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IMPROVING STUDENTS' THINKING SKILL BASED ON CLASS INTERACTION IN DISCOVERY INSTRUCTIONAL: A CASE OF LESSON STUDY

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ABSTRACT

Lesson Study (LS) activity aims to improve teachers' professionalism using discovery-based instructional design. Teachers' professionalism was measured based on communication during the learning process, especially questions and statements from the teachers and students on various topics. Thirty-two high school biology teachers and twelve model teachers involved in this research. The procedures of the LS activity included curriculum review (up to constructing learning objectives); lesson plan making; implementation of lesson plans; communication of the results; and workshop. The research showed that LS activity changed the questioning skills of the teachers and students. Changes in the quality of teachers' questions and statements were proportionate with the changes in students' answers quality. The quality of questions and statements affected the teachers' competencies; also, improved the quality of learning as it facilitated students' thinking of learning as thinking categories.

Keywords: discovery, lesson-study, lesson-plan, thinking-category, workshop

INTRODUCTION

Teachers' competencies are related to teacher professionalism. Teacher professionalism improvement can be integrated into Lesson Study (LS) activity to increase the supports for learners in the learning process as the LS activity contributes to the development process inherently in the context of social learning, thereby enhancing professionalism (Cajkler et al., 2013). According to Dudley (2014), the LS activity is prioritized on the observations on the students' learning process. It is done to ensure mutual respect, and it established between the participants, especially in the evaluations, which are used to solve learning difficulties found in the classroom. The LS activity has been proven to improve teachers' professionalism (Ylonen & Norwich, 2013). The results of the preliminary observation showed that teachers mostly dominated the learning process. As a result, it made the students had less opportunity to questioning and bringing the argumentation.

Question is the indicator of thinking processes (Chin & Osborne, 2010; Gallagher & Gallagher, 2013; Osborne, 2013), and the answer (in the form of statements) is the parts of the argumentation that needs to interconnect the concepts (Chinn & Clark, 2013). The LS activity, which focused on the students, does not impede the mutual interdependency between

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students and teachers. Thus, the interaction, in the form of questions and statements, contains content, teacher pedagogy, and the supporting knowledge. Meng & Sam (2013) stated that LS activity could be used to improve the mastery of technological pedagogical content knowledge (TPACK). Understanding and mastering TPACK, which aim to develop collegial professionalism, depend on the teachers, students, and dynamic learning content. Therefore, the interactions that occurred in the classroom help the students to learn the content understanding comprehensively and pursue their intellectual and social goals (Little, 2012). Moreover, collegial professional development to build shared knowledge has to be followed by the commitment and hard work to enhance the personal and teaching quality which also impacted to the improvement of the students' learning quality (Lewis et al., 2012).

A study by Baki & Arslan, (2015) about the LS activity on Pedagogical Content Knowledge (PCK), showed the prospective teachers construct better lesson plans than the teachers who do not participate in the LS activity. PCK is the knowledge of teaching about the specific topic that is needed to integrate the content knowledge and pedagogical for achieving maximum results (Harris & Hofer, 2011). The components of PCK are identified in lesson plans, which improve teacher competencies, starting from understanding to developing instructional designs arranged in the lesson plans. Practical Lesson Plan focusing on the students' activities to build their knowledge independently (student-centered learning) is the visualization of the constructivist approach, which has various instructional designs.

Constructivism is a learning theory based on Piaget's, Vygotsky's, and Bruner's theories. Constructivism is an active effort of independent knowledge building, influenced by the students' experiences, backgrounds, skills, and knowledge, and enables them to understand the problems in their way (Hung, 2016; Maker et al., 2015; Schcolnik et al., 2016; Smith, 2015). The efforts to build knowledge independently mean that students should not just imitate and follow the ideas spoken by the teacher while the students remain passive during the learning process. Students' passivity during the learning process forces the teachers to reflect on and improve instructional design which has a constructive framework; one of them is the discovery (Chi, 2009).

The discovery is an instructional design used to identify cognitive interpretation through formulated generalizations (Liu et al., 2014). The use of the instructional design can significantly improve students' cognitive, affective, and psychomotor (Balım, 2009) as well as the quality of questions (Widoretno et al., 2016). Discovery makes communication in the learning process to be more constructive. Although learning outcomes are less significantly improved, the instruction and communication in the learning process will get better (Chi, 2009; Williams et al., 2013). The considerations to implement the LS activity with the discovery are: (1) learning conditions (behavioral), cognitive knowledge, and constructivism, which serves as the most basic structured foundation for planning and implementing the instructional designs, are often done improperly (Ertmer & Newby, 2013); and (2) the ability to construct and implement the instructional designs independently is an indicator of teacher competencies (Kunter et al., 2013), which affects the quality of the learning process in terms of intervention, teachers' roles, evaluation of learning processes, and students' learning outcomes (Hattie, 2012).

The discovery is a learning model recommended by the Indonesian National Curriculum of 2013, which is widely used by the teachers. Therefore, it requires an analysis of the thinking process that occurred during the learning process for actions and fundamental improvements to the learning process and the used models. The condition of teachers' and students' thinking process based on the quality and quantity of teachers' and students' questions before and after joining the LS activity was examined in this study. The research objective was to analyze the role of LS activity in the category of the teachers' and students' thinking process based on the questions and statements occurred during the learning process.

METHODS

The LS is an activity that can be used to improve teachers' professionalism and competencies. Practical collaboration with the teachers from the Subject Teacher Consultation Forum was done to assess teacher competencies to implement the discovery models using the LS. Thirty-two teachers and twelve model teachers were involved in this research. For each teacher, six undergraduate trainee teachers were assigned as observers.

The practical collaboration procedures were modified from the LS activity cycle by Lewis et al., (2006) which consists of (1) Curriculum review as the teaching guide. The review focused on the student core competencies, basic student competencies, indicators, materials, and time allocation. Curriculum review was carried out at the Subject Teacher Consultation Forum meetings in the form of collaboration worksheets; (2) Planning the learning goals to get the expected data referring to the curriculum and research objectives, how to achieve them, the strategies, the initial observations for the basis of the proposed instructional design, and rationalization of achievement. The objectives, which target as the content mastery, were constructed by the collaboration between the researchers, biology teachers, and observers in the form of workshops (Suratno, 2012); (3) The implementation of the instructional design. This was preceded by modeling by the researchers. The instructional design was determined by reflection. The reflection was oriented to analyze the rationalization of real teaching implemented by the teachers. The revised instructional design was modulated by one teacher who served as an example. Real teachings were carried out by teachers who were responsible for Biology lessons in the Tenth Grade. The observations focused on the interaction between the teachers and students in the form of statements and questions, and the implementation of instructional design stages adapted to the topic; (4) Data sharing was conducted to reflect the suitability of the instructional design using observation results of real teaching documented using videos and various data.

The observations focused on the statements and questions from teachers and students. The statements and questions were further analyzed using the Revised Bloom's Taxonomy. The categorizations of the thinking process referred to Anderson et al. (2001), Those were: remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6) on the dimensions of factual, conceptual, procedural, and metacognition. The categorizations were based on the meaning of the action verbs as the visualization of the thinking process (Krathwohl & Anderson, 2009). The teacher competencies to implement the learning design were assessed using the instruments for assessing the syntax implementation modified by Forbes (2011), and adjusted to the topic and the stages of the Discovery. Then, instructional for the discovery was based on Chi (2009) and Saab et al. (2007) consisting of (1) Orientation; (2) Hypothesis generation; (3) Hypothesis testing; (4) Conclusion; and (5) Regulation.

The LS activity was implemented in two learning cycles. The first cycle was the baseline to assess the quantity and quality of the statements and questions from the teachers and students before the treatments. Those questions and statements were analyzed according to the categorizations of the thinking process and the knowledge dimensions. The next cycle was used to observe and assess the changes in the quality and quantity of the statements and questions from the teachers and students. The real teachings were conducted by the teachers in their respective schools.

The statements and questions from the teachers and students were analyzed using the categorizations of the thinking process by Krathwohl & Anderson (2009). The percentages for each category obtained from the total of questions or statements in each category were divided by the total of questions or statements in all categories and multiplied by 100.

RESULTS AND DISCUSSION

The stages of the LS activity referred to the cycle from Lewis et al., (2006) and Lewis (2015) with four modified stages. The first was to review and determine the components of the PCK and construct the discovery-based instructional design. This stage was a collaborative workshop with the Subject Teacher Consultation Forum. The workshop did not only produce the lesson plans but was also followed by an open lesson with the discovery-based instructional design. The open lesson was then evaluated and reflected. The results were used to consider the rationalization of achievability. The workshop produced the discovery-based lesson plan, which covered all components of the PCK. The next stage was designing the lesson plan used in the open lesson. The open lesson by the participants was based on the reflection results from the Subject Teacher Consultation Forum. The next stage was to implement the open lesson in the classroom real teaching and observations.

The observations were made by undergraduate education students. The results of the observation were documented in the form of video. All statements, questions from the teachers and students, and the discovery stage completion were constructed as the results of the workshop. The next stages were the reflections based on the obtained data.

Table 1. The Percentages of the Statements and Questions from the Teachers and Students for each of the Categories of Thinking Process in Cycle 1 and Cycle 2

Knowledge Dimensions		Teachers' Questions		Students' Questions		Teachers' Statements		Students' Statements	
		Cycle 1 (%)	Cycle 2 (%)	Cycle 1 (%)	Cycle 2 (%)	Cycle 1 (%)	Cycle 2 (%)	Cycle 1 (%)	Cycle 2 (%)
Factual	C1	0.00	0.00	**1.16**	0.00	**2.33**	0.00	**1.84**	**2.69**
	C2	**1.89**	**2.78**	**1.16**	**1.67**	0.00	**1.52**	**1.84**	**1.08**
	C3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Conceptual	C1	75.47	2.78	26.74	0.83	41.86	22.73	58.90	36.02
	C2	22.64	86.11	70.93	68.33	34.88	53.03	35.58	43.55
	C3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C4	0.00	**5.56**	0.00	**20.00**	0.00	0.00	0.00	4.84
	C5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.54
	C6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Procedural	C1	0.00	0.00	0.00	**3.33**	**16.28**	**19.70**	**1.84**	**11.29**
	C2	0.00	**2.78**	0.00	**5.83**	**4.65**	**3.03**	0.00	0.00
	C3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Metacognition	C1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

The statements and questions from the teachers and students were accumulated on the C1 and C2 category, except for the conceptual one in the second cycle, which was identified as the C4. These results showed that the teachers were dominantly shifted the thinking process from C1 to C2, but in the conceptual knowledge dimension, it was shifted to C4.

The improvement in the quantity and quality was identified from the decrease in the C1 types from pre-cycle to the second cycle, and also from the increase in the C2 from the pre-cycle to the second cycle. These changes were strongly related to the changes and improvement of teachers' competencies in implementing the discovery, although these changes did not yet occur in the procedural and metacognition knowledge.

Table 1 shows the changes in the thinking process caused by the learning process with the discovery-based instructional design. Those changes were more varied as they were found across different dimensions; factual, conceptual, and procedural. Moreover, the thinking processes were identified across different categories; C1, C2, and C4. The thinking process from the C4 category on the conceptual knowledge was relatively increased. Nevertheless, some categories; for instance, C3, C5, C6, were not yet observed in this research. These categories were classified as High Order Thinking (HOT).

The LS activity, which aims to improve teachers' competencies and professionalism, is not easy to be implemented (Anak Andrew, 2012; Subadi et al., 2013; Suratno, 2012). Teachers' professionalism cannot be concluded just from the two supporting components observed during the open lesson. The student activities during the open lesson were planned by the teachers; thus, the teachers have to master the topic and the instructional design used in learning. Topics and instructional design mastery need cognitive capacity and skills obtained from teachers' educations and experiences (Kennedy, 2016). Darling-Hammond, (2014) stated the teachers' experiences determine the teachers' skills and competencies. Similar to this, Coe et al. (2014) and Dogan et al. (2016) have shown the teachers' PCK mastery determine the learning process done by the teachers. The heterogeneity of teachers' backgrounds and experiences causes different topic and instructional design mastery as well as its implementations; also, it will affect the learning process and student learning activities.

The minimum standard of teacher professionalism is the skill in constructing and implementing the lesson plan at a specific topic. Such an ability is called by Harris & Hofer (2011) as the PCK. The teachers' mastery of the PCK is indicated in the lesson plan. The components of the PCK are: (1) proper and effective learning strategy selection for specific content; (2) developing the evaluation instruments; (3) planning the learning activities; (4) determining the learning objectives; (5) making connections between various concepts; and (6) building connections between the specific contents and other supporting concepts (Celik et al., 2014; Koh et al., 2014). Based on these components, the teachers need to master the topics or concepts, the evaluation techniques, and skills to interconnect various concepts visualized in the students' activities during various stages. However, it requires quite a long time and much effort to master those components. That is why in the two cycles of the LS, the changes in the categories of thinking process were not yet appeared.

The students' unrecorded statements and questions during the open lesson do not mean showing the students' inability to think and communicate. Teachers' skills and experiences in conditioning an ideal learning situation are factors influencing the students' learning activities. In the case of the LS activity, the teachers' mastery of the PCK was used to improve their professionalism and skill to construct and implement the lesson plan. Review of the changes in the category of thinking process should not be done only to assess the students, but also to assess changes in categories of teachers' thinking process as the effect of the LS activity. Furthermore, there are challenges to internalize the LS activity in the local learning process (Grimsæth & Hallås, 2015); therefore, it needs continuous practices to achieve maximum results.

By comparing the changes in the categories of thinking process at two different lesson plans on the instructional design, the improvements were centralized on the C2 and C4 of the conceptual knowledge. It means that the LS activity for the discovery-based instructions tended to improve the questioning skill, and the questions are the core of the thinking process (Osborne, 2013; Ziyaeemehr, 2016). In other words, the LS activity with discovery-based instructional design has more potential to improve and train the students' and teachers' questioning skill, although it is not yet able to shift the thinking process to the procedural knowledge and metacognition.

Further research is required to ascertain the assumptions why the discovery-based instructional design could not shift the categories of thinking skill to the C3, C5, and C6, and procedural knowledge as well as metacognition. The first assumption is that the LS activity is designed with constructivism approach and oriented to the skill and efforts for independent knowledge building (Smith, 2015). Thus, it could not focus on reflective-applicative thinking skills. The second is the absence of instrument evaluation for procedural knowledge and metacognition. The assessment of metacognition is correlated to the content knowledge and metacognitive awareness, which needs more specific instruments (Downing et al., 2009; McCormick et al., 2012).

After analyzing the changes in the thinking process, we found out it was not linear. This non-linearity was caused by (1) difficulties to solve the complex problems found around us was a significant challenge for the teachers as they were not accustomed to utilizing it; and (2) the requires continuous habituation and practices.

On the other hand, the LS activity has helped the teachers to improve their professionalism and skills. It was seen from the improvement in the quantity and quality of the statements and questions of the teachers and students. In this case, the LS activity successfully shifted the categories of thinking process based on the statements and questions from the teachers and students. The continuous and independent implementation of the LS activity in the Subject Teacher Consultation Forum is expected to improve the acquisition of the skills such as teamwork, communication, and HOTs which are needed to face the globalization.

CONCLUSION

The LS activity aims to improve teachers' professionalism through students' active participation and thinking process by communication as a question and statement. Teachers need to master the PCK and its implementation which affected by the experience, skill, academic ability, and working environment. The mastery of the PCK through the discovery-based instructional design has improved the student thinking process in various categories. This research showed that the LS activity changed the questioning skills of the teachers and students. Changes in the quality of teachers' questions and statements were proportionate with the changes in students' answers quality. The quality of questions and statements affected the teachers' competencies; also, improved the quality of learning as it facilitated students' thinking of learning as thinking categories.

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