# Enhancing the Competency of Pre-service Science Teachers in the Construction and Improvement of Science Lesson Plans for Lesson Study

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## Abstract

The purposes of this research were 1) to investigate the primary school pre-service science teachers' knowledge and understanding of lesson study process to construct and improve the science lesson plans for lesson study based on learner-centered approach and open-ended question and 2) to investigate the opinion of primary school pre-service science teachers toward the enhancing activity for lesson study. The participants of this research were a researcher of the Faculty of Education, Khon Kaen University and 5 primary school pre-service science teachers in science education program, Khon Kaen University. All 5 pre-service teachers practiced teaching at a primary school in Khon Kaen province. The enhancing process using lesson study steps were adapted from Fernandez & Yoshida (2004) and McMahon & Hines, (2008). The research tools were the documents related to lesson study, learner-centered approach, and open-ended question; the Likert scale questionnaires developed by the researcher; reflective writing; and meeting conclusion notes. The frequency, mean ($\overline{X}$), standard deviation (S.D), Wilcoxon Signed Ranks Test, and the content analysis were employed to analyze the data. The results revealed that the lesson study process applied in this study was able to enhance the participants'

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knowledge and understanding of lesson study in order to develop the better science lesson plans for lesson study. However, the application of lesson study in this study faced some constrains that caused by several factors, which were related to the school context.

**Keyword**s: Competency, Construction and improvement, Lesson study, Pre-service science teachers, Science lesson plans

## Introduction

Thailand has been faced with the crisis concerning poor academic achievement of students. At international assessment of TIMSS (Trends in International Mathematics and Science Study) in 2011 with 6,124 students of 172 schools from 45 countries and 14 states revealed that Thai students' mean score of science was 472 with rank of 29 and was assessed at low level (IPST, 2011). In addition, the results of scientific literacy for 15-year-old students assessed by the Programme for International Student Assessment (PISA) indicated that a mean score of 425 of Thai student performance in scientific literacy was statistically significantly below the Organization for Economic Co-operation and Development (OECD) average (500). Mean score of Thai students was ranked 49$^{th}$ from 65 countries (IPST, 2011). Especially, the results of Grade 6 students who took the O-NET during the year 2008-2012 showed that the scores of Thai students were very low with the means of percentage scores of 51.68, 38.67, 41.56, 40.82, and 37.46, respectively (ONEC, 2013). These low scores were consistent with PISA's 2011 results. Several factors were responsible for such poor student performance. One factor might be that there were too many science contents in the text books. Another factor might be that the emphasis was mainly placed on content knowledge not the application of the knowledge reflected in the ways in which

both the curriculums and the exams were formulated. In addition, the teachers themselves seem to lack necessary teaching skills to promote students' high-level thinking, which includes analytical, synthetic, critical, and creative thinking. It, therefore, came as no surprise that most Thai students lack incentive and enthusiasm for learning, which in turn leads to their poor performance in exams.

To address the aforementioned problems, many educators have suggested that the solution may lie in improving the teachers' teaching style. One way to do this is through the learner-centered teaching approach, which is, in simple terms, a teaching approach that encourages students to participate actively in the teaching and learning activities. Teachers should create active learning activities to foster knowledge, ability, and interesting of students by giving them an opportunity to learn and construct knowledge by themselves (Kammanee, 2009). The Thai Ministry of Education also strongly advocated the learner-centered approach to enhance student's capable of learning and self-development to their highest potentiality (The Ministry of Education, 2008). Some institutes promoted various teaching models of learner-centered teaching approach. However, most teachers are unable to effectively apply thelearner-centered teaching approach in their teaching.

The literatures revealed that the open-ended question is an effective mean to enhance students' high order thinking because the open-ended questions were asked in a form of open situation. Open-ended questions refer to questions or open situation constructed by the teacher for the students to apply knowledge, principles and theories in answering questions or solving problems or situations. Open-ended question is non-routine unstructured question in which possible answers are not suggested so it stimulates students' thought for a variety of answers to question, and the student answers it in his or her own words (Inprasith, 2006). The literatures also revealed that the Japanese lesson study is a worldwide accepted as an effective strategy to improve student's

performance. It has been a core of Japanese teacher professional development about 130 years ago (Nakatome, 1984 in Fernundez and Yoshida, 2004). Japanese teachers improved their teaching through "lesson study", a process in which teachers jointly plan of lessons, observe, discuss, analyze, and revise actual classroom lessons called "research lessons" (Yoshida, 2005). Lesson study is widely credited for the steady improvement of Japanese elementary mathematics and science instruction. Since 1999, lesson study has rapidly emerged in many sites across the United States. The lesson study gives Japanese teachers opportunities to make sense of educational ideas within their practice and change their perspectives about teaching and learning. Teachers learn to see their practice from the child's perspective and enjoy collaborative supporting among colleagues (Yoshida, 2005).

The aforementioned suggested that lesson study is a sustainable development of good teaching method for teacher (Lewis & Tsuchida, 1997; Stigler & Hiebert 1999; Yoshida, 1999; Lewis, & Perry, 2003). In Thailand, lesson study was applied in mathematics classrooms 10 years ago. However, it has no evident that lesson study is applied in science classroom in Thailand. Therefore, I (researcher) applied the lesson study process in enhancing primary school pre-service science teachers to construct and improve their science lesson plans for lesson study based on learner-centered approach and open-ended question.

## Purposes of the study

This study aimed to 1) investigate the primary school pre-service science teachers' knowledge and understanding of lesson study process to construct and improve the science lesson plans for lesson study based on learner-centered approach and open-ended question and 2) investigate the opinion of primary school pre-service science teachers toward the enhancing activity for lesson study.

## Research method

### Participants of the study

In lesson study, a small group of teachers meet on a regular basis to collaborate in planning, implementing, evaluating, and subsequent receiving feedbacks from teachers and students for revision of classroom lessons (Stigler and Hiebert, 1999). The lesson study teams are usually composed of 3-6 instructors (Cerbin, B. & Kopp, B., 2006). Therefore, five participants were selected purposively to be included in this study. They were primary school pre-service science teachers from science education program, Khon Kaen University who practiced their teaching at the same school in Khon Kaen province. The researcher is also a participant who is responsible for academic supervision in teaching and conducting classroom research of these five participants. The primary school pre-service science teacher participants and their responsibilities in this study were divided into 2 groups as shown in Table 1

**Table 1**. The primary school pre-service science teacher participants and students' grade levels in this study

| Primary school pre-service science teacher participants | Students' grade levels | | | | Number of Classrooms | Note |
|---|---|---|---|---|---|---|
| | 2 | 3 | 4 | 5 | | |
| Group I | | | | | - | Each lesson plan was taught for two rounds by each pre-service science teacher as below:<br>1) The original lesson plan (1st version) was taught to the first classroom<br>2) The revised lesson plan (2nd version) was taught to the second classroom<br>- Other participants of each group observed each other. After that, they met for reflection, discussion, and suggestions to improve each lesson plan. |
| Ps 1 | / | | | | 2 | |
| Ps 2 | / | | | | 2 | |
| Group II | | | | | - | |
| Ps 3 | | / | | | 2 | |
| Ps 4 | | | / | | 2 | |
| Ps 5 | | | | / | 2 | |

Ps = pre-service teacher

From the table, group I composed of 2 primary school pre-service science teachers, each participant implemented his/her lesson study in 2 classrooms of grade 2 students and group II composed of 3 primary school pre-service science teachers; the 1st participant taught grade 3 students; the 2nd participant taught grade 4 students, and the 3th participant taught grade 5 students. Each participant taught 2 versions of lesson plans to 2 classrooms.

Each primary school pre-service science teacher participant taught his/her lesson plans and investigated the results then wrote a research report.

## The instruments

The instruments used in this study were:

1. Documents related to lesson study, learner-centered approach, and open-ended question , which were used to enhance the primary school pre-service science teacher participants' competency in construction and improvement the science lesson plans for lesson study by researcher;

2. The 10-item Likert scale questionnaires for assessing the primary school pre-service science teacher participants' knowledge and understanding of lesson study process;

3. The field notes; and

4. The primary school pre-service science teacher participants' reflective writing.

## Research procedure

*Process of lesson study*

Researcher adapted and applied the lesson study steps of Fernandez & Yoshida (2004) and McMahon & Hines, (2008) to enhance the primary school pre-service science teacher participants to construct and improve their lesson plans as the followings.

Before starting to practice their teaching, the participants (pre-service primary school science teachers) participated in a meeting conducted by the researcher to enhance participants' knowledge and understanding of lesson study process, leaner-centered approach, and open-ended question using group presentation and discussion.

After participating in enhancing activities, each participant was required to create science lesson plans for lesson study according to the following steps of lesson study:

*Step 1. Collaboratively plan the study lesson.* The participants were asked to construct jointly the learner-center approach and open-ended question lesson plans for lesson study. The contents used in the lesson plans were varied according to participants' teaching contents. This constructed lesson plan was called as *the original lesson plan.*

*Step 2. Teach and observe the study lesson in action (First round).* Each participant implemented the constructed *original lesson plan* into his/her *1st classroom*, One pre-service primary school science teacher participant taught *the original lesson plan* to his/her first classroom, the other group members observed. The observers used the lesson plan as a tool for observation protocol. The observation aimed to examine the students' and teacher's behaviors during teaching period.

*Step 3 Discuss the study lesson:* After observing, the participants had a short meeting to analyze the strengths and weaknesses of lesson plan. In the discussion, they shared what they have observed and provided the reflections and suggestions to improve the lesson plan. Then each participant had to revise his/her lesson plan. This lesson plan was called as *the 1st update revised lesson plan (1st revision)*

*Step 4. Teach and observe the study lesson in action (Second round).* Each participant implemented *the 1st update revised lesson plan* into his/her *2nd classroom*. During teaching activities, other participants observed using the same process in the *Step 2*. Then each participant had to revise his/her lesson plan. This lesson plan was called as *the 2nd update revised lesson plan (2nd revision).*

Although each lesson plan was improved for 2 rounds but the *2nd update revised lesson plan* was not much complete. It also needed for further improvement. However, this study was able to conduct only 2 rounds for revised lesson study because of the time limit. So each science lesson plan in this study had only 3 versions of lesson plans; *the original, the 1st revision* and *the 2nd update revised lesson plan*.

## Data collection

Researcher collected the data of this research as the following.

1. Before and after the enhancing activities, the questionnaire was administered to investigate the participants' knowledge and understanding of lesson study process. The field notes were used during the meeting.

2. At the end of enhancing activities, the participants were asked to write the reflection toward the lesson study in enhancing their knowledge and understanding of lesson study process.

## Data analysis

The quantitative data were analyzed by frequency, mean ($\overline{X}$), standard deviation (S.D), Wilcoxon Signed Ranks Test, whereas, the content analysis was used to analyze the qualitative data.

## Results and discussion

The outcome of lesson study in enhancing the primary school pre-service science teachers' knowledge and understanding of lesson study process to construct and improve their science lesson plans for lesson study based on learner centered approach and open-ended question

1. The primary school pre-service science teachers' knowledge and understanding of lesson study process to construct and improve the science lesson plans for lesson study based on learner centered approach and open-ended question before and after participating in the enhancing activities were showed in table 1

In scoring the Likert scale, numerical values of one through five were assigned to each level of opinions: 1= Strongly Disagree (SD), 2 = Disagree (D), 3 = Uncertain (U), 4 = Agree (A), and 5 = Strongly Agree (SA).

Set the interpretation criteria for mean scores as follow:

$< 1.50$ = Strongly Disagree (SD)
$< 2.50$ = Disagree (D)
$< 3.50$ = Uncertain (U)
$< 4.50$ = Agree (A)
$\geq 4.50$ = Strongly Agree (SA)

**Table 2.** The knowledge and understanding of lesson study process to construct and improve science lesson plans for lesson study of primary school pre-service science teacher participants before and after participating in the enhancing activities (n=5)

| Items | Before | | After | |
|---|---|---|---|---|
| | $\overline{X}$ | Meaning | $\overline{X}$ | Meaning |
| 1. You create your own lesson plans to solve the teaching problems in science contents | 4 | Agree (A) | 4.80 | Strongly Agree (SA) |
| 2 You and your science friends create the science lesson plans together | 3 | Uncertain(U) | 4.80 | Strongly Agree (SA) |
| 3.You and your science friends identify the learning goals together | 2.60 | Uncertain U) | 5 | Strongly Agree (SA) |
| 4. You and your science friends design lesson plans together | 2.80 | Uncertain(U) | 4.80 | Strongly Agree (SA) |
| 5. You and your science friends create teaching medias for the teaching plans together | 3.20 | Uncertain(U) | 4.60 | Strongly Agree (SA) |
| 6. You and your science friends constructed the assessment tool together | 2.60 | Uncertain(U) | 4.40 | Agree (A) |
| 7. You and your science friends implement your created science lesson plans into classroom | 3.80 | Agree (A) | 4.80 | Strongly Agree (SA) |
| 8. You and your science friends take turn in observing while each friend performed his/her teaching, then meet in group to reflect and discuss the results after class. | 2.80 | Uncertain(U) | 4.60 | Strongly Agree (SA) |
| 9. You bring the reflection results to improve the lesson plans for further implementation | 2.80 | Uncertain(U) | 4.80 | Strongly Agree (SA) |
| 10. You write the results of whole work as a research report | 3.00 | Uncertain(U) | 4.80 | Strongly Agree (SA) |
| Total | 3.02 | Uncertain(U) | 4.70 | Strongly Agree (SA) |

**Table 3**. Comparison of participants' knowledge and understanding of lesson study process to construct and improve science lesson plans for lesson study of primary school pre-service science teacher participants before and after participating in the enhancing activities using Wilcoxon Signed Ranks Test

| Items | Before | | After | | Z-value | p-value |
|---|---|---|---|---|---|---|
| | $\overline{X}$ | S.D | $\overline{X}$ | S.D | | |
| 1. You create your own lesson plans to solve the teaching problems in science contents | 4.00 | .70 | 4.80 | .44 | -1.633 | .102 |
| 2 You and your science friends create the science lesson plans together | 3.00 | .70 | 4.80 | .44 | -2.121 | .034* |
| 3. You and your science friends identify the learning goals together | 2.60 | 1.34 | 5.00 | .00 | -2.041 | .041* |
| 4. You and your science friends design lesson plans together | 2.80 | 1.09 | 4.60 | .54 | -2.041 | .041* |
| 5. You and your science friends create teaching medias for the teaching plans together | 2.80 | .83 | 4.40 | .89 | -2.060 | .039* |
| 6. You and your science friends constructed the assessment tool together | 2.60 | .89 | 4.40 | .89 | -2.041 | .041* |
| 7. You and your science friends implement your created science lesson plans into classroom | 3.80 | 1.30 | 4.80 | .44 | -1.342 | .180 |
| 8. You and friends take turn in observing while each friend performed his/her teaching, then meet in group to reflect and discuss the results after class. | 2.80 | 1.09 | 4.60 | .54 | -2.041 | .041* |
| 9. You bring the reflection results to improve the lesson plans for further implementation | 2.80 | 1.09 | 4.80 | .44 | -2.041 | .041* |
| 10. You write the results of whole work as a research report | 3.00 | 1.00 | 4.80 | .44 | -2.070 | .038* |
| Total | 3.02 | .807 | 4.70 | .424 | -2.023 | **.043*** |

* P <. 05

Table 2 and Table 3 revealed that the desirable characteristics of lesson study process to construct a suitable science lesson plan based on learner-centered approach and open-ended using lesson study process were fostered and enhanced in participants after participated in the enhancing activities. The participants' knowledge and understanding average score was at the uncertain (U) level ($\overline{X}$ =3.02, S.D = 0.807) and after participated in enhancing activities the knowledge and understanding average score was increased to the

strongly agree level ($\overline{X}$ = 4.70, S.D. = 0.424) which indicated significant difference at the .05 level as shown in Table 3 (Z-value = -2.023, p-value =.043 with the difference of mean scores = 1.68).

The results showed that the enhancing activities were able to effectively enhance the primary school pre-service science teachers' knowledge and understanding of lesson study process to construct better science lesson plans for lesson study. Due to the enhancing activities were deliberately designed based on the lesson study process that required participants to work together in creating, implementing, reflecting, suggesting, and improving the lesson plans. The results were consistent with the research results conducted by Lewis & Tsuchida (1997); Stigler & Hiebert (1999; Yoshida (1999); Lewis, & Perry (2003).

However there were two items didn't show statistical significant differences between means scores of participants before and after participated in the enhancing activities. They were item 1, "You create your own lesson plans to solve the teaching problems in science contents" (Z= -1.633, p-value=.102 with the difference of mean score = 0.8), and item 7, "You and your science friends implement your created science lesson plans into classroom" (Z= -1.342, p-value=.180 with the difference of mean score = 1.0). Despite of non-significant difference between these two item means of the participants' knowledge and understanding of lesson study process before and after participated in the enhancing activities, the knowledge and understanding of lesson study were shifted up 0.8 (from $\overline{X}$ = 4.00 to $\overline{X}$ = 4.80) and 1.0 (from $\overline{X}$ = 3.80 to $\overline{X}$ = 4.80) on the rating scale, respectively. After participating in enhancing activities the knowledge and understanding average scores for these two items were raised up one level from the agree level to the strongly agree level. These results may be an effect of too small sample size to detect for the significant improvement of participants' knowledge and understanding of lesson study process by item1 and item 7.

*The results derived from pre-service science teachers' reflective writing*

The reflective writing revealed that the participants gained knowledge and understanding of the lesson study process rather well. They were able to construct the tentative lesson plans (original lesson plans). They mentioned that lesson study was a technique that emphasized on identifying the teaching and learning problems and the development of lesson plans by teachers themselves. They reflected that the lesson study processes were that teachers worked in a team, co-created lesson plans, reflected, and improved their lesson plans. They also mentioned that teaching and learning based on learner-centered approach and open-ended questions enabled students to learn better. Because the students had to practice to solve the problems based on their own judgments. Lesson study is congruent with open-ended question which is non-routine unstructured question in which possible answers are not suggested so it stimulates students' thought for a variety of answers to question, and the student answers it in his or her own words (Inprasith, 2006). Teachers only prepared teaching materials and used open-ended questions to stimulate student's thinking. This reflection was also consistent with the learner-centered teaching approach, which is, teachers should create active learning activities to foster knowledge, ability and interesting of students by let them learn by themselves (Kammanee, 2009). Some pre-service primary schools science teachers thought that the lesson plans constructed and improved by lesson study process were able to help students learn better. These reflections were consistent with current research finding in the area of lesson study illustrates that collaboration of teachers, through the use of lesson study groups, increases student achievement (Lewis, 2000). The pre-service science teachers 'reflective writings were shown in the following excerpted:

*Knowledge and understanding of lesson study:*

According to the process that teachers who teach the same subject work together in order to set goals of lesson plans and write the lesson plans together. Bring lesson plans to teach, observe, reflect, suggest and conclude. Then, bring the conclusion to improve lesson plan for the next class. This process is a key element that leads to the improvement of lesson plans and to the effectiveness of the next class teaching.

(Ps. Siwa's reflective writing)

The lesson study is co-operative process to develop for the better teaching plans: to find the activity that is suitable to teaching and learning in the school context

(Ps Kan's reflective writing)

In each teaching and learning activity, I and my friends think together to find ways to solve the teaching and learning problems that will lead to the high benefit of the students.

(Ps Su's reflective writing)

I can see plenty of benefits for teachers. For example, teachers who teach at the same level and the same subject construct lesson plan jointly. Start from setting the goal, creating activity to achieve that goal. Implementing the lesson plan and reflecting both good and weak points as well as indentifying weak point to be improved. These processes enhance teacher self-development on content as well as teaching and learning management.

(Ps Hat's reflective writing)

*The effect of lesson plans constructed based on lesson study toward students' learning*

> The good lesson plans that teachers use also have positive impact on students' performance. So in my opinion the lesson study is very useful way to develop lesson plans for teachers
>
> (Ps Siwa's reflective writing)

> The lesson plans that are improved by teachers give impact on students' learning a lot. Due to after teachers improve the weak point of previous classroom and implement into the second classroom. The students do not get confusion and difficulties when they conduct the activities. They also understand the lesson better.
>
> (Ps Hat's reflective writing)

*The problems in implementation of the lesson study.*

The pre-service teachers reflected that the school contexts were not suitable to conduct science lesson study. Due to several problems i.e the number of student per classroom is too big (more than 50). The school had only one science laboratory room and also lacked of laboratory instruments and instructional media. There is a wide range of students' academic ability in a classroom. The in-side school supervisors are unable to give any suggestions to pre-service teachers because they lack of lesson study knowledge.

> The school context is a major constrain. It effects on teaching and learning activities. There is big number of student per classroom (more than 50 students). The school has only one science laboratory room but every science teacher wants to use it, so it was occupied all the time of teaching periods. Therefore, many teaching and learning science lessons have to use normal classroom.
>
> (Ps Siwa's reflective writing)

The school lacked of science laboratory instruments and instructional media such as LCD projector, magnetic board, and internet system

(Ps Tee's reflective writing)

Classroom and science instruments are not enough. Due to there are many students per classroom.

(Ps Kal's reflective writing)

The number of science laboratory room is not enough; school environment is not suitable to learn science. Some in-side school supervisors don't understand about lesson study and the importance of peer observation in the process of lesson study.

(Ps Su's reflective writing)

However, this lesson study is not much success as it should be. The school context is not suitable for lesson study activity. It lacks of some instructional media, classroom is too small when compares to the number of student. No space for teacher to walk around the classroom.

(Ps Hat's reflective writing)

*The suggestions toward enhancing activities*

The suggestions of participants derived from form the meeting discussions were as the followings.

- Pre-service teachers should work together with in-service science teachers in every step of the lesson study.
- The information taken from VDO, the pictures, and field notes were very useful for meeting for reflection. So all teaching activity should have them.

- Teaching schedule should be arranged for observers to have enough time to observe the whole teaching activity.
- The school administrators should provide more attention to pre-service teachers who conducted lesson study.
- The participants teachers of the lesson study should teach in the same grade level
- The academic ability of students in the target groups of lesson study should be similar.

The above problems and suggestions above revealed that there were many problems in applying the lesson study in actual classroom situation. These problems caused by several factors. The main problem is that the lesson study is a new concept for Thai educational system. So many teachers and administrators are not familiar with the concept of lesson study. The school's contexts are also not ready for applying the lesson study for upgrading the quality of teaching and learning science subject. These problems were consistent with the conclusion of Inprasith (2009) that lesson study is an innovation which is influenced by the socio-cultural context. Because this innovation emerged in Japan more than hundred years ago, therefore, teachers in Japan practice it as a routine work. In Thailand, the socio-cultural context is very different from Japan. Therefore, the implementation of lesson study in Thailand needs a lot of collaboration from teachers and school administrators in adjusting and changing their beliefs toward teaching and learning management of lesson study for the benefits of students, teachers, and society.

## Conclusion

The results showed that the primary school pre-service science teachers understood the process of lesson study after they experienced in enhancing activities. They revealed that the lesson study process enhanced the collaboration of jointly working in creating, implementing reflecting, discussing, suggesting, and improving the lesson plans for lesson study. The lesson plan can help students to learn better and be happy in learning. *So it is able to conclude that the lesson study activities enable to effectively enhance participants' knowledge and understanding of lesson study process to construct better science lesson plans for lesson study.* However, the application of lesson study process in this research faced many constrains caused by several factors, which were related to the school context.

## Suggestion

The results derived from this research finding suggested that before implementation the lesson study to enhance teachers to construct and improve the science lesson plans in actual school context and the researchers would like to overcome such constrains, they have to study and understand the school context every well. They have to take seriously in consideration of collaboratively working with people within the schools. Try to encourage and to give an opportunity for the school supervisors and school administrators to see the benefits and the importance of the lesson study before asking for further collaboration. It is hard work but it is possible and worth to try.

## Acknowledgement

I acknowledged the financial support from the development project on high order thinking in Mathematics of students in the Northeastern region, 2014, Faculty of Education, Khon Kaen University, Thailand.

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