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To: Lilla Adulyasas

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Subject: LICE-2013 Paper Acceptance Letter

Dear Lilla Adulyasas,

We are pleased to inform you that your paper titled "Enhancing Secondary Students' Geometric Thinking and Teachers' TPACK through Lesson Study Incorporating Phase-Based Instruction Using GSP" by Lilla Adulyasas and Dr Shafia Abdul Rahman, has been accepted for oral presentation at the London International Conference on Education (LICE-2013) to be held at the Marriott London Heathrow Hotel, London, UK, from the 4^{th} to 6^{th} of November 2013.

Please proceed with your registration as soon as possible.

Looking forward to meeting you at the LICE-2013.

C. Shoniregun.

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Enhancing Secondary Students' Geometric Thinking and Teachers' TPACK through Lesson Study Incorporating Phase-Based Instruction Using GSP

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Abstract

This study was carried out by quasi-experimental and case study research design to investigate the effects of Lesson Study incorporating Phase-Based Instruction (LS-PBI) using GSP on Thai students' geometric thinking and teacher's Technological Pedagogical and Content Knowledge (TPACK). Three groups of mixed ability Grade 7 (12-year old) students were taught a particular geometric topic in turn by three different teachers. Pre- and post-tests were used to assess students' geometric thinking while interview and observation protocol were used to assess teachers' TPACK. Findings indicate that there was a significant difference in the pretest and posttest scores in each group and there was a significant difference in the posttest scores among the three groups of students. The analysis also shows teachers' development of TPACK from 'recognizing' to 'exploring' level. The findings suggest that LS-PBI using GSP was effective in enhancing both students' geometric thinking and teachers' TPACK.

1. Introduction

Geometry has taken a centre stage in the mathematics curriculum in Thailand since it is considered as the vital content in mathematics which connects to real world situations (Geddes & Fortunato, 1993). The ability to think geometrically can lead students to have spatial visualization –an important aspect of geometric thinking, geometric modeling and spatial reasoning that will provide ways for students to understand and explain physical environments and can be an important tool in problem solving (NCTM, 2000).

Despite the fact that geometry is very important and many studies in Thailand have attempted to develop students' geometric thinking, the statistical data shows that Thai students still lag behind in mathematics and geometry in comparison to national and international averages. The examination results evaluated by the National Institute of Education Testing Service (NIETS, 2012) in the Ordinary National Educational Test of middle school students in Thailand show that the average mathematics score of secondary school students from 2008-2012 were 32.66%, 26.05%, 24.18%, 32.08% and 26.95% respectively which are less than 50%. Additionally, the results from The Programme for International Student Assessment (PISA) 2009 have found that the average score of Thai student was 419 which is significantly below the average of OECD and Thailand was ranked in the period of 48-52 out of 65 countries. Besides, the scores of Thai students decrease continuously from PISA 2000 to PISA 2009 (OECD, 2010). More specifically, the Trends in International Mathematics and Science Study (TIMSS) latest results in 2011 shows that the average geometry achievement of Thai students was 415 which is significantly lower than the international average and Thailand was ranked 28 in average geometry achievement out of 49 countries (Mullis, Martin, Foy, & Arora, 2012). These findings suggest that the teaching and learning of mathematics and in particular geometry in Thailand can benefit from further innovations and improvement.

The van Hiele theory (van Hiele, 1986) which describes five levels of geometric thinking and the phase-based instruction which is a teaching strategy to move up the levels of geometric thinking through five phases of learning has been applied in many studies related to teaching and learning of geometry and has shown success in developing students' geometric thinking (Liu & Cummings, 2001).

Besides the van Hiele theory, a much more concern is to find ways to make students understand the concepts in geometry. During the last decade, researchers found that using technology such as GSP was useful in developing students' understandings of geometric concepts (Connor, Moss, & Grover, 2007). The studies suggest that GSP is useful in enhancing children's thinking through van Hiele's hierarchy because it allows students to discover relationships among geometric concepts through *investigation* (Key Curriculum, 1999).

Hence, the integration of technology, pedagogy with the teaching content is important in developing students' understanding of a particular mathematical content. In this context, it is essential that teachers develop their TPACK. Koehler & Mishra (2009) stated that "TPACK is the basis of effective teaching with technology, requiring an understanding of the representation of concepts using technologies; pedagogical techniques that use technology in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones."

Although it may appear that ICT is an important factor that makes students succeed in learning *mathematics, OECD (2010) mentioned that students* who use the most ICT have the minimum score. Therefore, it seems that mere use of technology is not enough to improve students' learning. Teachers need to consider and improve their teaching as well because in today's world, the needs and interests of children are very different from those in the past decades and the traditional approach may not respond to the potential of the children (Battista & Clement 1999).

Therefore, it follows that teacher aspect is a factor which is the key of successful learning because quality learning outcomes are associated with quality teaching (Hattie, 2009; Smart et al., 2008). This suggests that professional teacher development is an important element that brings out professionalism in teachers, which will lead to student success.

Lesson study is one of the professional teacher development programs which many scholars have *studied for developing teaching process* and *it* obviously shows success in teaching and learning because it provides opportunities for teachers to work collaboratively, have a deep understanding of the pedagogy and cultivate the skill of observation, analysis and reflection of the teacher (Lewis, Perry, & Hurd, 2009; Isoda, 2010).

For these reasons, this study purposes to study the effects of lesson study incorporating phase-based instruction (LS-PBI) using GSP in enhancing secondary level students' geometric thinking and teachers' TPACK with the aim of improving the teaching and learning of geometry in Thailand.

2. Objectives of the study

1) To determine the extent to which LS-PBI using GSP enhances secondary students' geometric thinking.

2) To determine the extent to which LS-PBI using GSP enhances secondary teachers' TPACK.

3. Theoretical framework

To study about students' geometric thinking and teachers' TPACK, this study was guided by the van Hiele theory of geometric thinking and the theory of TPACK. According to the van Hiele theory, levels of geometric thinking and phase-based instruction are described for determining students' level of geometric thinking after learning by phase-based instruction using GSP. In addition, levels of TPACK are also described for determining the level of teachers' TPACK before and after the intervention.

3.1. Levels of geometric thinking

The learning objective in the Basic Education Core Curriculum 2008 in mathematics for students in grade 7 requires students' geometric thinking particularly up to level 3. The three level descriptors for assessing students' geometric thinking are as follow:

Level 1 Recognition: The student can learn names and recognize figures of 2D and 3D geometric shapes by their appearances. The properties of the shapes are not perceived. The distinguishes of the 2D and 3D geometric shapes is based on the perception not reasoning.

Level 2 Analysis: The student can identify the components and properties of 2D and 3D geometric shapes by their investigation but the relationship between two figures is not identified.

Level 3 Order: The student can logically order properties and relationship between properties of 2D and 3D geometric shapes. The student can give informal arguments to justify his/her classifications of 2D and 3D geometric shapes but does not operate within mathematics system. The student can follow simple deduction but cannot understand proof.

3.2. Phase-based instruction

For this lesson, plan student must step up from phase one to phase five.

Phase 1 (Information): In this phase, students get acquainted with 2D and 3D geometric shapes which they have faced in real life. This phase student examined the examples and non examples of 2D and 3D geometric shapes by the pre-constructed which teacher provided on the GSP program then they did the activities by recalling the name of 2D and 3D geometric shapes. From this phase, teacher can know the prior knowledge of students.

Phase 2 (Guided Orientation): Students are guided by tasks which involve different relations of 2D and 3D geometric shapes. This phase students investigated and can understand the properties of the shapes by dragging and unfolding the pre-constructed of 2D and 3D geometric shapes which teacher provided on GSP program.

Phase 3 (Explicitation): Students become conscious of the relations and express them in words which are the technical language of 2D and 3D geometric shapes. This phase, students discussed about the properties of 2D and 3D geometric shapes from their investigation of the pre-constructed which teacher provided on the GSP program.

Phase 4 (Free Orientation): Students are challenged by doing more complex tasks to find their own way in the network relation. This phase students were given the activities by answering the questions in the student worksheet.

Phase 5 (Integration): Students summarize all what they have learned about properties of 2D and 3D geometric shapes on the student worksheet.

3.3. Level of TPACK

There are five levels in which teachers will progress through when learning to integrate GSP in their classroom. These levels provide a framework as a lens in assessing teachers' TPACK when integrating GSP in teaching and learning in the classroom (Niess et al., 2009).

Recognizing (knowledge): Teachers are able to use GSP and recognize the capability of GSP in teaching and learning geometry but not yet and unwilling to integrate GSP in their teaching and learning geometry.

Accepting (persuasion): Teachers will form the positive or negative attitude in integrating GSP in teaching and learning mathematics at their specific grade level. Teachers may attend some professional development training about GSP. Then they try to use the ideas from the training with the students in their classroom. Teachers practice geometric ideas with GSP but GSP is not consistently thought of when they think about teaching geometry.

Adapting (decision): Teachers engage with the activities which will lead them to decide whether they will adopt or reject the GSP in teaching geometry. Therefore, teachers will start experiment with integrating GSP as a teaching tool in their classroom (only in the low level cognitive activities such as drill and practice) to see whether they should adopt or reject the technology. They manage the classroom by using prepared worksheets to guide students the teaching content.

Exploring (implementation): Teachers eagerly integrate GSP in their teaching and learning contents. Therefore, teachers who decide to use GSP start to design lesson aligning with the curriculum which integrated GSP as a learning tool for students that will build students' understanding in geometric concept. Teacher in this level try to investigate the different ways for teaching geometry and are willing to demonstrate new ways of thinking about geometric concepts with GSP as a learning tool and also allow students to use GSP in investigating, exploring, problem solving and decision making.

Advancing (confirmation): Teachers evaluate the results of integrating GSP in teaching and learning geometric content and make changes in the curriculum to take advantages of GSP affordances. By the capability of GSP, teachers develop their lesson plan effectively by using GSP in a variety of ways to help students enhance their understanding of geometric concepts.

4. Research Design and Sample

A mixed method research design using quasi-experimental and a case study was employed to study the effectiveness of LS-PBI using GSP on Thai students' geometric thinking and teachers' TPACK. Purposive sampling technique was used to select three classes of mixed-ability students in grade seven (group 1: N=30, group 2: N=28 and group 3: N=29) and five mathematics teachers who have more than 10 year experiences in teaching geometry from a secondary school in Yala province, Thailand.

5. Instruments

1) Lesson plan through phase-based instruction using GSP in the topic of "Properties of 2D and 3D geometric shapes"

2) Pretest and Posttest for assessing van Hiele level of geometric thinking of students

3) Interview protocol for assessing teachers' TPACK

4) Classroom observation protocol for observing students' geometric thinking and teacher's TPACK

6. Procedure

1) Prior using LS-PBI using GSP, a pretest was administered to the students in group 1, group 2 and group 3 to determine their initial level of geometric thinking. In addition, five teachers were interviewed to determine their initial level of TPACK.

2) Next, the first teacher carried out the phase-based instruction using GSP. During this time, the other teachers observed the teaching and learning to see the difficulties in students' learning. At the same

time, teachers' TPACK were observed. Then a posttest was administered to the students in group 1.

3) After the first lesson study session of students in group 1, the group of teachers reflected on the teaching and learning process and revised the lesson plan by focusing on students' difficulties and the development of their geometric thinking as evidenced from their observation.

4) Following this, the revised lesson plan was taught for a second time by the second teacher to the students in group 2. Students' geometric thinking and teachers' TPACK were observed. Then Posttest was administered to the students in group 2

5) The same process was repeated to the students in group 3.

7. Data analysis

This study employs both quantitative and qualitative approaches. The researcher employed quantitative data analysis in identifying the level of geometric thinking, comparing the pretest and posttest scores, and comparing the posttest scores among 3 groups of students. In addition, qualitative data analysis was used in identifying the level of teachers' TPACK.

7.1 Identifying the level of geometric thinking

The criterion used in this study to identify the students' van Hiele level of geometric thinking was adapted from Usiskin(1982). From the items in each level, if a student can correctly answer 60% or more from the questions in each level, he/she will be considered as passing the criterion of that level.

After that students are assigned a weight sum scores. A student will get 1 point if he/she meets the criterion on items 1-6 (level 1), 2 points if meets the criterion on items 7-12 (level 2) and 4 points if meets the criterion on items 13-20 (level 3). Once students got the points from each level, the points in each level will be combined to become a weight sum score. Finally the classification of the van Hiele level of geometric thinking will be identified according to the Usiskin's operational definitions (Usiskin, 1982). The weight sum scores 0, 1, 3 and 7 are assigned to the van Hiele level 0, 1, 2 and 3 respectively.

7.2 Comparing the pretest and posttest scores

The total score of each pretest and posttest is 12 points. To compare the mean scores of the pretest and posttest of students in each group before and after the intervention, a paired samples t-test was used for testing these three hypotheses;

Hypothesis 1: There is a statistically significant difference in the mean scores of pretest and posttest in the geometric thinking test of students in group 1. (1st lesson study session)

Hypothesis 2 : There is a statistically significant difference in the mean scores of pretest and posttest in the geometric thinking test of students in group 2. (2nd lesson study session)

Hypothesis 3: There is a statistically significant difference in the mean scores of pretest and posttest in the geometric thinking test of students in group 3. (3rd lesson study session)

7.3 Comparing the posttest scores among 3 groups of students

Since it is hypothesized that in the last lesson study session, students will be taught using the last revised lesson plan which supposes to be the best one. Therefore, the Analysis of Covariance was used to compare the posttest scores of students in group 1, group 2 and group 3 for testing hypothesis 4.

Hypothesis 4: There is a statistically significant difference in the mean scores of posttest in geometric thinking test among the three groups of students.

7.4 Identifying the level of teachers' TPACK

Five-level descriptors of TPACK adapted from Niess et al. (2009) as defined in this study were used to assess teachers' TPACK. Data of each participant includes pre and post interview, notes from classroom observation protocol and verbal transcript of videotape recorded in the classroom activities.

8. Results

The results are presented into 4 parts based on data analysis. Items 8.1-8.3 present the effectiveness of LS-PBI using GSP on students' geometric thinking and the item 8.4 presents the effectiveness of LS-PBI on teachers' TPACK.

8.1 Students' level of geometric thinking

Table 1: Frequency and percentage of students in each group at each van Hiele level

	Group 1		Group 2		Group 3	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Level 1	8 (26.67%)	1 (3.33%)	6 (21.43%)	0 (0%)	7 (24.14%)	0 (0%)
Level 2	14 (46.67%)	5 (16.67%)	15 (53.57%)	4 (14.29%)	13 (44.83%)	4 (13.79%)
Level 3	4 (13.33%)	22 (73.33%)	5 (17.86%)	23 (82.14%)	6 (20.69%)	25 (86.21%)
No Level	4 (13.33%)	2 (6.67%)	2 (7.14%)	1 (3.57%)	3 (10.34%)	0 (0%)
Total	30 (100%)	30 (100%)	28 (100%)	28 (100%)	29 (100%)	29 (100%)

From Table 1, the results show that the initial van Hiele level of students in group 1, group 2 and group 3 were predominantly at level 2 (46.67%, 53.57% and 44.83% respectively). After the intervention, the van Hiele level of students in group 1, group 2 and group 3 were predominantly at level 3 (*73.33%, 82.14%* and *86.21%* respectively). This indicates that some students progressed from level 1 to level 3 and some students progressed from level 1 to level 2. **However, there is just only one student in group 1 who did not make any progress in the level of geometric thinking. The results also reveal that group 3 has the most percentage of the students who attained level 3 (the highest level). This indicates that lesson plan 3 which was taught to the students in group 3 is the most effective.**

8.2 Comparison of students' pretest and posttest scores

The results of comparing pretest and posttest in each group by using Paired Samples T-Test are shown in Table 2.

Table 2: The comparison of students' pretest and posttest scores

Group	test	Mean	Std. Deviation	t	Sig. (2-tailed)
Group 1 (N=30)	Pretest	7.13	1.28	6.751	.000
	Posttest	8.97	1.27		
Group 2 (N=28)	Pretest	7.54	1.48	7.833	.000
	Posttest	10.04	1.17		
Group 3 (N=29)	Pretest	7.24	1.15	10.410	.000
	Posttest	9.93	1.03		

Table 2 shows that there is a statistically significant difference between the mean scores of pretest and posttest of students in group 1, group 2 and group 3 respectively (*p = 0.000). Since the mean* score of posttest was greater than pretest in every group, we can conclude that each lesson plan which was taught by phase-based instruction using GSP is effective.

8.3 Comparison of students' posttest scores

Table 3: The comparison of the posttest scores among 3 groups of students (1)

Dependent Variable: Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	27.157a	3	9.052	7.017	.000
Intercept	170.021	1	170.021	131.796	.000
Pretest	6.720	1	6.720	5.209	.025
Lesson Plan	18.015	2	9.007	6.982	.002
Error	107.073	83	1.290		
Total	8206.000	87			
Corrected Total	134.230	86			

a. R Squared = .202 (Adjusted R Squared = .173)

Table 4: The comparison of the posttest scores among 3 groups of students (2)

Dependent Variable: Posttest

Parameter	B	Std. Error	t	Sig.
Intercept	8.365	.718	11.656	.000
Pretest	.216	.095	2.282	.025
[Lesson Plan 1]	-.941	.296	-3.180	.002
[Lesson Plan 2]	.041	.302	.136	.892
[Lesson Plan 3]	0a	.	.	.

a. This parameter is set to zero because it is redundant.

Table 3 shows that there is a statistically significant difference in the mean scores of posttest in geometric thinking test among the three groups of students (p = 0.002). This shows that there is a difference between the posttest scores of students in group 1 who were taught using lesson plan 1, group 2 who were taught using lesson plan 2 and group 3 who were taught using lesson plan 3.

Particularly, Table 4 shows that the p-value of *lesson plan 1 is 0.002 which is less than 0.05.* This suggests that the posttest scores obtained using **lesson plan 1 and lesson plan 3 show statistically significant difference. However, the p-value of lesson plan 2 is 0.892 which is more than 0.05, which suggests that the posttest scores obtained using lesson plan 2 and lesson plan 3 show no statistically significant difference.**

8.4 The effectiveness of the LS-PBI on teachers' TPACK

The researchers utilized levels of TPACK as described by Niess et al. (2009) as a lens for assessing teachers' TPACK.

Before the intervention

The data from the pre interview indicated the initial TPACK level of all participating teachers. Four participants (Suwanna, Pawinee, Jitra and Nutnapa) *were identified as being at the 'recognizing'* level. The data for these four participant teachers show that they did not integrate any technology in any of the classes. Although they **knew that GSP has capability in teaching geometry, they did not prefer to use it in the classroom. They were concerned with the differences of student readiness in learning with GSP and this would consume time of learning the content. Excerpts from the interview are shown below:**

Pawinee: I do not prefer to use GSP in the classroom because I'm worried that some students are not ready in learning with GSP since they have no experience about this program.

Jitra: I'm afraid that some students will not easily understand how to use GSP in learning. So, it

might take a lot of time to make them understand how to use GSP and this will take time in learning the content. That's why I decided not to use GSP.

However, Malee, who has just 3 year experiences in teaching mathematics was identified as being at the 'accepting' level. She sometimes integrated GSP in her teaching for grade 9 students but never used it for grade 7 students. Since she had some experiences in teaching mathematics using GSP, she thought that GSP might help in motivating student in learning geometry.

Malee: When I was in the university, I took some courses on using GSP in teaching and learning. I feel that GSP is an interesting program which can visualize geometric shapes. I try to use GSP just only when I have time left after teaching by traditional ways because I think that I should finish my main job in teaching that content first before I motivate students to use GSP.

After the intervention

After the intervention, teachers' TPACK levels were identified using data from classroom observation and post interview. One teacher (Jitra) was identified as being at the '*accepting*' level, while the other three teachers were identified as being at the '*adapting*' level (Suwanna, Pawinee and Nutnapa) and the last teacher (Malee) was identified as being at '*exploring*' level.

Accepting Level

Jitra is the one who was identified in this level. She has good attitude in integrating technology in teaching and learning because she found that students were enthusiastic when she carried out phase-based instruction using GSP in teaching the topics. However, she is much more confident in teaching without technology.

Jitra: It is very surprising to see students are very enthusiastic when I show the GSP constructs. So, I feel that this can motivate students in learning geometry. However, I still think that my traditional ways of teaching can make students understand better since I have 26 years experiences in teaching mathematics and I have produced a large number of students who are successful in learning mathematics without using technology. Although in this study I must use GSP but I am still not sure that I will use it in my own classroom.

Adapting Level

Three teachers (Suwanna, Pawinee and Nutnapa) were identified at this level. They feel that after they were involved with the phase-based instruction using GSP, there are many geometric concepts that they can integrate GSP in their teaching.

Nutnapa was assigned to teach in the first lesson study session. She said that although she had some experiences in GSP training, she never used GSP in teaching.

Nutnapa: I found that there are many contents such as the cross section and the properties of 3D geometric shape that I can integrate GSP in the teaching. I found that students gave good response and seemed like they understood the contents well.

Suwanna was not assigned for teaching in any of the lesson study session but she was involved in and observed all lesson study sessions.

Suwanna: From my observation in LS-PBI using GSP sessions, I understand how GSP can help teachers and students in the teaching and learning. I found the usefulness of GSP in the teaching and learning of many geometric contents. And I plan to use this designed lesson in my own classroom.

Exploring Level

Malee was the only teacher who was identified as being at the '*exploring*' level. She was assigned to teach in the last lesson study session. She was eagerly integrating GSP in her teaching and tried to investigate the ways of using GSP in demonstrating 3D geometric shapes.

Malee: I felt very happy looking at students who were interested and enthusiastic in learning using GSP. From the previous lesson study session, I found that spinning of the pyramid shape created by GSP made students visualize well. However, the only one shape which is a pyramid was shown. For my next lesson, I plan to show more spinning shapes. So, tonight I will try to construct other spinning shapes if I can.

9. Conclusion

From the results, analysis suggests that students' initial van Hiele level of geometric thinking about the properties of 2D and 3D geometric shapes ranged from level 0 to level 2. After the intervention, students' level of geometric thinking ranged from level 1 to level 3. However, we can see the progress of students' geometric thinking in group 1, 2 and 3 by the frequency and percentage of students which show that the initial van Hiele level of students in every group was predominantly at level 2 but after the intervention, the van Hiele level of students in every group was predominantly at level 3. Moreover, students in group 3 who had been taught the last revised lesson plan has the most percentage of the students who were at level 3 (highest level). This suggests that LS-PBI using GSP has a positive effect on students' geometric thinking in learning this topic. This finding can make teachers to become aware of the potential of this approach as an effective instruction in teaching geometry.

Additionally, the results show that the mean score of posttest was greater than pretest in every group. It indicates that each lesson plan which was taught by phase-based instruction using GSP was effective. These findings are consistent with Choi-Koh (1999) and Chew (2009) which reported that phase-based instruction using GSP had enhanced students' understanding in learning geometry.

The comparison of posttest scores among group 1, 2 and 3 indicates that there is a difference between the posttest score of students in group 1 who were taught using lesson plan 1, group 2 who were taught using lesson plan 2 and group 3 who were taught using lesson plan 3. Particularly, the results indicate that posttest scores of lesson plan 1 and lesson plan 3 had a statistically significant difference. However, the posttest scores of lesson plan 2 and lesson plan 3 show no statically significant difference.

Though the posttest scores of lesson plan 2 and 3 showed no statically significant difference, the posttest scores of both lesson plan 2 and 3 (revised lesson plan) are different and higher than the posttest score of lesson plan 1. Moreover, group 3 has the highest percentage of students who obtained the highest level of geometric thinking. This suggests that lesson study process of teachers working collaboratively in observing, analyzing, reflecting and revising the lesson plan has an effect on students' learning. Although the main objective of lesson study was to contribute to the improvement of mathematics teaching, the results on the effectiveness of lesson study on student achievement are consistent with the study of Meyer & Wilkerson (2007) which reported that students' achievement in mathematics appeared to be improved and lesson study had a positive impact on students' engagement in mathematics.

Furthermore, the results on teachers' TPACK revealed that initial level of all teachers were at the first level (recognizing) but after LS-PBI using GSP, teachers enhanced their TPACK to level 2, 3 and 4 (accepting, adapting and exploring). The analysis also shows that LS-PBI using GSP which is the process of working collaboratively in order to see, plan and create lesson which integrated GSP to help students in understanding the concept can enhance teachers' TPACK since all of them progressed in their TPACK from one level to a higher level.

This study suggest that well-designed teaching and learning process using phase-based instruction, appropriate instructional tool (such as GSP) and improvement of teaching methodology and teacher competencies by lesson study are the elements that can enhance the understanding in learning geometric concepts and teachers' TPACK at the same time.

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