
		• These scientific concepts can be integrated into other learning areas such as "occupation and technology" corresponding to the Basic Education Core Curriculum B.E. 2551 (A.D. 2008). • Students have learned from learning resources. • Students have improved their achievement and have more interests in learning. • Students have gained more knowledge about science and their local wisdom from five science learning stations.
Have not applied	11 (47.82)	• The school internet system is not ready. • Teachers teach in technology subject not science subject. • Teachers have not enough time to teach based on their school workloads.
Will apply in the future	1 (4.35)	• Teachers will integrate these concepts to social science subject for primary students in the future.

Question 3: Have you applied the knowledge about "blended mobile learning model and approaches" in your teaching? And why? Please explain your results or reasons. Teachers' responses can be seen in Table 6.

Table 6: Teachers 'responses toward question 3

Items	Frequency (%)	Results or reasons
Have applied	8 (37.78)	• Students can learn better. • This way of teaching can promote students' thinking, interests and curiosity in their learning. • Students can send their assignments back to the teachers via social networks using tablets and smart phones. However, some students secretly play games and Facebook. • Students have gained more knowledge.
Have not applied	11 (47.82)	• The school internet system is not ready. • Schools have not enough tablets and teaching materials compare to the number of students. • Students and teachers have not enough knowledge about using tablets. • Teachers have not enough time to teach based on their school workloads.

Table 6 (Cont')

Items	Frequency (%)	Results or reasons
Will apply in the future	4 (17.39)	• Schools will completely have tablets for all students in the future. • Teachers will integrate these concepts to social science subject for primary students in the future. • Teachers will set a special class teaching by using tablets.

Discussion and implications

From the development of online science learning resources integrated with the local wisdom of Sa Kaeo province, the working staff conducted academics services in the form of a workshop about using a Blended mobile learning model for learning on tablets. Additionally, the working staff has studied the results of the project through three aspects of knowledge, which are the concept of using a tablet as a tool of learning (in iOS and Android systems), scientific concepts of five learning stations and Blended mobile learning model and approaches. In addition, we also studied the participants' satisfaction toward the project. The results found that, although, teachers' understanding of the three aspects of knowledge were significantly increased, they still had problem understanding scientific concepts, due to the fact that they teach in primary and lower secondary school levels and did not have degrees in science. These may obviously affect their understanding in science. Therefore, during the workshop, speakers provided the participants with opportunities to ask questions about content used in the workshop and also discuss together in groups. Moreover, working staff created an online social network for teachers in order to discuss problems while they were teaching using tablets at school. Additionally, from the follow-up process asking about teachers' applying the knowledge from the project in science classes, the results revealed that using a tablet as a tool of learning in the classroom is good for students but the school internet system needs to be ready. Moreover, tablets also help students in searching for science project information and can promote students' interests in science learning, which corresponds to Shih et al. (2010). Shih et al. (2010) stated that, even though students have no prior knowledge at all when they come to the class, learning by using a mobile device can promote students' interest in learning at a high level. However, Adams, & Hayes (2009) have studied using tablet PCs in mathematics learning. Their results revealed that most students would like to learn in this way but there are also many students who do not think that a tablet would help them to promote the development of their learning experiences.

According to teachers' opinions who have applied M-learning and tablets in the science classroom, the responses showed that tablets are a good teaching resource. Similarly, the research of Hulls (2005) discovered that tablet PCs can help teachers to use marks with various colors to draw the students' attention to the class and make lectures more interesting. We can claim that wireless and M-learning serve as useful tools for learning in a student-centered system. Besides, teachers' opinions also indicated that students can answer the questions from activities in the website which is consistent with Shih et al. (2010) and Goodwin (2012). The results of these two studies found that students can answer the questions in worksheets with plenty of information.

More importantly, regarding learning through science learning stations integrated to local wisdom using M-learning, students have gained more knowledge about science and their local wisdom from the five science learning stations. Shih et al. (2010) has reinforced that learning this way can be used for students with different levels of

achievement. Furthermore, this way of learning can promote students' thinking, interests and curiosity corresponding to Galligan et al. (2010) and Sivakumar (2016) which mentioned that the tablet PCs in teaching and learning are able to create learning environments and also to enhance learning opportunities for both students and teachers.

The additional responses from the follow-up found that students can send their assignments back to the teachers via social networks using tablets and smart phones. However, some students secretly play games and Facebook in class. This accords with the study of Shuler et al. (2013) and Kopecký et al (2021) which revealed that mobile devices frequently were not allowed to be used in schools. This may cause obstructive factors that affect students' learning. For teachers who have not applied tablets in the classroom, their reasons are similar. Teachers have not enough time to teach based on their school workloads. Besides, teachers and students' knowledge about using tablets and mobile smart phones are inadequate. The teachers need a handbook of guideline on how to use both iOS and Android tablets. If teachers and students can use the tablets and M-leaning efficiently, they will find that these devices and learning model can be used in several useful ways such as recording video and audio in order to assess student's learning behaviors, sending useful information to students, connecting to email and taking notes. Moreover, tablets are portable for learning in other places (Jisc Regional Support Center, 2012; Sivakumar, 2016).

Teaching and learning this way normally have to occur in an internet-enabled environment. The most important problem for using this way of teaching and learning is that schools are unable to provide the internet system. As a result of the internet problem of the school, this leads us to suggest considering how to conduct teaching and learning science using tablets in the offline environment for further study.

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A Study on the Use of Information Technology to Enhance High School Students' Science Learning

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Abstract. The major purpose of this study was to investigate the learning outcomes of using information technology in high school students' science learning. A total of 31 high school students participated in this study. During the teaching and learning processes, students were guided to explore the topics of information technology and Earth science, with students instructed to operate a 3D imaging technology system in their Earth science learning. This study searched both quantitative and qualitative data as the sources for the analyses. A research instrument was used, namely a learning questionnaire (four-point Likert-type scale), to gather students' feedback on using information technology and the 3D imaging technology system. In addition, a rubric was used to evaluate the students' mineral and rock projects. The data underwent frequency and t-tests, and indicated that the integration of information technology into Earth science learning promotes students' learning outcomes. According to the rubric assessment results, the presentation of minerals and rocks in the students' projects fully represented the students' understanding of minerals and rocks and showed how they had introduced 3D photographic techniques into their projects. Therefore, it can be concluded that the teaching and application of 3D photography is beneficial for improving Earth science learning and the information technology literacy of high school students.

Keywords: earth science, educational technology, information technology, science learning

1. Introduction

In secondary education in Taiwan, the instruction of Earth science is generally included in the science and technology curriculum and is compulsory for all high school students. King (2008) pointed out that Earth science education focuses on cultivating learners' understanding of the Earth's materials, the effects of the Earth's activities, and the structure of the Earth, etc. Dal (2009) further pointed out the core content of Earth science education should, primarily, contain discussions on the following themes: (1) the structure of the Earth, (2) the dynamic evolutionary mechanism of every Earth shell, (3) the role and the movement of the Earth in the planetary system, and (4) organisms on Earth.

However, many researchers have discovered students have several misconceptions about Earth science. These include: (1) misconceptions about minerals, rocks, and fossils

(Dal, 2009; Dove, 1997, 1998; Ford, 2005; Kusnick, 2002; Sharp, Mackintosh, & Seedhouse, 1995); (2) misconceptions about geological processes and time (Dal, 2005, 2007, 2009; Trend, 1998, 2000, 2001; Zen, 2001); and (3) misconceptions about earthquakes, plate tectonics, and the structure of the Earth (Barrow & Haskins, 1996; Kali & Orion, 1996; Marques & Thompson, 1997; Rutin & Sofer, 2007; Sneider & Ohadi, 1998). Students in Taiwan also have misconceptions about Earth science (Chen & Hsiao, 2013; Chiu, Hou, & Tang, 1997; Jiang, 1993, 1997; Lai, 2010, 2015a; Lai & Wu, 2005). Therefore, a major teaching issue is how to use proper teaching strategies to correct the students' misconceptions, and establish the correct understanding about Earth science for high school students.

To improve the students' learning regarding the concepts of the different aspects of Earth science, and reduce their misconceptions, many researchers have proposed different teaching methods and strategies, and such teaching has demonstrated good results (Allison, 2005; Bereki, 2000; Gibson, 2001; Kali, Orion, & Eylon, 2003; Lai, 2010, 2015a; Semken & Freeman, 2008; Veal & Chandler, 2008; Wellner, 1997).

Educational technology has grown rapidly in tandem with contributions and support from information and internet technologies. Ho (2012) indicated that the impact of information and network technologies on education is very profound, and that teaching and learning were significantly affected by these changes. Ho (2012) further emphasized that the instructional use of new information and internet technologies should include not only diverse teaching methods, but also increasing teacher/student interaction and new ways of learning. Huang (2013) also indicated that primary and secondary school students' information technology literacy will be better prepared by information courses and by teachers who apply information technology in their teaching methods. Many researchers found that information technology has the potential to improve students' learning, Lai (2014) pointed out that knowing how to integrate information technology into education is the key to promoting students' learning. As the production cost of the 3D image has been greatly reduced due to the progress of technology, more and more people are willing to use 3D image production and application (Lai, 2015b; Lan & Chung, 2008). In addition, Lai (2014, 2015b) found that 3D photography was beneficial for improving students' learning with regards to course content and information technology literacy.

Since information technology has the potential to improve students' learning, this study attempted to integrate 3D photography into high school students' learning of Earth sciences. Therefore, the major purpose of this study was to investigate the learning outcomes when using information technology in high school students' science learning.

2. Methodology

The teaching activities of the teacher included instructing the students to explore topics related to Earth science and information technologies, and to operate a stereoscopic image technology system (3D photographic equipment) to display the characters of different minerals and rocks. The 3D photographic equipment used in this study included 3D scanners, digital cameras, and personal computers. During the filming, using an integration of 3D software, filmed images were immediately synthesized into 3D images. The obtained 3D images were then stored as different image formats, which could then be conveniently used in the post-production of a minerals and rocks project.

2.1. Target group

In total, 31 high school students participated in this study.

2.2 Methods of Inquiry

This study searched both quantitative and qualitative data as the sources for the analyses. This study also explored students' learning performances in information technology and how they incorporated it into their Earth science learning. The discussion emphasized students' 3D photography learning feedback and their minerals and rocks projects. The research evaluation included a rubric for students' minerals and rocks projects, feedback from the teacher, and learning feedback from the students. First, the rubric for the minerals and rocks project was used to assess students' learning performances regarding 3D information technology. The assessment focused on the quality of the 3D animation produced in the students' projects. Second, the feedback from the teacher was used to understand the teacher's teaching and feedback regarding the use of 3D photography, and students' learning performances related to information technology. Finally, with respect to the learning feedback from the students, based on the evaluation model of Kirkpatrick and Kirkpatrick (2007), this study adopted a learning questionnaire (four-point Likert-type scale). As the basis for the analyses, the learning questionnaire asked eight questions in order to collect students' feedback on the operation of 3D photography. The Cronbach's α reliability for the eight items of the learning questionnaire was .83, showing that the research instrument had good reliability. The validity of the research instrument was examined by three science educators, and it was confirmed that the research instrument had good validity.

3. Research Findings

3.1. Students' Performances in the Minerals and Rocks Project

The students who took part in the study were divided into groups, each with two to three students, to carry out 3D photography technology learning and production. After finishing the 3D image editing, they further compiled the mineral and rock content, and carried out a minerals and rocks project. A total of 31 students completed 14 3D minerals and rocks projects. Then, the teacher used the rubric and evaluated the students' projects based on the qualities of their 3D animation, the correctness with regards to the minerals and rocks, and originality.

According to the assessment results, with respect to the content of the students' minerals and rocks projects, all 14 projects fully displayed the special effects of 3D animation. The presentation of the 3D images of minerals and rocks, the composition of the pictures, the textures and colors, and the 3D animation fully displayed the delicate effect of the 3D images. In general the entire project on minerals and rocks was presented delicately and exquisitely with the use of the 3D effects and had rich information about the characteristics of minerals and rocks. All students had made an effort to emphasize the uniqueness and beauty of the minerals and rocks so as to draw the attention of the viewers. It is revealed that the presentation of minerals and rocks in the students' projects fully represents the students' understanding of minerals and rocks and how they introduced 3D photographic techniques into their projects.

3.2. Students' Feedback on the Application of 3D Photography

After the high school students had completed the 3D photography technology learning and their minerals and rocks projects, this study carried out an investigation using a learning questionnaire. A total of 31 high school students gave effective answers. The background of these high school students consist of 9 males and 22 females. The summary of the results for the students' learning questionnaires is shown in Table 1.

Table 1: Summary of the results of learning questionnaire on 3D photography (N = 31)

Item	Strongly agree		Agree		Disagree		Strongly disagree	
	N	%	N	%	N	%	N	%
1	11	35.5	16	51.6	4	12.9	0	0
2	7	22.6	24	77.4	0	0	0	0
3	15	48.4	16	51.6	0	0	0	0
4	19	61.3	12	38.7	0	0	0	0
5	21	67.7	10	32.3	0	0	0	0
6	15	48.4	16	51.6	0	0	0	0
7	17	54.8	14	45.0	0	0	0	0
8	12	38.7	18	58.1	1	3.2	0	0

According to Table 1, the results from the learning questionnaire are as follows: (1) 87.1% of the students indicated that 3D photography was easy to operate while 12.9% of the students indicated that they disagreed; (2) 100% of the students indicated the functions of the 3D photography were sufficient for use; (3) 100% of the students indicated that 3D photography was charming; (4) 100% of the students indicated that 3D photography could help increase students' comprehension of Earth science content; (5) 100% of the students indicated that 3D photography could help students conduct Earth science experiment exploration; (6) 100% of the students indicated that they loved to apply the 3D photography in their Earth science learning; (7) 100% of the students indicated that, after using 3D photography, they were willing to use the technique in other learning activities. Finally, overall, 96.8% of the students indicated that they loved producing and using 3D photography, while 3.2% of the students indicated that they disagreed.

In addition, in order to find out if there was any difference between boys and girls with regards to 3D photography and Earth science learning, a t-test was performed. The results from the t-test indicated that there was no difference between boys and girls for 3D photography and Earth science learning (t=.629, p=.534). The results showed that both boys and girls had the same positive opinions of 3D photography learning and Earth science learning.

The study results showed that high school students highly praised the qualities and functions of 3D photography, indicating that the students agreed that 3D photography could help students with their learning. Finally, overall, 96.8% of the high school students indicated that they liked producing and using 3D photography. This means that a large proportion of the students approved of the introduction and use of 3D photography in Earth science learning.

3.3. Teaching Feedback

In addition to discussing the learning feedback from the students, this study also used a teaching feedback questionnaire to collect the teacher's opinions with regards to teaching Earth science and 3D photography. According to the results of the teaching feedback questionnaire, the teacher indicated, "hands-on learning activities can really stimulate students' learning motivation and also reduce the cost of mineral and rock hand specimens." Secondly, with respect to the benefits of 3D photography for the students, the teacher further pointed out, "3D images could provide more opportunities for students when practicing and producing minerals and rocks projects. Meanwhile, interactive mediums and 3D photography can provide students with experience and enhance their creativity." Finally, the teacher stated, "In general, the learning and teaching of 3D photography is quite simple and easy, but the time spent on filming can be too long and this would usually mean the post-production time is insufficient.

Fortunately, students didn't mind spending extra time after class to complete their minerals and rocks project." To summarize the teaching feedback from the teacher, the teacher positively confirmed the 3D photography teaching and the students' learning effects. This suggests that the feedback from the teacher is consistent with that of the students, indicating that both the teacher and the students support and approve the application of 3D photography in the teaching and learning of Earth science and information technology.

4. Conclusion

As 3D images are more and more commonly used in educational settings, when we are promoting students' learning, efforts should be made to find ways to improve the application abilities of 3D technology for students, enabling them to strengthen their knowledge of information technology. This study applied 3D photography to Earth science learning activities, and discovered that most of the participating students had a clear understanding of the functions of 3D photography, and were satisfied with using 3D photography in their Earth science learning. Evaluation of the minerals and rocks projects of these students demonstrated that most of them were able to properly use 3D animation skills to enrich the presentation of the characteristics of the minerals and rocks. The learning feedback from the students indicated that 3D photography met the requirements and expectations of high school students. They highly approved and supported the fact that 3D photography can enrich their learning of Earth science, and promote the demonstration of minerals and rocks. They were willing to apply this technology to other subjects. To summarize, this study believes that the teaching and application of 3D photography is actually beneficial for improving Earth science learning and the information technology literacy of high school students.

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Teaching Chemistry Effectively with Analogy in Thai Year 10 and 12 classrooms

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Abstract. Analogy can be an effective tool to assist learning and teaching in science classrooms. Accordingly, the main research purpose of this study was how Thai chemistry teachers use analogies effectively through a professional development programme. The main research question was how to improve Thai chemistry teachers' effectiveness to teach chemistry concepts with analogies. Action research was used to generate and develop the lesson plans based on the interest, experience and competency of a group of in-service chemistry teachers who were willing to participate in the PD programme. As a result, five lesson plans were developed based on their experience of teaching in different school contexts. Several chemistry concepts to be taught included isomerism, electrophilic aromatic substitution, molecular shape, polar and non-polar molecule and length and energy bond. This paper focuses on teaching isomerism with an analogy. Although it might not be easy to seek appropriate analogies which are exactly suitable for the students, teaching with analogies did seem to be an interesting way for in-service teachers to teach chemistry. This finding might be an indication that commencing and embracing the use of analogies can be an inspiration for learning and teaching chemistry.

Keywords: earth science, educational technology, information technology, science learning

1. Introduction

One of the subjects with which students have difficulties to learn is chemistry because there are many abstract concepts requiring students to use their imagination to understand these concepts. In order to gain a deep understanding of chemistry concepts, students need to link three types of representation together, namely, the phenomenological, model and symbolic types. Consequently, to unlock students' comprehension, representing the chemistry concepts in terms of the macro, submicro and symbolic levels together is necessary to assist students' learning (Gilbert & Treagust, 2009). By using analogies that have been introduced by science educators, we can effectively teach concrete chemistry concepts (Duit, 1991; Orgill & Bodner, 2004). In addition, science educators believe that the use of analogies is one of the appropriate instructional strategies that can be used to teach all branches of science. Treagust (2001, 2015) has pointed out that analogies are believed to support students' learning of chemistry by raising students' motivation to learn the concepts by creating visualizations

to explain abstract concepts and helping students to connect scientific concepts with real life situations. As a thinking tool, analogies can help teachers be creative in explaining difficult and abstract concepts (Harrison & Coll, 2008). Furthermore, in teaching chemistry, teachers are a crucial factor in linking the use of analogies and model so that students develop a complex understanding (Coll, France & Taylor, 2005). Thus, in this study, Thai chemistry teachers were encouraged to improve the effectiveness of their teaching with analogies.

In contrast, some researchers believe that analogies can mislead and distort ideas and information if analogies are not appropriately used for explaining a concept and are unfamiliar to students (Aubusson, 2006). Therefore, teachers should be aware and concerned about using appropriate analogies in teaching. This concurs with Tyson, Treagust and Bucat (1999) who have suggested that by monitoring students' comprehension of the scientific concepts, teachers can develop their teaching strategies to facilitate their students' understanding. Therefore, when used appropriately, it seems that analogies are crucial tools to enhance students' learning and improving teachers' teaching of chemistry concepts. Furthermore, Treagust (1993) asserted that effective teaching and learning can be generated by teachers' deep understanding of the topics and knowing how to transform the content knowledge into knowledge for teaching. Thus, more opportunities of knowing how to teach effectively with analogies should be provided for teachers through this PD programme.

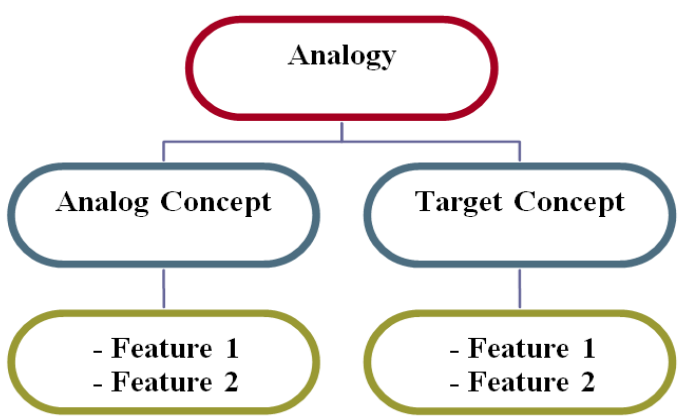


Figure 1: A conceptual representation of an analogy. (Glynn, 2015)

Both advantages and disadvantages of using analogy in teaching and learning need to be considered. To gain more benefits and limit the constraints, an interesting teaching strategy called the FAR guide (Focus-Action-Reflection) was presented as a guide for Thai teachers in the analogy workshop.

2. Methodology

This study focused on teachers' experiences when teaching and learning with analogy. The research explored chemistry teachers' perceptions and encouraged teachers to teach chemistry concepts of interest through this project. It is very important to understand and represent chemistry teachers' perceptions based on their own experiences. There is no right or wrong ways about teachers' perceptions but this study was designed to seek and explore teachers' thinking about their own teaching for future improvement. All teachers who came into this project were willing participants, desiring to improve themselves, so learning about science teaching to help each other was based on their real experiences.

2.1 *Participants*

The participants of this study were volunteers based on their interest. There were three in-service teachers who had experiences teaching chemistry concepts in year 10-12 classrooms and also they were willing to participate in this PD programme to improve themselves in teaching with analogies. Each has been teaching more than fifteen years in different high school contexts in Thailand. One of my voluntareers, who never heard about teaching with analogy before, is from Krabi city located in southern Thailand. The second teacher is from Beung Kan city located in the upper northeast of Thailand. The third teacher is from Chaiyabhum city that is located on the other side of the northeast of Thailand. They are far from Khon Kaen University approximately 1,500, 400 and 200 kilometres, respectively.

2.2 Methods of Inquiry

An appropriate research design based on research paradigms and research questions is necessary to ensure the best research outcome (Cohen, Manion & Morrison, 2013). As I noticed before, to answer the research question - How to improve Thai chemistry teachers' effectiveness to teach chemistry concepts with analogies - action research should be used to collect data about the process of developing a lesson plan. e This research question focused on chemistry teachers examining their own practice and also improving a group of in-service teachers in generating and developing the lesson plans. The qualitative data were collected to gain more in-depth understanding of the data from the three cases of in-service chemistry teachers who have experienced teaching chemistry concepts. As a case study, in-depth data were collected by evaluating lesson plans, in-depth interviews, focus groups, classroom observations (verbal and non-verbal behaviors), documents and audio-visual material (Creswell, 2012). The data were analysed in each cyclic of the process of reflection involving the implementation of potential solutions in using analogies in chemistry teaching and monitoring the impact.

At the beginning, I conducted the research by asking teachers about their educational background and interests. I spent the majority of the individual conversation asking the teachers about their opinion of analogies in general: if they like analogies, what do you know about analogies so far, what are the advantages and disadvantages of teaching with analogies, how do you use analogies in the classroom, and how analogies should be used to be effective in the chemistry class. I also asked about specific analogies that have been used in the classrooms and how they were taught. All of the qualitative data were gathered to be a portrait of this study.

An analogy is process of analysing similarities between two concepts. The familiar concept is called the analog and the unfamiliar science concept is called the target (Treagust, 2001; Glynn, 2015). A systematic comparison appears in Figure 1 (Glynn, 2015).

When presenting the workshop, the teachers were inspired by the introduction of the portrait of analogy including what is the analogy, the pros and cons of teaching with analogy, and how to teach with analogy. Moreover the teachers were challenged and enlightened with their ideas through the exemplars of teaching with analogies. The illustrations of real activities were shown to make the teaching clearer for teachers. The TWA (Teaching-With-Analogy) Model (Glynn, 1989; Glynn, 2015) was used as a framework to conduct the workshop and lead the teachers to create the lesson plans. By following the six steps are 1) introduce the target, 2) recall the analog concept, 3) identify similar features of the concepts, 4) map similar features, 5) indicate where the analog breaks down, and 6) draw conclusion about the concepts. That this is an interesting way to teach with analogies, all teachers were in agreement. As a teacher, I also agree but the difficulty is the next step. Based on my experiencing in teaching chemistry for fifteen years, it is not easy for teachers to generate the appropriate analogy

for the students and that was my worry. Hence, as a researcher, the FAR Guide, which is the interesting way in using analogy in the classrooms, was presented as a teaching guide, as shown in figure 2 (Treagust, Harrison & Venville, 1998; Harrison & Coll, 2008).

Focus	**Pre-Lesson planning**
Concept	Is it difficult, unfamiliar or abstract?
Students	What do the students already know about the concept?
Analog	Is the analog something your students are familiar with?
Action	**In-Lesson action**
Likes	Discuss the features of the analog and the science concept?
Unlikes	Draw similarities between the analog and the target or science concept.
	Discuss where the analog is unlike the science concept
Reflection	**Post-lesson reflection**
Conclusions	Was the analogy clear and useful, or confusing?
	Did it achieve your planned outcomes?
Improvements	In light of the outcomes, are there any changes you need to make next time you use this analogy?

Figure 2: The FAR guide for teaching and learning with analogies.
(Treagust, 1993; Harrison & Coll, 2008; Treagust, 2015)

In the process of generating and developing the analogy lesson plans, the action research took an important role to lead this workshop successfully by following the cycles through the plan (introducing how to teach with analogy and providing the analogy exemplary followed the FAR guide), act (generating the analogy, applying the analogy into the lesson plans), observe (discussing and sharing ideas with each other, pre-teaching with analogy, evaluating and improving the analogy) and reflect (improving and developing the analogy lesson plans) (Cohen, et. al., 2013). As a result, the analogy lesson plans were generated based on teachers' interest, as individuals experienced and shared various ideas in a small group of in-service chemistry teachers.

3. Research Findings

Not surprisingly, each of the participants embraced using analogy in their mind as an inspiration that seemed to be an optimistic view. In order to determine how these Thai chemistry teachers use analogies effectively, all data were collected which included indvidual written journals and in-depth interviews with all teachers during the workshop and also after pre-teaching and discussing with each group. This study found that teachers' previous experiences in teaching is an important factor in generating the analogy. Analogies were generated based on teachers' previous experiences, their teaching context and their background and also with students' familiar experiences. Teachers individually thought about their familiar concept and tried to develop the analog and link it with the target before bring that idea into a group to discuss and evaluate it together. After that we spent plenty of time to discover, the crossword analogy lesson plan for teaching isomerism that had been accepted to use in then chemistry classrooms.

Table 1: The crossword analogy

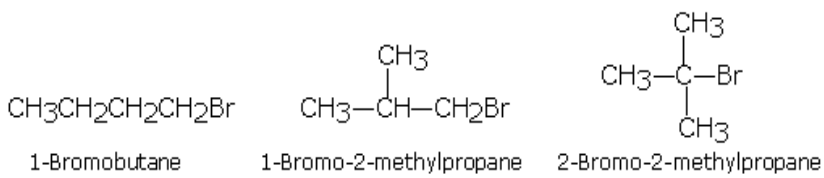
<table>
<tr><th colspan="3">The Crossword Analogy for Isomerism</th></tr>
<tr><td rowspan="3">Focus</td><td colspan="2">Concept
An isomer is a molecule with the same molecular formula but has a different structural or spatial arrangement of the atoms within molecule. These atoms or groups of atoms can be arranged in different way around the central carbon to give different molecules. As the result, isomers of the same molecule have the potential to have different physical or chemical properties and also different names.
 
1-Bromobutane | 1-Bromo-2-methylpropane | 2-Bromo-2-methylpropane</td></tr>
<tr><td colspan="2">Students
Students could not image how the isomers are different, especially, the geometric isomers, cis-isomer and trans-isomer. Students only see the information as shown in the table in the textbook but they do not really see the how the isomers have different structures.</td></tr>
<tr><td colspan="2">Analog
The crossword is basically a game which is familiar with all students. Students have the alphabet cards in their hands such as SMILE and try to make up new words along with the meaning of each word, how to pronounce, and how the write. While the alphabets have been arranging, students have been learning, motivating and working together.
  </td></tr>
<tr><td rowspan="4">Action</td><td colspan="2">Likes-Mapping the Analog to the Target</td></tr>
<tr><td>Analog-Crossword Game</td><td>Target-Isomerism</td></tr>
<tr><td>▪ The alphabet cards
▪ New words
▪ The different order of the alphabet cards
▪ The different pronunciations of each word
▪ The different meaning of each word</td><td>▪ Atoms or groups of atoms within molecule
▪ New isomers
▪ The different structure of molecules
▪ The different names of each isomer
▪ The different physical or chemical properties</td></tr>
<tr><td colspan="2">Unlikes-Where the Analogy Breaks Down</td></tr>
<tr><td colspan="2">▪ This is a two-dimensional representation of a three-dimensional isomer.
▪ The new word has meaning, whereas the isomer does not
▪ The atoms or groups of atoms can be arranged in different way such as cycle or chain or branch, but the alphabet cannot.
▪ There are the chemical bonding relating each atom in the molecules, whereas the alphabet cards are not there.
▪ The position of atoms or a groups of atoms and double-bond or triple-bond needs to be identified while naming the isomers.</td></tr>
</table>

Table 1 (Cont')

Reflection	**Conclusion** It is interesting that students related so well to this analogy for isomerism, although at the beginning students seemed to be worried in finding the new words.
	Improvement The crossword analogy may work well with running this game as a competition.
Content standard	The Chemistry 5 textbook of IPST.
Suggested teaching strategies	Allowing students use online dictionary that helpful and raising the crossword game interesting. STONE, SMILE, TEAM, MEAL, TIMES, and LIVE- these words can be used and easy for students to find out.

A group of Thai teachers did not deny that talk and chalk is an easy style used in the classroom especially when they have to give a basic theory of organic compounds. The chemistry textbook is a key source of learning which provides various examples and exercises.

Nui: How did you teach the isomerism before?
April: Normally, I just talked and wrote the example on the blackboard, following the textbook that usually use.
Nui: Did you teach isomerism by using the model?
April: Yeah, I sometimes do that but students still get confused and could not be clear when we arranged a methyl group or atom.
Nui: How did you get this analog?
Tanva: Honestly, we thought about something can easlily move and be easy to see how it is different when it is moved.
Nui: İs this analogy appropriate or familiar with your students?
Irin: I am sure that all students are familair with it but we might not be sure that it is appropriate with all students. This analogy is not complicated and also it is an easy one to prepare the material. We just need to prepare the cards and encourage them to play.

I also agree that the previous experience in teaching can be a key to unlocking the ideas. Based on my experience as a chemistry teacher and I have been teaching in high school (Year 10-12) since 2004, the text book tonly contains the words and overwhelming explanations. I have never seen other activities which can illustrate or demonstrate to help students understanding or build up the concreat ideas about isomerism. Discovering this analogy supported teachers' comprehensive understanding of the chemistry concept and this is crucial for generating the lesson plans to assist the learning chemistry. As Eva mentions, teachers' content knowledge is important to create an appropriate analogy that will be familiar with students. As below, Eva also supported this idea.

You (researcher) introduced and showed us that analogy can be a picture, model, activities or something else. We started from a big idea and think about an analogy which can be used but we failed. After discussing with a group, I realised that we need to focus on the content first and understand it and look back how we taught so far then catch up on some points. An analog cannot explain all of the target concept but just give a concrete idea or feeling through direct experience and hand it on to light all ideas up. My students already knew that isomerism is a compound which has the same

molecule but different structures. The crossword analogy played important roles that gave more visualisation and gained deep imagination. [Eva, journal, 2015]

Teachers created the analog based on their previous experiences in class and linked it with new ideas of teaching with analogy. They have tried to map the feature of both analog and target and shared their ideas with a group that had a lively discussion. While teachers were thinking of their own analogy, some teachers asked me to explain the analogy to map it to the chemical concept. It seems that some teachers were feeling umcomfortable with the lack of content knowledge.

I cannot immidiately use your analogy [the crossword analogy] in the class because I never taught this concepts before, although I have been teaching chemistry fora long time. I need to review the content of isomerism first and also need to do some pre-teaching. That is why I asked you to give me more explanation about this concept. [Eva, interview, 2015]

More evidence from April supports the idea that knowing the content knowledge is needed. Interestingly, the text book does not contain the activities or hands-on activities to help students gain more understanding. It only shows some examples of pictures which represent the structure of compounds and verbal explanations.

After I have learnt how to teach with analogy through the example of the clay analogy activity to explain the chemical reaction.[F-Focus] I realised that I need to understand deeply about the concept which I am going to teach. I started my analogy from the hydrocarbon concepts which is my familiar concept and have been teaching for a long time. From my experience, I knew how difficult it is, some students can find out the isomerism but they might not exactly gain a deep understanding of the topic. Although I provided them more verbal explanations over and over again to help them visually and also wrote it up on the blackboard several times, that did not work well. Students just followed my steps without clearly understanding.

[A-Action]The crossword analogy would be familiar with all students. They used to play this game sevearal times in English class and I also played. Students have to make up a new word based on the alphabet cards which they have got. Then have to find out the meaning and how to pronunce the words. When we rearrange the alphabet, we get the new words, which have different meanings and pronunciations. It can be related to the isomerlism like we move the methyl group or double bond, then we got the new compounds which have the different names, structures and properties. [R-Reflection] When I introduced the crossword analogy, students seemed to gain more comprehension via the senses. [April, journal, 2015]

Knowing how to teach with analogy, especially mapping the features that are neccessary. All teachers have no doubt that they have to seek the like and unlike features of the analog and target. However, the analogy cannot represent all of the concepts, it needs to be guided. Hence, teachers need to find it out to decrease the misunderstanding in using analogy and to be certain that students are not misled to the concept.

> *Based on the lesson today about the analogy, if someone wants to teach with analogy, they need to find it out first that how to teach. You cannot bring the analogy lesson plans into the class and follow the stages of the FAR Guide, you need to know more. It is important that how much the students percieve and gain more understanding, how do they mapping and linking the features. Especially, mapping the like and unlike needs guidance. [Tanva, journal, 2015]*

Knowing how the analogy should be used is needed for effective teaching. The study found that analogy can be used to introduce the new target (science concepts) to guide and engage students' interest. And also it can be used as a visual and sharped the comprehensive understanding from the lessons. Most of teachers asserted that an abstract and difficult concept need an analogy. When I asked teachers to clarify their ideas, April responded as follows:

> *The crossword analogy was used as the second plan after I taught and described isomerism. This concept was taught by a lot of talking about it in my first teaching and I saw nothing in the eyes of my students. When the crossword analogy was used in the classroom, this concept was clearly in students' minds. [April, journal, 2015]*

All of students I spoke with also confirmed that isomerism is an abstract and the difficult concept. Students need to use their imagination to help them gain more understanding. Some students accepted that they just write down the example on the blackboard to follow the teachers without any deep understanding. But after students played the crossword analogy along with discussing with each other, it seems to be easy to understand the concept. Analogies can be used to help students learning by introducing and summarizing the concepts. And also it can be used as the illustration to connect the findings. In effective teaching with analogy, it is not only about how the analogy should be used clearly but also applying the analogy into the stages of lesson plans that need to be underlined. Moreover, the clear purpose of using the analogy will be directed to effective teaching.

Another interesting finding mentioned by all teachers is to use the analogy in pre-teaching so as to evaluate the analogy and also raise teachers' confidence before using the analogy in the classroom. Well- organized use of the analogy leads to effective teaching in classroom. As a novice researcher, I also support this idea.

> *Through discussion we have been learning a lot things, my analogies have been edited more than five times from a group but that is great, it is now complete!!, Irin said. [Irin, interview, 2015]*

Individual analogy before bringing it to a group to find out if analogy will work or not - that was helpful and brilliant, Tanva responded. [Tanva, interview, 2015]

Nui, you look like our partner rather than a researcher. And we are not only doing the research but we are sharing the experiences with each other. I was a little bit nervous when I have to teach in front of you. Because all of you are teachers but it gave me confidence about mapping the like and unlike for the analogy and target, April said. [April, interview, 2015]

Obviously, teachers gain more benefits from the pre-teaching such as sharing new perspectives, evaluating the analogy lesson plans, discussing the most effective teaching with analogy, and being well organized in using the analogy. It can also raise the teachers' confidence and, they all supported the teaching. Hence, providing an opportunity and plenty times for teachers to work with a group needs to be a consideration for conducting in-service workshops.

4. Conclusion

This study portrays how Thai chemistry teachers used analogies to effectively teach chemistry concepts with analogies. The research showed that teachers' experience is the most important aspect to create the analogy and also that teachers' comprehensive understanding of the related content knowledge is of equal importance. In bringing the analogy into a class, the familiarity of analogy for the students needs to be considered. Teachers need to be clear that when an analogy is used in the classroom that this is related to the abstract concepts or difficult concept and there is a visual image. Moreover teachers need to know how the analogy should be used and applied in the lessons plans, to be more specific how to introduce the science concept or help students to summarize the concept. And the last important view is the pre-teaching that helps teachers to have more confidence and also evaluate the effective of using the analogy before bringing them into classrooms.

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Developing of Bachelor Student's Learning Achievement in Basic Research Methods in Science through Constructivist-based Teaching

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Abstract. The aim to this research is to study development of bachelor's degree student's learning achievement, majoring in Biology and Zoology in basic research methods in sciences by constructivist-based teaching.at one university in Bangkok. Participants were the bachelor's degree student who, registered the course entitled biology research methodology and in zoology research methodology in second semester of academic year 2013. The qualitative data and the conceptual, interpretation were collected by interviewing, observation, testing forms, attitude forms and satisfaction with learning. Quantitative data were analyzed with finding frequencies and means. Qualitative data were analyzed with content analysis. The findings showed that giving examples that is clear and related to students' research experience could enhance the student' understanding of the lesson. Grouping the students according to their needs with mixed gender and ability could help students to concentrate in learning and promote the cooperation in the activity. Using various methods to engage students in the learning process could lead positive attitude toward learning. Moreover, providing a group of advisor for each group of students also could promote students' learning achievement and desirable behavior. Encouragement, empathy and reward could encourage the students to respond by asking questions and answering to questions in the class.

Keywords: Learning achievement, Basic research methods, Constructivist-based teaching

1. Introduction

Biology and Zoology are branches in Sciences that study about organisms. In order to understand the nature of organisms, it is necessary to use the process of scientific inquiry, which is related to giving explanation or forecasting phenomena by utilizing experiments, reasoning and using an imagination. From National Education Act, B.E. 2542 and second revised edition (revised edition, B.E. 2545), Article 24 Paragraph 2 mentions that "Let institutes and concerned units relating to educational management, manage the learning that emphasizes on learners by promoting thought process, learning capability, process of knowledge inquiry, process of solving problems, process of building a body of knowledge, emphasizing arrangement of activities that help learners

to learn from real experience, evaluating students by considering from their development and using diverse evaluation methods that are suitable for learners and real conditions matching with learners and real conditions." (Office of National Education Committee (ONEC), 2002).

Nonetheless, success in learning management depends on knowledge and experience of instructors. Therefore, it is necessary for teaching activities to qualified instructors that meet the standard mentioned in Article 52 of National Education Act (ONEC, 2002). However, performance of instructors also depends on their original experience (Loucks-Horseley, Love, Stiles, Mundry, Hewson, 2003:7). Positive experience of teachers leads to efficient learning management (Rye and Dana, 1997). However, some instructors are not confident that student centered learning management will have more efficiency than learning which emphasizes on instructors as principle (Chin, 2000). According to concept of scientific technology and society, instructors must encourage students to express ideas and listen to those ideas. Students should participate not only in listening, but also in teaching students and their teacher learning together. Students learn from instructors and instructors also learn from students (Rye and Dana, 1997). In addition, Tsai (2001) found that teaching instructors, who prepare and teach according to concept of scientific technology and society, understand more in this concept and show better performance in teaching according to the constructivism.

Principle of basic research method in science are regarded to be important to the process in education, research and sciences which are to study research, analysis or experiment systematically according to method in science in order to find facts, new knowledge that can bring to set up rules, theories or according to practice. Benefit of researches in sciences has diversification to become building new knowledge, expanding knowledge into perfection and bring that knowledge to make practical uses. Therefore, students will be able to carry on research successfully and must understand all concerned subjects with process in sciences namely, 1) Assigning research problem or research topic, 2) Set hypothesis of the research, 3) Research planning, 4) Research operation, 5) Collecting data, 6) Analysis of data by statistic, 7) Testing hypothesis, and 8) Interpretation and summary of research results (Wongratana, 1999; Chantalakhana and Uechiewcharnkit, 2008; Punpinit, 2009; Promjouy, 2011).

Based on the researcher's teaching experiences, students have knowledge and skill as well as good attitude in connection with writing and method in order to propose research outline. However, it was found that students lacked of understanding in scientific research process, namely limited problem, research problem or research topic, research hypothesis, research design, collection of data, analysis of data and conclusion etc. In addition to lack of experience in writing research outline, knowledge and understand in various topics, namely topic names, research work, writing, introduction, objective, material and method etc. Furthermore, students still have negative attitude to process of research in science and writing research outline is rather difficult. They feel uncertainly to start writing. Therefore, researchers as permanent instructor has an interest in developing success from learning of university students for Bachelor Degree about rules of basic research method in science by having management of learning with emphasis on process of inquiry. The result from this research study will be basic data for educational institutes and concerning universities in management of learning to promote success from learning of students by learning according to the theory of building knowledge by oneself.

Research Objectives

To develop learning achievement of bachelor's degree students on basic research method in science using constructivist-based teaching.

Theoretical Framework

National Education Act B.E. 2542 and revised edition (second edition) B.E. 2545, section 4 direction of educational arrangement, article 24 mentioned that arrangement of learning process for educational institutes and units concerned proceeded in the following: 1) Preparing contents and activities matching with learner's interest and talent by considering differences among individuals 2) Training skill in thought process, management, confronting to situation, and applying knowledge for preventing and solving problems 3) Managing activities to lead the learners to learn from real experience, to be train to be able to work, have thinking ability, love to read and promote long life learning 4) Managing a and teaching by integrating knowledge in various fields proportionally and well balancing including implantation of virtue, good social value and desirable characteristics in each course 5) Promoting and supporting instructors being able to provide atmosphere, environment, learning media and accommodation for learners to occur learning and intelligent including ability to use research as a part of learning process, according to instructors and learners, they might learn together from media of learning and teaching and other scientific sources 6) Managing learning to occur any time, every location where there were jointly cooperation with parent, guardians, and people in all sectors of communities for joint development of learners as potential (ONEC, 2002). The learning theory on principle of managing learning matching with National Education Act B.E. 2542 and revised edition (second edition) B.E. 2545 was Constructivism.

Constructivism was the learning theory of cognitive psychology, which was basis from work result of Piaget and Vygotsky. They explained that structure of wisdom (Scheme) had been developed by passing through process of absorption or thorough permeation (assimilation) and process of adjusting structure of wisdom (accommodation) in order to person being in equilibrium. Piaget believed that everyone would develop respective steps from relative reaction and experience with environment and society. Vygotsky values culture, society and languages which would be the medium in learning while every student had knowledge, understanding concerning something already and new learning would have basis from original knowledge and original experience of learners which would give good efficiency and such knowledge would not have to conflict with original knowledge and understand so that learning increased continuously. Learners were constructors of knowledge by themselves and the important factor was not established process of learning from information but it was the process of learning that learners had to search, look for, survey, investigate, experiment by their own with various means to occur knowledge, understanding and acknowledge meaningfully to be able constructing knowledge organ (Roadrangka, 1997; Siripunkaew, 1998).

Constructivism is learning theory, which learners do not wait for data by imitating words and summaries of other persons, but they construct knowledge on the basis of original experience and from relationship with other person (Richardson, 2003). Therefore, instructors taught according to the theory of constructivist that was important because instructors were leaders to bring this theory into practice in the classroom. From characteristics of managing learning along the theory of constructing knowledge organ by oneself as already mentioned, it was found that learners had opportunity to learn and perform activities matching along direction of Act as prescribed in National Education Act that emphasized learners as importance which was the important heart of educational reform. Therefore, arrangement of learning experience to university students in Biology and Zoology had knowledge and understanding in relation to managing learning along the theory of constructivist by oneself before they would graduate to become scientists that would be strengthened to push forward for success of educational reform.

2. Research Methodology

This research has its roots in the interpretive paradigm. The researchers attempted to understand and to explain to what extent was the constructivist-based teaching approach enhance the bachelor student's learning achievement in Basic Research Methods in Sciences, which they took in the second semester of the 2013 academic year. Using an interpretivist perspective, the researchers analyzed the qualitative data gathered from the interviews with and related documents of learning.

Research Participants

The participants of this study were 43, 3rd year students in of Bachelor of Science (B.S.), majoring in Biology and Zoology of one University in Bangkok. They registered in the course entitled biology research methodology and, zoology research methodology in second semester of academic year 2013. In average, the participants are 20 years old and with 2.89 G.P.A.

Content of the Study

Basic research method in science consists of subtopics as follows: (1) Principles and research methodology in science, (2) Writing research proposal, (3) Research proposal presentation, (4) Information searching, (5) Using reference database, (6) Discussing the problems and difficulties in proposal writing and supplemental activities, (7) Research Ethics, (8) Ethical use of laboratory animals, (9) Usage and maintenance of scientific equipment, (10) Safety standards in the laboratory, and (11) Research proposal presentation.

Research Instruments

1. Journal entries

Journal is a tool that students could record what they have learned including students reviews of the learned contents and activities in each learning period. After the students have learned a lesson, at the end of the class they will write a journal and sent it to the researchers on the next lesson. At the end of semester, there were a total of 11 journals, which each student sent to the researchers.

2. Pre-test and Post-test of research method in science

Researchers develops pre- and post-test for assessment the student's achievement on basic research method. Steps in development of the test are as follow: 1) Synthesizing research works relating to basic research method in science 2) Constructing framework of question in the tests 3) Developing in the tests 4) Evaluating the test by bringing the testing form to 3 experts in educational science to examine the contents to improve correctness, compactness, transparency of question and their scope in order to comply with the objective in constructing the testing form and the researchers can use the testing form which has the characteristic similar to the study groups and return them for correction prior actual evaluation.

3. Presentation evaluation form

The researchers used presentation evaluation form completed by instructor and students to evaluate characteristic of students during presentation, i.e. cooperation both during presentation and working period, understanding of materials, ability to answer questions, details of content and personality.

The presentation evaluation form of this research consists of 5 criteria to evaluate various qualities of students during their presentation. Each criteria ranks form 1-5 in total of 25 scores with an empty space at the end of the form for additional comments.

4. Teamwork evaluation form

The researchers used teamwork evaluation form to investigate the development of teamwork skill in each group of students. Students are evaluators for their own group.

They will comment about participation, listening to other's opinion concentration, enthusiasm, responsibility and cooperation. Evaluation form consists of 4 topics. Each topic has score level of 1-5, summed up to the total score of 24. Students will complete the evaluation form 4 times throughout a semester. Also, at the end of the evaluation form there is a space to write comments.

5. Diagram of social dimension

Diagram of social dimension is the tool to investigate students' relation between team members to improve their attitude, improve their relationship and promote a better atmosphere in the classroom. The diagram of social dimension is constructed by asking students to write down 3 names of students that they would like to work with. Construction of diagram of social dimension will be made prior and after learning management.

6. Attitude test about writing and method to present outline of research work

Researchers develop "Form of measuring attitude to writing and method to present outline of research work" by following these steps to construct the testing form: 1) Inspect document related with writing and proposal presentation method in order to construct question. 2) Constructing question by having 5 options, i.e. strongly agree, agree, neutral, disagree and strongly disagree. The character of contents will be both positive and negative. 3) Bring the form to 3 experts in science and educational science to investigate whether the content comply with the standard. 4) Adjust question forms according to experts' suggestion and then test it with the controlled group of students. 5) Find confidence of the form measured by using alpha coefficient before using it with real study groups as needed.

7. Informal interview log

Researchers recorded information interviews with students to acquire detailed answers as needed or in case the previous answers are unclear. This kind of interview is flexible, and the inquirer can convey questions in different ways until students understand them. If there is any misconception, it can be corrected in a timely manner.

Data Collections

The researchers has explained research details including asked the willingness of students who give data for this research. If there were some students who are not willing to give data, the researchers would not use their data in this research. When researchers and students agree with relating research format and guideline in learning management, the researchers will ask students to work on testing form and measuring attitude form regarding learning scientific research method. Then, the students were asked to write 3 names of students who they wanted to work with in the paper distributed by researchers. This step is for making diagram of social dimension before learning management; it takes 1 hour.

From there, researchers organized activities according to 11 developed plans for a period of 5 weeks, 3 hour each, for total 45 hours. These activities are process of searching by learning management with emphasis not only on content aspect but also on that learners can study by themselves. Students must collect information, make a presentation and then discuss while the help of instructors. In each study period, the researchers records the researcher's learning management, and the researchers asks students to keep the record of learning for rebounding their thought after activities in each topic every time. Besides, the researchers also examines students' answers in the activity result sheets and informal interview in the aspect that researchers needs additional information. Each interview takes about 15-20 minutes. Students in each group evaluate their groups in total of 3 time/month. And after students in each group finish their presentation, the researchers let the students discuss what they still

misunderstand, exchange ideas, and summarize information received from doing activities

When the learning management was completed, researchers asked students to complete testing form and measuring attitude concerning learning in relation to rule of research method in science which are the same set of testing prior learning management and asked students to write 3 names of the students that they wanted to work together for into distributed sheets for making diagram of social dimension of the classroom in 1 hour.

Data Analysis

Researchers established creditability of information by triangulation method from reading and summarizing materials from interview tape, discussion while doing activities, answers of students in activity sheets and records of learning. After that, the data from each student are brought for grouping and found basic statistical values of each group.

For the data of measuring attitude in writing and proposal presentation, the positive scores are classified into 5 levels: in the most agreeable selector in total of 5 scores; very much 4 scores; moderate 3 scores; small 2 scores; and the least 1 score. For negative levies to give scores in reversal and to find basic statistic of scores, attitude to learning in the content of rules of research method in science.

In addition, the researchers considered the presentation evaluation result and evaluation result of groups whether average scores of students in each group in each week were higher or not including considering diagram of social dimension of the classroom after learning management whether there were increasing distribution of student names or not. If student had more relationship, diagram of social dimension after learning would have more distribution of student names than prior the learning management. From there, the researchers found relationship of data by analysis of data from all tools for achieving themes which could clearly reflect to successful result in learning at Master's Degree level on topic of rules of basic research method in science by managing learning with emphasis on searching process. When analysis of data was completed, researchers brought the result back to study groups to examine correction of data interpretation.

3. Research Findings

From data analysis, the researchers presented research result concerning development of student's potentiality in management of learning at level of Bachelor degree on topic of basic research in Zoology and Biology by learning according to constructivist-based teaching as the following themes.

1) Giving clear examples and matching with direct experience in research in order to help students to easier understand learning content

Before managing learning, 35 students did not have enough experience in learning according to theory of constructing knowledge by oneself, but they might be egocentric with managing learning like original form which the instructor waited to explain learning content by power point program and then asked students to record as in the program. And there were some students who still have open-minded to accept management of learning as new line in example of student text which mentioned " I would like to receive instructors' summarized document that get improved from teaching in each year. However, this method was good that we could give our viewpoint at first"

With this reason, researchers explained details about characteristic of managing learning according to line of theory in constructing knowledge by oneself so that

students knew before the beginning of managing learning between management of learning and researchers had surveyed the original knowledge of students in each topic which it was found that majority of students for total of 30 persons still understood concerning searching technical data, article reading, academic subjects, process of research in science, writing outline of special problem, not many that researchers brought examples of research articles and theses in science for students to mobilize brains and discussion or idea exchange in front of the classroom and mentioning composition of research work in science including good and not good characters of writing in each composition for topic of merit in researchers. Researchers brought an example of song and news regarding merit of students as aspect in discussion or ideas exchange.

In addition, researchers invited senior students to exchange experience with students concerning presentation of special problem outline, presentation of research work and working result to be published as technical article in international journal for giving students the most direct experience.

The researchers found that 37students understood process of research in science and could arrange outline of special problem at the end of learning this course as example of student record "I am proud in attempt and working result by oneself and has consciousness that this is learning process in science in order to receive new knowledge and resulted in learning to work." In addition, students still recognized their own research work, realized in importance in the preparation of readiness before presented orally research work and was building inspiring effort to wish for success like senior students after presentation of each senior students, students jointly asked questions both experience and technique of preparation for readiness of senior and still had many questions concerning research work as example of content from record of learning that students mentioned "Learning this course gave me more understanding in method and technique in writing outline of special problem. However, in order to write perfectly, we had to learn by ourselves for accumulating experience."

2) Arrangement of student groups as needed by mixing sex, ability to help others concentrate and ability to cooperation with others.

Before management of learning, researchers found that when students grouping for activities, students often requested to be selected with members in their own closed friends' groups. Students with lower sense of responsibility often stayed in the same group and persuaded others to keep talking which resulted in a learning atmosphere that may led to misunderstood learning content. Example of mentioned student "Dear Instructor, a person who was good in learning, he did not want to select me" and " Dear Instructor, If I had to be with him, I could not dare to chat or propose anything with him." Therefore, researchers had to solve such problem by letting students to select group of 3-4 person before. From there, there was a study of behaviour history in learning of students with lower sense of responsibility before distribution of students to be in each group containing only one.

From management of learning, researchers found that 30 students had skill of working groups in more various fields, i.e. presentation of opinion; listen to proposal of others, ability to present in front of the classroom. From sampling to unofficially interview students, researchers found that students jointly worked in groups with closed friends and had confidence which may lead them to have intention and cooperate in working group as the student said "Working in the same group with closed friend give him or her the courage to express opinion or it would be easier to understand each other. If he or she had to be in the same group with unclosed friend, he or she would not dare expressing any opinion because he or she was afraid that others would turn down her

proposal." From the mentioned data, it was found that there were matching score level. Group of student who were given friends within the group throughout the period of learning, it was found that score levels of all groups increased after students had jointly activity.

3) Using diverse methods for students with participation in process of learning to improve students' attitude toward learning

Before management of learning, researchers found that giving lecture was dull and students might lose their attention but this may lead them to cooperate in other activity. If instructor gave emphasis on lecture and mix it with teaching media in front of the classroom, students would be interested in early period of the lecture only. After that, students would lose their interested and some students will start using their mobile device. This particularly group of students normally sit behind the classroom. In addition, when students were together for discussion in various aspects concerning the content, the researchers found that some students did not wish to participate in discussion an group representative seem to be the same students as in the first week period. Student still did not seem to be familiar with the method of learning with joint discussion that sometimes uses common sense in discussion more than academic knowledge. Some students did not accept or listen to others' opinion. Therefore, these resulted in learning management struggle as usual. So, researchers adjusted management of learning by emphasis on participation of students with more diverse methods, i.e.

- Reduce lecture as content in Power Point Program by increasing discussion with more moving picture or clip video.
- Bring real samples to present and bring them to discussion and exchange idea in the classroom.
- Try to persuade students who do not agree to join discussion by realizing to participate including building up motivation by giving scores to student who has participated.
- Use bingo game to control expression of ideas from each group to eliminate the redundancy of an answer or conclusion. After the students in each group have jointly presented their opinions, then summarize was received. From there, researchers and students jointly summarized. Students in each group will check answers of group and present their opinions that are not the same with others.
- Sampling group names or inform learners to know the frequency in participating expression of ideas or questioning in the classroom.
- Alternate representative from each group to present discussion result in front of the classroom.
- Provide an instructor to supervise each group for suggestion when student was mistaken in the aspect of discussion. This can make the discussion be more compact and help them finish the discussion on time.
- Rotate the seats of students in each semester for students. So, each student could have a change to sit in front of the classroom that is near instructor. This made the students alerted, interested and students intended to learn more.

From management of learning, researchers found that most of students (about how many persons) like joint discussion/exchange of ideas as found in learning record of students. It is mentioned, "This course was very good, and students learned via idea exchange that exercises though process more only receiving. Moreover, by this way, we knew attitude and opinions our friends." Besides, number of times that students lost their concentration during learning activities, for examples, playing smart phone and tablet, chatting outside main points obviously decreased. Students also participated in various activities very nicely. This reduced presentation time, stimulated students in other groups who were waited to do their own presentation to have time to consider their answers and

also stimulated learners to try to present other opinions that were overlooked. This brought about more diverse ideas from the class. It was written in record book of learning that "Learning in practical style or expressing opinion in the class is beneficial; it could be applied to our research" and "Expressing opinion from what we knew before." Researchers summarized attitude of students concerning management of learning on topic of rules of basic research in science by learning as theory of constructivist. It was found that after management of learning, there was average score equal to 3.67.

4) A coach instructor for each group of students helped them in learning and having desirable behaviour.

Before management of learning, researchers found that students were not accustomed with the instructor which resulted in they did not daring to express opinion because they were afraid of criticism and rather not gave cooperation in activities. Most of students would not come on time and that made teaching learning is not complete according to the objectives because the lesson had to be taught continuously. Students who did not come on time would not understand all the content that resulted in boringness, and then they persuaded friends in the group to chat as a student mentioned "Things that made this course was not satisfied and make me want to skip were terrible listeners during others' or my presentation." Besides, some students did not dress according to the regulation of university such as slippers, female students with trousers or t-shirt covered with grown and male students with shirts outside trouser and etc. They reasoned "We do not want to often iron university shirts, it is easier to put on grown instead of ironing our uniform" and "Today I (female) have physical education class, so I dress up like this."

The researchers solved such problem by arranging a coach for looking after students in each group as an advisor while they were brainstorming or analyzing various aspects before representatives of groups came out to present. The researchers found that students tried to express opinions intentional because when there were some doubts, they could ask their coach suddenly that resulted in more understanding about form and details of activities with objective of active and still help solving problems of deficiency in presenting working result in front of the classroom due to group representative often went out to show opinion by oneself without talking, agreeing and collecting ideas from summary of the group. The students showed more enjoyment in learning, had more courage to express opinions and present their work. The students asked questions when they recorded by student "At first, I felt that this class was horrible because I did not know where to start, but later on I found out that this course was more enjoyable than in the beginning and not horrible at all." Thus, atmosphere of the classroom were better and resulted in better relationship of students as seen from diagram of social dimension before learning and after learning. It was found that after learning there was change to select friend who wanted to join work by distributing student groups that were selected more before learning. In addition, familiarity and closeness between instructor and students could help students to improve and amend from subjective for an example, late attending classroom of students during first period of classroom it was found that most of students came late to classroom. Researchers had warned them but in general it could solve the problem during first period but after that students again came late. Researchers used by talking method with students who came late cordially and was very pleased to students who came in time. It was found that student who used to have behaviour by coming late, improved to come in time and suggested friend who also came late to improve to come in time. In addition, it was found that most of students who dressed improperly for an example, putting slippers in the classroom. Research used methods by building familiarity and talking. Similarly it was found that students had well improved.

Researchers had admired students who improved themselves as good examples to other students in the classroom.

5) Encouragement could promote students to ask more questions and give more answers.

In the first week period, the researchers found that students were not familiar with process of learning which students were builders of knowledge by themselves. Therefore, there are only a few students who volunteered to ask and answer and when managing learning had passed for a period of time. Only when there were about 10 students who set up more question and answer but mostly there were original student groups in spite of instructor had given special scores. Thus, researchers tried to build up motivation, especially gave special scores which found that students would come to join in the first period but later on they would begin sluggish which indicated that students still lacked of being enthusiastic in searching knowledge, responsibility, intention and endeavour. Therefore, the learning process was adjusted by talking and inquiring problems/causes that make they did not ask and answer the question. Students gave the reason in the following "I had little basic knowledge and did not understand the topic taught which made me shied to ask question or be afraid of wrong answering"

Thus, researchers tried to encourage and asked about the student's progress form time to time including asking more question to the students. It was found that students tried to answer more. Some students ask and answer questions inappropriately. Researchers tried to indicate advantage and disadvantage by talk to them privately including suggesting impersonally both in and outside the classroom for students to learn mostly by themselves.

4. Conclusions and Discussions

Before management of learning most of students did not have experience of learning as constructivist-based teaching, but they got used to have original learning management that instructor lecturing with Power Point Program and let students jot down on their notebooks. When the researchers managed learning by using theory of constructivist by giving the clearly example and matching with direct experience in research to help students understanding content of learning easier. Grouping students as the students needed in mixed gender and ability helps students to pay more attention and have cooperation in activities. Use of diverse method in order to give students having participation in process of learning management to help students with good attitude to increasing learning. There was a coach for each groups them in learning and promotes desirable behaviour. Encouragement could help students willing to ask and answer questions related to study material.

Before management of learning, characteristic of learning for students who still waited for receiving data that were quite different from learning by theory constructivist which learners were not persons who waited to receive data by imitate word form and summary of others but building knowledge was on basis of original experience and from having more interactions with others (Richardson, 2003). Therefore, a teacher who taught by constructivist-based teaching was important because the teacher was the leader to practice the theory in the classroom.

During management of learning, researchers tried to adjust management of learning to be suitable with learning characteristic of students. It was found that to give a clear example and in line with direct experience in research to help student in easier understanding content of learning in line with Brooks and Brooks (2001) that mentioned a teacher who taught in line with this theory which should be promoted about curiosity of learners by providing direct experience to learners which that experience caused contrariness with hypothesis of students then teachers stimulated learners to join discussion in opinion both between teacher and others. The researchers still found that grouping students according to need of students by mixed gender could help students to have learning intention and cooperation in activities which was different from most researches with emphasis on managing groups in mixed sexes and capability without considering learners need.

Applying diverse method to students makes them have good attitude towards learning. Due to building knowledge by oneself, learners had to search, look for, survey, investigate and research by themselves. Various methods made happening knowledge and understanding and recognizing meaningfully (Rodrangka, 1997). In addition, there were coaches for helping student closely to be good learners and have desirable behaviour matching with National Education Act B.E. 2542 and revised edition (second edition) B.E. 2545, that mentioned that teachers could arrange atmosphere, environmental conditions, learning media and accommodating for learners to learn and be intelligence including develop virtue good social value and desirable character. The most important thing that instructor found was courage, ability to promote students in asking and answering more questions according to the learning content which is additional information from Brooks and Brooks (2001) that teachers who taught by constructivist based teaching should promote learners to ask questions that stimulate thinking process, to ask open-ended questions and to ask questions to each other.

From research result on development of student potentiality by management of learning of bachelor's students Basic Research in Science by constructivist-based teaching, the researchers recommends instructors who were responsible for managing learning to students including personnel concerning with production of teachers that we should manage activities to promote students to be responsible by themselves not by compulsoriness or pressuring students by reducing scores increasing time in discussion for every students to have participation in discussion. Recommendation for future work, researcher should follow up students about researching and presenting in real situation.

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Science Pre-service Teacher Reflection on Pedagogical Knowledge and other Essential Practical Skills Needed for Practicum according to School Context in Thailand

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Abstract. This study focused the views of 38 science preservice teachers on their concern during practicum experience in Thai school context. Written reflection and non-structured interview during group seminar were utilised to construct an idea of science preservice teacher concern on their practicum experience. Qualitative method was implemented to understand and illustrate circumstances of the phenomena. Data were inductively categorized into 8 themes of the science preservice teacher' concern refereeing to 4 aspects, classroom instruction, social resilience, school condition, and other assigned academic work from school and university. The finding reveals the essential condition of quality experience during education programme to support effective practicum experience in Thailand, which has to consider various dimensions not only practical knowledge and skills for classroom instruction but also other dimensions such as communication, social value and culture.
Keywords: science pre-service teacher, pedagogical knowledge, practicum

1. Introduction

In Thailand, there is an organization monitoring teacher education so-called the Office of the Educational Council by the Secretariat Office of the Teachers' Council of Thailand (2015). Candidate teachers have to obtain their practicum experience through their teacher education programme. Such programmes aim to develop the knowledge, skills and attributes of preservice teachers in order to prepare them to be an effective teacher and meet all requirements needed of school context.

The practicum is accounted as indeed crucial phase for teacher education where preservice teachers initially attain chances to apply and practice the practical knowledge and skills that they have learned in their teacher education programs to the real school environment (Barton et al., 2015). Having said that, practicum is believed to offer valuable experiences to support candidate teachers in preparing them to meet the needs of actual classroom and school context for prospect teachers (Phromsa-ard, 2019). Preservice teacher conceives lacking of experiences of the real context, so that it is essential for them to gain practical knowledge and skills in all perspectives in order to be able to response to the assigned task such as instructional and some other tasks from school context (Roehrig et al., 2007) as being teacher in the real world does not mean they have to connect solely with classroom instructional, teacher also have other aspects of work in school depend on school context.

Practicum is undeniable that challenge and stressful endeavour for many preservice teachers to initially implement knowledge into practice (Gardner, 2010). Studying viewpoint of preservice teacher during practicum experience might allow educators to understand the preservice teacher concern as the preservice teachers are in the position to explore themselves related to context (Caires & Almeida, 2012; Husin et.al., 2021). Studies on initial teacher preparation programs often aimed at technical/cognitive growth of preservice teacher (e.g., scientific, pedagogic or subject matter knowledge). However, it seems that fears and doubts realized during the practicum provides a vital opportunity for teacher educators in supporting preservice teacher essential knowledge and skills, emotional and moral growth in the preparing period of the teacher profession (Poulou, 2007; Thongnoppakun and Yuenyong, 2019). Doubts, fears and dilemmas experienced during the practicum are seen important and, hence, studied by several researchers, though with some other alternative terms such as challenges (Koc, 2012) concerns (Goh & Matthews, 2011; Poulou, 2007). However, research on teacher education regarding practicum often focus on teaching practice (Goh & Matthews, 2011; Poulou, 2007; Nuangchlerm, 2009). The factors generating stress during practicum should be identified and necessary precautions should be taken to minimize their occurrence, thus, pre-service teachers can make effective use of practicum (Celik, 2008; Sutaphan and Yuenyong, 2021).

Direct experience from the practicum in combination with opportunities to reflect critically on the experience and emergent problems in the real-world context would be able to assist teacher education in the sense of understanding their need and concern for practicum or prospect teacher (Jantrasee et al., 2018). More than that critically reflection on practicum experience would be benefit for preservice teacher themselves as it believed that the process of reflection would stimulate them to gain self-evaluation and self- awareness for being effective teacher. As they release their weakness, the preservice teacher would aware of that and would stimulate the need for improvement.

It is important for both course-work and practicum be recognised as essential context for preservice teachers to learn about their knowledge and skills that support teacher profession. It seems to be worth addressing the concerns of students related to their teaching practice experiences as gaining more detail on the practicum experience would ensure that the teacher education programmes will attempt to manage programme to meet the goal of effectively preparing preservice teachers for being prospect science teacher in school environments (Poulou, 2007) by minimizing the sources of concern and maximize the benefits of teaching practicum (Caires and Almeda, 2005).

The Faculty of Education, Nakhon Phanom University responsible for teacher education in Northeastern region. The division of science education has prepared for science teacher development to the educational service. Science teacher educational programme essentially gain practical knowledge and skills to prepare the preservice teacher for effective prospect science teacher. Hence, this study will attempt to explore and address science preservice teacher' concern on the experiences during their practicum experience. The result of this study is expected to be light for teacher educator on effectively preparing professional development knowledge and skills for science preservice teacher.

2. Methodology

This study is aimed to explore the concerns on practicum experience of science preservice teacher from faculty of education, Nakhon Phanom University, Thailand. Teacher education in Thai context, Secretariat Office of the Teachers' Council of Thailand (2015) has prescribed in curriculum that preservice teacher has to gain experience on practicum for one year as the practicum should be long enough to better prepare pre-service teachers for their careers. Teacher preparation programs, recently, lasted for four years. Practicum course at Faculty of Education, Nakhon Phanom University is provided in two practicum courses in two semesters, the second semester of the third year and first semester of the fourth year. Before that teacher students enroll school experience in their first and second year already. The school experience course is aimed students to observe and get acquaintance with the school environment whereas practicum course expects preservice teacher to teach at least 8 hour a week and conduct the other work as they are teacher in the school. Science preservice teacher will spend about 2 months in the school for first practicum course. This study collected data on the second semester of the third-year science preservice teacher in 2021 academic year. These preservice teachers have been prepared under science education curriculum in all aspects for prospect science teacher include subject matter courses, general education courses and practical pedagogy as well as the ethics of the profession expecting preservice teacher to implement in the practicum. The practicum does not provide only an opportunity for preservice science teachers to plan and teach science lessons in the classroom but also learn other context related to professional teacher in actual school environment. Preservice teacher will have to work with experience in-service teacher, cooperating teacher, and university supervisor as facilitator to guide and support during the practicum. Group seminars related to practicum are the primary data sources for the study at the end of practicum course.

Purpose of the study

This study aims to explore and describes preservice science teachers' views on their own practicum relating to their concern.

2.1 Research Design

This study implemented qualitative research on interpretative paradigm to understand the context of SPT experience (Cohen et al., 2000, Creswell, 2014). This research is aimed to understand and address pre-service teachers' concerns during their practicum. Preservice teacher concerns were elicited by means of group seminar after first semester practicum has finished. At the end of the practicum experiences, participants were asked to prepare a final reflection, which was designed to encourage participants to reflect on and discuss the success and problems they experienced throughout the practicum. The preservice teacher's concern written and narrative reflections were subjected to content analysis. Qualitative data was collected by written reflections, and narrative reflection on group seminar was audio-taped then transcribed for the analysis to construct a picture of the experiences of preservice science teachers to identify how they succeeded, struggled and learned as a part of their practicum.

2.2 Participants

Participants were 38 preservice science teachers enrolled in the practicum course at The Faculty of Education, Nakhon Phanom University, Thailand in 2021 academic year during their second semester of their third year.

2.3 Data collection instruments

The instruments utilized for data collection in this study included questions for written reflection on group seminar after the practicum. Four questions compose of (1) What aspects that they need (expect) serving from teacher education programme in university to emphasis more for effective science teacher profession (2) what are their worries during their practicum experience (3) What aspects that they have to develop for being professional teacher (what are their weaknesses that they consider to overcome) (4) What are obstacle or barrier on effective profession during their practicum experience were employed. All questions are intended to elicit information on preservice teacher concern during practicum according to actual experience in Thai school context. During the group seminar, there will be a non-structured interview further on some interesting points of the participants' reflection in order to encourage participants to elaborate their concern as they experienced it in more detail. Pseudonyms have been substituted for their preservice teacher names as SPT (Science Preservice Teacher) and there will be a number after abbreviation such as SPT1, STP2 refers to science preservice teacher number 1 and number 2.

2.4 Data analysis

Data analysis was structured on inductive thematic coding. The data analysis process in this study took place with a grounded, data-driven approach (Creswell, 2014) to coding and organizing information, eventually leading to emergent themes from the written data. During the analysis process two researchers worked together. At the initial stages, both of the coders worked separately then the theme were shared and discussed. The analysis continued with a detailed examination of samples in each theme. Emergent themes evolving around the codes were refined as the analysis progressed. The themes, codes and illustrative examples were critically evaluated until an agreement has reached.

3. Research Findings

The Science preservice teachers reflect their own practicum experience regarding their concern during practicum experience, the analysis led to determination of 8 main themes. The themes with their dominant and noticeable features will be clarified with illustrative quotations as follow;

Concern of Pedagogical Knowledge

Practicum offers preservice teacher the first chance to transfer pedagogical knowledge into practice, so that participants show anxiety toward pedagogical theories during the practicum experience in various aspects such as pedagogical method (instructional approaches and strategies), instructional media.

SPT illustrates their concern of their insufficient pedagogical knowledge on various approach to transfer scientific concepts in a different environmental context. Teacher education programme in the university have to sufficiently provide pedagogical knowledge for them in order to create various learning activities in different contexts.

> SPT3: "I want to gain knowledge on designing learning activities for different content. Like, when we see specific content, we know straight away what approach or activities we should design for this content."

Preservice teacher also refers to knowledge on designing interesting worksheets to captivate student's attention rather than worksheets from a book.

> SPT1: "I want to gain more knowledge on the teaching approach to stimulate student's interest in the lesson; I don't want to teach from the book only. And I want to be able to create interesting worksheet for students as I notice that colorful worksheets, having cartoon pictures in them, can draw student's attention into the worksheets. Students seem to enjoy working more than before"

The preservice teacher mentioned knowledge to compose rigorous instructional plan and sufficient knowledge to implement various approach appropriate for different content knowledge.

> SPT2: "I want to gain more knowledge of creating and designing instructional plan in various approach and cover different content knowledge. Like, when we see content knowledge then we could be able to design appropriate teaching strategies straight away."
>
> SPT6: "My cooperative teacher always uses 5E cycle approach for her instructional plan, and always follow the same path on her teaching, teaching from the book, watching VDO and doing the practice from the book. So that I want to be able to implement various techniques on my teaching and be able to design various techniques on the instructional plan rather than 5E cycle only."

Instructional media was abandoned, lecture method is still usually used in science classroom from cooperating teacher so that the preservice teacher desire to gain more knowledge on creating and designing instructional media or designing experiment activities to stimulate students' interest for students to participate in the lesson rather than only talk and chalk technique.

> SPT1: "I wish I could have sufficient knowledge and ability to create and design various instructional media to stimulate student's interest as students used to with lecture method leaning from book and power point presentation"
>
> STT4: I notice that my cooperative teacher does not implement much pedagogy in her teaching as she follows book nothing else on her teaching and assigned practice from the book or watch VDO but there was no experiment implemented. So, what I want more is knowledge to create instructional medias or experiment for students."

Preservice teacher mentions pedagogical knowledge implemented for individual different of students.

> SPT5: "As I have to teach 3 different classes, and students have in each class are different. Students in the first and second class attain good background knowledge whereas students in the third class are not fast learners. So, I want to be able to implement different techniques for different type of students. I want to be able to implement different techniques for different kind of students."

Science preservice teachers express their concern on many aspects of pedagogical knowledge such as instructional approach, instructional technique, instructional media, instructional plan, designing experiment but assessment. Although, all pedagogical knowledge concerned has been taught in teacher education programme, it has not really been practiced in the real-world situation.

Concern of Subject Matter Knowledge

Science preservice teacher illustrate their concern about incorporating indigenous science knowledge for science classroom.

Preservice teacher seems to worry about insufficient subject matter knowledge to transfer to student as they have to explain body of knowledge. And they also express their concern about the process of preparing content knowledge for their lesson.

> SPT11: "We need to be precise on the content knowledge that we teach, I quite worried not to be able to explain that content knowledge clearly and accurately, if students will understand about the content knowledge I explain to them. I worried if the knowledge I explain to students is accurate."
>
> SPT5: "I worry about subject matter as I teacher secondary students, I have to prepare about content knowledge that I have to teach. I have to transfer

> the content knowledge to students. I worry how would I explain that knowledge for students and make them understand it"
>
> SPT3: "I have to prepare more about the content knowledge, make myself to understand the knowledge in order to teach students to understand it easily. I have to understand deeply in order to monitor students learning, if they answer correctly when they do activities. Like, when we have to transfer knowledge for students to understand but I feel that I am not yet be able to explain the content deeply, I worry if I understand the content enough to explain for students correctly."

Preservice teacher worries of having insufficiency subject matter knowledge to transfer to student in order to be able to answer student's questions from students in their teaching.

> SPT7: "There are number of questions on science content knowledge which related to fact but sometime the questions from students are from their experience such as from cartoon. Sometimes there are questions that I cannot answer."
>
> SPT11: "We need to have precise science content knowledge on the topic that we teach, we have to prepare and study if we are not sure about it as when students ask, we have to be able to answer to students' questions."

Preservice teacher refers to their worried about thinking of knowledge implication in everyday living.

> SPT9: "We have to think about linking science content knowledge with situation in everyday living whether the science content that we teach will be able to apply in student's daily live so that it will be easier for students to remember the knowledge"

It seems that students do not have confident on their knowledge of subject matter as they view science content knowledge as body of knowledge and they have to understand everything in order to answer student's questions.

Concern of Classroom Management

Classroom management seems to be one of the most concerned aspects of science preservice teacher during their practicum.

Classroom management has become a real concern for many SPT especially when they realised the mentor difficulties from some students:

> SPT20: "LD (disorder learning) students pay no attention on the lesson; they always talk and play. They even induce and persuade other students to play. It is really difficult to central LD students into the lesson. Some students forget to take their daily pills lead to misbehave, run around the classroom."

Participants express the concern on their own teaching time management.

> SPT5: "I worry of how to manage time about the content that we teach as science content is complicated and huge."

Another point in concern of classroom management is about time management on their teaching consequence from students.

> SPT2: "Students often get to the classroom late, for example 10-15 minutes late, consequent less time for classroom teaching so I could not be able to manage the lesson to achieve indicator in the instructional plan."

Participants mention their concern on classroom management regarding students misbehave. Sometime, as they are preservice teacher they did not receive respect from students.

> SPT6: "I want to have idea and knowledge to manage the classroom regarding students misbehave. I worry if I could deal with it when I confront with this kind of students."
>
> SPT9: "As I am the preservice science teacher, students are not really listening or paying attention when I teach, some time they even bring the work

> from other subjects such as Thai language, English language, to work during the lesson I am teaching science."

Participants express concern about student's attention to the classroom, so they need to gain understanding and knowledge to manage this.

> SPT11: "I need more idea about classroom management. As when I teach in front of the classroom, students will pay attention on the lesson about first 5-10 minutes of the lesson. After that they will have loud chat and play, the classroom quite chaos. I tell them to be quite and pay attention to the lesson, they stop talking for about 3 minutes then the classroom goes back to the chaos. I need classroom management technique for my teaching."

Participants desire to gain knowledge on classroom management in various situations, they need guidelines to deal with problem solving in different situations.

> SPT7: "I want to gain knowledge on dealing with problems during instruction in the classroom. For example, in case students misbehave, I worry if I could manage the problem good enough."

As this practicum course was the initial actual experience of preservice teacher practicing their knowledge in the real classroom situation as they are individual different in human. Lacking experience might lead to fear and lack of confidence. In order to deal with situation, they need to gain an experience.

Concern of University workload

Preservice teacher has two dimensions of work, school context and university context. It seems that they really worry about the workload assigned to hand in to university supervisor after practicum in school has finished and they have to come back to study on other course works at the university.

> SPT24: "I worry about the workload that I have to finish during the practicum. To elaborate this, in practicum course, there are worked assign from the pre-service teacher practicum experience center from university and the work that we have to do at school during practicum."
>
> SPT11: "we have to spend only about 2 months for practicum in this semester but we have been assigned a lot of work from pre-service teacher practicum experience center such as the report which I think this extra workload is quite a lot. And more than that, after 2 months practicum we have to come back to study other course works at the university, so it makes me worry."

This concern reveals that they are not really able to focus on their classroom as they have to work in many aspects (work to hand in for university, and work for their further coursework). It is interesting point for the university to consider and improve this aspect to minimize student's stress.

Concern of Classroom Research

One of the assigned tasks for science preservice teachers on their practicum experience is science classroom research. The first course of practicum experience, science preservice teacher is assigned to attain a proposal of the classroom action research.

Participants express their concern on determining the topic of action research.

> SPT18: "I worry about classroom research because there was online teaching during my practicum experience. And I think that I have to observe the classroom in order to frame problems for my classroom research but there are not many things to observe as not many students attend the online teaching. So, it is more difficult for me to scope the topic for my classroom research."
>
> SPT35: "I worry about classroom research as time limitation and online teaching. Sometimes, there was only 5 students in the online

> classroom, and I do not really know where and how to focus on the classroom observation for classroom research. What skills that students lack of, like that."

The naïve expression form participants reveal a lack of experience in conducting research and think of the idea of a topic for classroom research.

Concern of Covid-19 Pandemic Situation

It is undeniable that the Covid-19 pandemic situation has an impact on teaching management. There was concern about teaching management during the situation both online and school dimension.

In case of teaching management in school, participants mention that keeping social distance they had to divide students in one classroom into two sections resulted in confusing in teaching schedule and learning activities as there were government holidays and school activities mess up teaching schedule.

> SPT7: "I am responsible to teach 7 sections, according to pandemic covid-19 situation, students in each section have to be divided into 2 groups, which means I have to teach 14 groups. Usually, I teach science 2 hours a week so I would be able to teach science to each group for 1 hour. So, it is very difficult to manage to teach them through the same level of topic. And sometimes, students themselves could not manage their learning."
>
> SPT9: "In the pandemic situation, school will divide one section students into 2 groups, these groups come to school on different days. For example, group1 comes to school on Monday, group2 comes to school on Tuesday. Sometime I barely see students in certain group result from government holiday and school activities, and it affect my teaching plan and schedule."

In case of online teaching, participants were not prepared for this situation, so they illustrate suffering from teaching management through online means as it is difficult to draw students' attention and monitor through the online teaching. And more than that, participants refer to concerning about the difficulty of stimulating student's skills and knowledge.

> SPT6: "I think that online teaching does not support active learning for young students. I notice that students lose their interest through online teaching, and it leads to not attending online classes. This results in discontinuing learning for students, unlike teaching and learning in the classroom."

Participants relate online teaching with loosen student's competency.

> SPT:5 "Pandemic covid-19 situation, we have to manage the classroom into online teaching. I notice that online teaching does not support students' skills or even content knowledge in a continuous way."

Teacher educator programmes should consider to aspects of technological concern and should prepare candidate teachers to the benefit of technological, pedagogical, and content knowledge (TPACK) (Koehler and Mishra 2009).

Concern of School Condition

Many participants refer to workplace (infrastructure and facilities), and working conditions as a matter of their concern.

> SPT2: "There is no projector and laboratory material support working."
>
> SPT18: "There is no projector in the classroom that I teach, I need to borrow from another room when I really have to use it. There is no facilitator in the classroom to support teaching, there is only a blackboard in the classroom. When I really have to do an experiment, I have to bring all laboratory glassware to the classroom that I teach, it is not convenient."

SPT4: "There is limited laboratory materials, some students cannot get to experiment, teacher have to demonstrate instead of students doing the experiment. There is no projector to support teaching, I need a projector to present my PowerPoint."

Moreover, other activities in school also concern science preservice teacher practicum experience as they affect teaching schedule.

SPT24: "There are many school activities and it leads to limited teaching time."

Participants get used to the teaching style by means of PowerPoint presentation and doing experiments in the laboratory which is induced from university. Preservice teacher should attain fruitful teaching means and mindset to be able to flexibly design teaching methods regarding the context of their work.

Concern of Social adaptation and resilience

Preservice teacher illustrates concern of adaptations and interactions with members of school community

SPT2: "My concern during practicum was that I was worried about communication with teachers and students in school. I am not really certain in what kind of vocabulary is appropriate to communicate with teacher and student"

SPT5: "I am not sure how to approach and communicate with my cooperating teacher."

SPT14: "…there was a situation where I was asked to deliver the exam paper to the teacher, there was no message with it so I am not sure what to say when I deliver it. I do not know how to communicate in a formal way. I am really worried about social adaptation with the new working environment."

Thai culture especially in schools where there is strongly hierarchy culture, students are on a different level with teachers, they have to pay deep respect for teachers. Even in the teacher community, young teachers have to pay respect to senior teachers. So as preservice teacher who was a student and has just become candidate students, it might be difficult for them to overcome the barrier of this hierarchy. School culture in Thailand does not focus on academic work where members in the community are at the same level.

4. Conclusion

The finding of this study provides important insights into the notion of SPT concern on their practicum experience and it suggests that direct experience from practicum lead to their consideration of practical knowledge and skills for being prospect teacher. The finding reveals that STP concern led to different interrelated categories including content knowledge, pedagogical knowledge, classroom research, infrastructure and facilities (school environment condition), classroom learning management, other work load, online teaching situation, and social adaptation. SPT concern led to fruitful opportunities for SPT to develop themselves as they also composed of self-evaluation and self-awareness process.

In term of ongoing discussions on the development of effective teacher preparation programmes, SPT concern in this study reveals that the participants are insecure of confident in knowledge implementation, although they have learned all essential knowledge and skills from teacher education programmes. It might infer that the teacher preparation course should address more on knowledge implication and real situation practicing for preservice teacher to embed their confidence on classroom instruction and classroom research, and to expose them to the experience of their real-world teaching situation.

Regarding participant concern about online teaching, teacher education programme should consider the importance of technology combined with pedagogical knowledge. TPACK should be utterly prepared to the most benefit of technology to teaching method for preservice teacher in the technological era.

Another crucial point is that SPT concern seems to represent that the experience from university implants their concrete mindset on teaching science. For example, many participants mention the term "transfer knowledge" rather than thinking of setting an environment for students to construct knowledge (Tobin, 1993). This kind of mindset led participants to frame the importance of body of knowledge and they have to answer questions correctly as an authorized person. Concern about not having a projector and laboratory is also the example of inducement from teaching in university as they have been taught in this way so they look for something that they are familiar with. To minimize this concern, students' mindset should be paradigm shifted from positivist to constructivist.

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