The roles of lesson study in the development of mathematics learning instrument based on learning trajectory

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Abstract. This study is aimed to describe Lesson Study (LS) activity and its roles in the development of mathematics learning instruments based on Learning Trajectory (LT). This study is a narrative study of teacher’s experiences in joining LS activity. Data collecting in this study will use three methods such as observation, documentations, and deep interview. The collected data will be analyzed with Milles and Huberman’s model that consists of reduction, display, and verification. The study result shows that through LS activity, teachers know more about how students think. Teachers also can revise their mathematics learning instrument in the form of lesson plan. It means that LS activity is important to make a better learning instruments and focus on how student learn not on how teacher teach.

1. Introduction

Innovation is the key to improve the quality of mathematics teaching and learning. That is why, teacher’s creativity is needed to create innovative mathematics learning so that teachers as decision makers in learning are expected to arrange learning that can enable students to learn. [1] Asserts that teachers are required to make decisions in which the decision-making process consists of planning for learning, implementing teaching strategies, and evaluating the outcomes of planning for learning and learning strategies. It is related to teachers’ responsibility to arrange learning instrument. According to [2], learning instrument which compiled by teachers consists of lesson plan, learning materials, learning media, evaluation, and student worksheets.

Based on [3], the most important thing to design teaching instrument and the learning process itself is the teacher can reach the goal with figuring out every student’s situations, how the proper words, with whom, what to do, what to say, and how the class will be if the goals are reached. So, in making the learning design we need to have similar thoughts to student’s. He added that teachers are still complaining that they don’t know whether the design they made is similar to student way of thinking or not. This is consistent with finding fact, observation result pointed out that the old teacher’s mind set is how to teach in class, not how the students learn. This problem can be accommodated by using LS in developing a mathematics learning instrument based on LT. This problem can be accommodated by using LS in developing a mathematics learning instrument based on LT.

LS is currently a topic of worldwide attention, refers to a process in which teachers progressively strive to improve their teaching methods by working with other teachers to examine and critique one another’s teaching techniques [4]. By the LS process, teachers work together to determine what is important for students to understand about the content of lesson, and to figure out how to teach the best for their students [5]. LS places teachers at the center of the professional activity with their interests and a desire to better understand student learning based on their own teaching experiences. The idea is simple: teachers organically come together with a shared question regarding their
students’ learning, plan a lesson to make student learning visible, and examine and discuss what they observe. Through multiple iterations of the process, teachers have many opportunities to discuss student learning and how their teaching affects it [6]. Based on those, so we can conclude that LS is a collaborative model of planning lessons together, to observe each other and reflect on learners’ progress alongside a mentor, learn from other colleagues and support staff through triads that shown in Figure 1.

![Lesson Study Activity Cycle](image)

**Figure 1.** Lesson Study Activity Cycle [7]

In planning a lesson, they predict how students are likely to respond to specific questions, problems and exercises. Teachers try to put themselves in the position of a student and imagine what it would be like to experience the material and lesson activity as a novice. In order to investigate student learning during the class period, teachers try to design a lesson that makes students’ thinking visible that is, open to observation and analysis. [8] Mathematics learning instrument based on LT is learning instrument where teachers make predictions in planning a lesson on how students might learn math in particular. The prediction in this case is related to how the ability of thinking and understanding of students will develop in learning activity designed by teachers. Formally, learning trajectories are descriptions of children’s thinking as they learn to achieve specific goals in a mathematical domain, and a related, conjectured route through a set of instructional tasks designed to engender those mental processes or actions hypothesized to move children through a developmental progression of levels of thinking [9]. A hypothetical LT is a term for that serves the role of outlining a path that students can take to learning new content. Part of documenting this path (HLT) is the role that the teacher plays in this development. In this way, answering questions about the development of student thinking and the role of the teacher creates a possible path, an existence proof of a path for student learning. Having such a model can aid other researchers, curriculum developers, and teachers. For researchers, it illustrates linear algebra understandings that are possible for beginning mathematics and science students, and adds to the body of knowledge documenting such understandings. For curriculum developers, it describes potential paths for curriculum design. For teachers, especially, it provides suggestions as to ways to draw out their students’ understandings in this content area and perhaps more broadly [10].

Submission of LT can only be hypothetical, because the experience of the teacher making decisions and adapting the aspects of the planned activity in the response is to prove the students’ thinking and learning, the different aspects and levels of understanding will become apparent to the teacher. In addition, the term hypothesis is used for teachers to be flexible in changing the direction of learning and adapt aspects of activity that have been planned in response to student responses throughout the learning. Therefore, LT that is designed still in the form of hypothesis or allegation then called HLT.

Based on description above, LT is important in developing mathematics learning instrument which is designed to notice how students learn. As well as LS, it is an excellent program for mathematics teacher professional development in order to make real improvements in teaching and learning sustainably. This study aims to know how important the roles of LS for developing mathematics learning instrument based on LT.
2. Methods
This study was conducted in high schools in South Kalimantan Province, Indonesia. This is a narrative study [11] to describe the experiences of two LS participants teachers about LS activity, this is related to development of mathematics learning instrument. These participants are two young teachers that work in a state high school. These participants joint the same LS activity that was held in Banjarbaru region with teachers as participants from senior high school and vocational high school background.

First participant is AM, a teacher of a senior high school and has been teaching for three years. the second participant is VA, a teacher of a vocational high school and has been teaching for seven years. In this study, the opinions of two participants about their engagement in LS activity and its role in developing learning instruments based on LT will be described. The development of the instrument discussed in this study is focused on developing lesson plans. The topic in this study is to discuss about the educational background, teaching experiences, and school environment of both participants.

Data collecting in this study will use three methods such as observation, documentations, and deep interview. Observation method is used to observe the activities of both participants as model teachers in LS activity for three months from September until November in 2014. Interview method is used to get some data or to strengthen some important data that cannot be found with observation. Documentation as curriculum vitae is used to check the validity of data found by observation interview. In this study, the researchers are the main instrument to collect the data.

Collected data from observation, documentation and interview are analyzed by using steps consists of data condensation, data display, and conclusion drawing/verification [12]. The interview and observation results then are condensed, and triangulated with documentation. The results are finally concluded as empiric data about the role of LS in developing student’s mathematic learning instrument based on LT.

3. Result and Discussion

3.1 Result
Participant AM is a female and her last educational background is bachelor of mathematics education. AM has begun her career as a mathematics teacher at a senior high school since 2010. AM teaches in one of the top schools at the high school level. When she attended the LS activity, AM was selected as one of the math teacher who represented her school to participate in LS activity. AM was also one of the model teachers who selected in the LS activity.

AM has used direct learning which is to explain the subjects, give examples, and then drill for the exercises. AM still used the conventional approach to design learning instruments. AM argued that she did not feel a significant change with the holding of LS activity towards the development of learning instrument especially in designing LT based learning.

"... nothing is different, because I and all subjects teachers in school often discuss the student’s character in the class, so I can take some steps to treat students specifically. Thus, the treatment of teachers to students in each class is different. But overall, at least this LS activity opens my knowledge of learning”.

Participant VA is also a female and her last educational background is bachelor of mathematics education. VA has begun her career as a mathematics teacher at vocational high school since 2006. VA teaches in one of the leading schools in the vocational high school level. When VA attended the LS activity, she was selected as one of the mathematics teacher who represented her school to participate in LS activity. VA also became one of the model teachers who was selected in the LS activity.

VA has used direct learning which is to explain the subjects, give the examples, and then drill for the exercises, but her teaching techniques is more typical and interesting. Interaction in teaching and learning of VA is not only in one way but also two ways. VA interacted by doing questioning technique through the learning to examine student's understanding to the subject.

According to VA, LS is a place for teachers to evaluate the learning for this time. In the LS activity, teachers can discuss everything from planning, implementation, and reflection of learning which has they did.
"Through the implementation of LS, teachers who act as observer learn from the model teachers who teach in the classroom. The teachers discuss from planning, execution and reflection. That reflection is taken for the next better LS activity. From these activity can be known what the lack of learning activity that have been done, such as the readiness of teachers in delivering the subject, readiness of students to learn, the availability of school of facilities and infrastructures, the suitability of learning models used or other factors. In addition, the maturity of learning plan is needed to achieve the learning objectives. It is very important that the model teachers can maximize their performance in classroom teaching. The shortcomings that arise during the LS is served as a common learning material for both the model teacher and teachers as observer. In other words, the focus in the reflection step in LS implementation is the learning activity, not on the model teacher”.

3.2 Discussion
This LS activity give an illustration that the activity does not fully give a significant influence on the successful of development of mathematics learning instrument in the form of lesson plan based on the learning path of students. Based on the narrative descriptions of the two participants, starting from the background of participant AM with the last education is bachelor of mathematics education and has been teaching for four years. According to participant AM, she can understand the character of the students through discussion with all subjects teachers in the same school. They share information about the character of students which they teach. It even gives more information to AM to provide treatment to their students than the implementation of LS. However, AM admitted that LS activity opens her knowledge of learning, although it did not directly give advantages in her teaching and learning activity.

It looks contrast to participant VA, she has the same educational background as participant AM but she has teaching experience longer, it is about eight years. VA felt the opposite. VA considers LS as a way to learn for herself and all teachers to understand the learning process in term of teachers' perspective, students, and facilities in the school. Thus they can make improvements in designing instruments in the form of lesson plans so that the next lesson can be better.

This is in line with study conducted by [13] in 2006 entitled LS as a model for building pedagogical knowledge and improving teaching where the results showed that College lesson study is an opportunity to work with colleagues on substantive issues and problems related to teaching and learning. Although instructors design only a single lesson, what they learn from the experience applies to other classes and contexts. The aim of lesson study is not merely to produce a well-crafted lesson, but also to build capacity, expertise, and knowledge to improve teaching and learning in a broad spectrum of disciplines and fields.

Researchers also made an interview to one of teachers in LS as observer. The observer explained that after one of teachers held a learning in model class, they held a reflection step where model teacher and all teachers as observer share their knowledge each other after doing the learning and how the students’ respond to the learning. Teachers as observer were also given the opportunity to give some suggestions to model teacher about everything which related to next better learning. It is reinforced by Imarotul Muhibbah’s testimony that was involved in Suzuki’s study [14], she described that through LS, she can learn about student, the way they think, the difficulties they feel, and how to make a learning instrument that not just theoretical, but also practical. This activity makes both model teacher and the knowledge of teachers as observer increase so that in next learning learning teacher can make a better learning learning and instruments and more focus to student LT.

The differences of opinion from both participants may be due to the condition of the school of each participant. Where participant AM teaches in high school while participant VA teaches in a vocational high school. With or without LS activity, it does not give big effect on the development of mathematics learning instrument, because the characteristic of AM’s students is excellent in mathematics learning achievement. The next factor which causes the difference of opinion from the two participants above is participants’ intensity in joining the LS activity. VA is more active than AM in the LS activity. For example, hardly ever did VA absent in each activities, while AM sometimes presented in each activities. This allows VA to know more details about the process in LS activity.

Differences in points of view are also the factor of this problem. AM just looks at a small thing about the usefulness of LS activity. AM more focuses on the benefits of LS activity in the progress of her classroom development. While VA views LS activity generally by looking at the benefits of LS
for all participants from various high schools and vocational high schools with different school character.

4. Conclusion

From the above discussions, LS activity has some roles in developing mathematics learning instrument based on LT. But, it depends on some factors, for example school environment, teacher’s background, and student’s characteristic. Basically, through LS activity, teachers know more about how students think, it is easier for teachers to create HLT. Related to HLT, teachers also can revise their mathematics learning instrument in the form of lesson plan. It means that LS activity is important to make a better learning instruments and focus on how student learn not on how teacher teach.

By doing LS activity, academicians and education practitioners can equate perceptions about the instruments and learning process as well as reflection materials to improve the quality of teacher professionalism, learning process, student activeness, and others. Because of time and participant number limitation, this study needs suggestion and improvement in the next study.

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