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Improving The Instructional Abilities of Science Teacher Candidates Through Lesson Study

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Abstract: Lesson study was a practical approach to improve the quality of instruction and use widely in professional development programs for teachers. This article presents an innovative approach to developing the instruction ability and skills of science teacher candidates when actual teaching practice in a classroom through lesson study. Based on the lesson study approach, science teacher candidates worked collaboratively to understand the curriculum and state the desired learning outcomes; design lesson plans; teach a common lesson in 4 different classrooms; and conduct reflection to share, discuss, and refine their lesson. The teaching abilities and skills are assessed based on knowledge of the subject matter, quality of lesson plans, and learning practices. The result showed that the lesson study approach was a vital structure that helped science teacher candidates improve their teaching skills and ability. The research result gives implications for development programs for science teacher candidates will be discussed in light of these findings.

Keywords: Lesson study; Science teacher candidates; Instructional ability

Introduction

The teacher candidates have some problems of practice in learning how to teach science effectively (Appleton, 2013; Darling-Hammond & Bransford, 2007; Davis et al., 2006; Davis & Smithey, 2009). The problems of teaching practice include engaging students in science, organizing instruction, and understanding students (Mikeska et al., 2009). The teacher candidates must develop a repertoire of instructional techniques, strategies, and approaches (Doering et al., 2003; Eick & Dias, 2005; Feiman-Nemser, 2001) to foster productive learning communities for effective teaching (Hammerness, 2005).

The challenges in learning to teach can also be framed as problems of practice (Lampert et al., 2013; Schwarz, 2009; Mikeska et al., 2009). The teacher candidates must learn how to teach effectively, such as engaging students in instructional activities, organizing instruction, and developing productive learning communities. Furthermore, teacher candidates must build their knowledge about the subject matter, arrange science content into teaching material, plan student activities, and teach science in a fun manner.

Several ways have prepared teacher candidates to have good teaching skills. The educational institution has an appropriate curriculum and programs to prepare prospective teachers. One of these programs helps the candidates to analyze teaching and learning in a particular context, such as teaching practice at school. Teacher candidates observe the actual instruction in authentic education or with video and conduct reflection to analyze instructional activity. Then, they allowed teaching with microteaching and reflecting on their teaching using performance assessments and portfolios (Darling-Hammond & Bransford, 2007). The other program can conduct preservice teachers engaging in multiple planning, teaching, and reflection cycles to organize education (Zembal-Saul et al., 2000). Furthermore, teacher candidates can build knowledge of teaching and confidence through observing and discussing quality science teaching practices (Rice & Roychoudhury, 2003).

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Even though teacher candidates face many challenges in content knowledge and learning how to teach effectively. Recent studies have indicated that teacher candidates have a limited understanding of subject matters (Chabalengula et al., 2011). James & Scharmann (2007) state that preservice teachers with little prior knowledge of the concepts they intend to teach often fail to focus on critical attributes of target concepts by composing their lessons around textbook definitions of scientific jargon. Regarding effective teaching, most teacher candidates struggle to bridge subject matter knowledge with pedagogy to use content knowledge to help all students learn (Ball, 2000). Ideally, teacher candidates integrate their ability to use it flexibly in authentic teaching situations (Davis et al., 2006).

One alternative program to provide knowledge and experience for teachers and teacher candidates is through lesson study activities. Lesson study is a teacher professional development model widely applied worldwide, including in learning science and mathematics. Lesson study allows teachers to develop their understanding and professional skills to improve learning processes and outcomes. The lesson study can enhance instruction by developing teacher knowledge about content, pedagogy, and student thinking. Teachers can build a professional community and improve teaching materials (Lewis et al., 2009). The teacher carries out cycles of reflective learning practices within a particular time, referring to the learning objectives set. The process included developing a lesson plan; teaching a lesson to students that are carefully observed by team members who collect data on student learning; discussing the class they observed; and revising it based on what they have learned (Lewis, 2002; Perry & Lewis, 2009; Wang-Iverson & Yoshida, 2005). Lewis (2000) describes five characteristics of lesson study for a successful practice: 1) lesson plans are developed collaboratively in groups, 2) teachers observe peer-to-peer learning practices as model teachers; 3) learning materials are directly related to daily life, 4) the implementation of learning practices is recorded, and 5) reflection is carried out on collaborative learning practices.

Lesson study can be used to develop teacher professionalism, especially in designing lesson plans (Cavey & Berenson, 2005). The results of this study indicate that growth in understanding (what to teach) leads to an increase in knowledge of teaching strategies (how to teach) as prospective teachers participate in lesson plan studies. Research by Lawrence & Chong (2010) shows that collaborative learning in lesson study activity increases knowledge, perspectives, and insights about instruction and subject content and connects daily practice to broader and longer-term goals for student learning.

For teacher candidates, lesson study can examine their efforts to conduct instruction (Sims & Walsh, 2009). Parks (2008) states that the structure of implementing lesson study provides equal opportunities for team members to view learning to produce effective learning practices. Sims & Walsh (2009) describe that teacher candidates pay close attention to learning strategies and accept suggestions and constructive criticism in developing lesson plans. Those instructional strategies include questioning techniques, anticipating student responses, and how lesson flow affects student understanding.

Although lesson study has been widely applied to develop professionalism but has not been widely used to develop teaching skills in science teacher candidates' programs. For this research, lesson study is involved in developing the ability and skills of teaching prospective students of science teachers. Teacher candidates learn to understand science content and practice teaching skills in authentic teaching with a lesson-study approach. The main problem in this research is the ability of science teacher candidates to understand the science content and how to improve their teaching skills after the workshop program.

Method

The participant consisted of six science teacher candidates from the physics education program, faculty of teacher training and education, University of Jember. Six teacher candidates in small groups work as a lesson study team who meet regularly to plan, design, implement, evaluate and refine their lessons. The lesson study process followed in each program use NSW and Malaysia model (White et al., 2007), as shown in figure 1. The first stage of the process consists of steps: problem identification, lesson planning, and lesson implementation, where the class is observed by five teacher candidates, one senior teacher, and one university instructor. The following steps are lesson evaluation and review of results. The second stage consists of reconsidering the lesson, implementing the study, and evaluating and reviewing. The final stage is the sharing of results. As a model teacher, one teacher candidate in a small group implemented their research lesson five times during the summer workshop. The remaining group members later collected data to analyze and revise the study. All team members discuss planning, implementation, and continuous revision.

The source information of this research is the group discussions which captured all contributions, questions, and issues from the participant, senior teacher, and university instructor, observation field notes, and individual group interviews conducted by a senior teacher and university instructor. The instructor has the role of a facilitator in the discussion process. All

discussion was audio-taped and recorded to make transcripts.

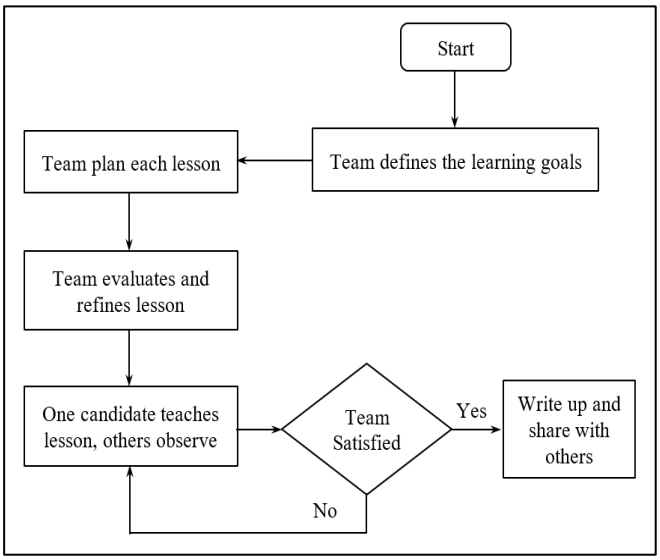

Figure 1. The steps of lesson study

The research data includes the ability of teacher candidates to understand science content, design lesson plans, and teach skills according to the lesson plan that has been designed. Data on the ability to understand the subject matter is obtained through tests conducted one day before the open class. The test results were corrected and assessed using scoring rubrics designed by researchers. Teaching materials are subject matter about temperature and heat. Those topics are moot about thermometric properties of substances, temperature scale, temperature measurement, expansion, calorimeter, and heat transfer. Data on the ability to design the lesson plan was obtained through the assessment of the lesson plan document and was scored using a rubric consisting of five aspects; 1) competency and indicator formulation, 2) selection and organization of teaching materials, 3) selection of learning resources, 4) learning strategies, and 5) assessment of learning outcomes. Teaching skills were assessed using an observation sheet and a scorecard based on an assessment rubric consisting of four aspects of teaching steps; 1) pre-learning, 2) opening lessons, 3) core learning activities, and 4) closing activities. The core activities consist of several sub-aspects, i.e., the mastery of the subject matter, the learning strategy, the utilization of learning resources, the challenging learning and spurring the involvement of the students, the assessment of the process and the learning outcomes, and the use of the language.

The goal of this research was to describe the understanding of the subject matter and instruction skills from participants. To reach that research goal, we analyze the data from various sources. The transcripts of discussions and interviews were read to allow for an understanding of the phenomena under study. The data were then organized and analyzed. The inferences were drawn regarding various theoretical concepts highlighted in the literature.

Result and Discussion

Research data is based on students' mastery of subject matter, lesson plans, and implementation of teaching practices. Lessons are designed in discussion forums with the team. The performance of learning is carried out by the model teacher (one of the students). Other students act as students during teaching practice, and the observer observes learning activities. Documentation of the implementation of learning tactics is shown in Figure 2.

Figure 2. Implementation of the lesson study

The three primary data obtained in the research include prospective teacher mastery of subject matter, planning design, and implementation of teaching practices. The subject matter taught is about temperature and heat. The results of this research are shown in Table 1, Table 2, and Table 3. The score for understanding to subject matter for the candidate as a model teacher is shown in Table 1, the score for planning the lesson is

shown in Table 2, and the score for instruction skills is shown in Table 3.

Table 1. The score of understanding for the candidates as a model teacher.

The topic of subject matter	Time of Lesson	Score
Thermometric proper of matter	The first lesson (70 minutes)	80
Scale and Measurement of Temperature	The second lesson (70 minutes)	90
Pemuaian	The third lesson (70 minutes)	80
Calorimeter	The fourth lesson (70 minutes)	70
Heat transfer	The fifth lesson (70 minutes)	80

The study results show that the teaching skill of science teacher candidates in carrying out learning are included in the outstanding category. The achievement of learning practice scores is above 70 (scale 0 - 100). The lowest value is shown by the ability of the calorimeter material, which is 70, and the highest value is on the material scale and measurement of temperature, which is 90. Lesson study requires science teacher candidates to conduct discussion and collaboration activities to analyze and improve teaching materials. All team members study the material and explain the already understood material and ask about the physics material that other team members do not understand. Various problems regarding physics material were discussed in the forum. This activity can develop knowledge of teaching material. Lawrence & Chong (2010) show that collaborative teacher learning in lesson study activity improves knowledge, perspectives, and insights about subject content, enabling the connection between daily practice and broader and longer-term student learning goals. It is used to enhance instruction by developing knowledge (of content, pedagogy, and student thinking), building teacher professional community, and improving teaching materials (Lewis et al., 2009). Students can jointly study the subject matter and how to teach it in groups collaboratively.

The ability of science teacher candidates to design lesson plans in a suitable category with a score above 3 (scale of 0 - 5). The ability to create lesson plans increases from the 1st to the last cycle (5th cycle). This result shows that lesson study can improve the ability to design the lesson plan for preservice teachers. Cavey & Berenson (2005) stated that lesson study could be used to develop teacher professionalism, especially in creating the lesson plan. The other program can conduct preservice teachers engage in multiple cycles of planning, teaching, and reflection so that they are able to organize education (Zembal-Saul et al., 2000). By involving the whole team, learning plans can be well designed. Each team member provides suggestions for improvements to the learning plan.

Table 2. The score of planning the lesson.

Lesson Plan Components	Score in Cycle				
	1	2	3	4	5
Formulation of competencies and indicators of learning outcomes:					
Clarity	3	3	4	4	5
Completeness	3	3	3	4	4
Conformity of indicator with competency	3	3	3	4	4
Selection and organization of teaching materials:					
Compatibility teaching material with competence	4	4	4	5	5
Compatibility teaching material with student character	4	4	4	4	5
Sequence and systematics of teaching material	3	3	3	4	4
Suitability of teaching material with time allocation	4	4	5	5	5
Selection of learning resources					
Compatibility of learning resources with competency	4	4	5	5	5
Conformity of learning resources with learning materials	4	4	5	5	5
Suitability of learning resources with student character	4	4	4	4	5
Teaching strategies					
Conformity of teaching strategy with competence	3	3	3	4	4
Conformity of teaching strategy with learning materials	3	3	3	4	4
Compatibility of teaching strategies with student characterm	3	3	3	4	4
Appropriateness of teaching strategy with time allocation	3	3	4	4	5
Assessment of learning outcomes					
Conformity of assessment techniques with competencies	3	3	4	4	4
Conformity test with an indicator of learning outcomes	3	3	4	4	4
Clarity of assessment procedures	3	3	4	4	4

Table 3. The score of teaching skills.

Observation Aspect	Score in Cycle				
	1	2	3	4	5
Pre-teaching					
Readiness of classrooms, tools, and teaching media	3	3	4	4	5
Checking student readiness	3	4	4	5	5
Opening lesson	3	3	3	3	4
Conformity of apperception activities with teaching materials					
Explaining competencies to be achieved	3	4	4	5	5
Teaching core activity					
A. Understanding of teaching materials					
Shows an understanding of teaching materials	3	3	3	4	4
Connecting teaching materials with other relevant knowledge	3	3	3	4	4
Explaining the teaching materials under the learning hierarchy	3	3	3	4	4
Connecting teaching material with the real life	3	3	4	4	4
B. Teaching Strategy					
Apply teaching fits the competencies to be achieved	3	3	4	4	4
Apply teaching fits the needs of students	3	3	4	4	4
Apply teaching in sequence	3	3	3	4	4
Controlling the class	3	3	4	4	4
Doing teaching contextually	3	3	4	4	4
Apply teaching that enables character development	3	3	3	3	4
Apply to teach suitable with the time planned	3	4	4	5	5
C. Use of teaching resources					
Shows skills in using the instructional media	3	4	4	5	5
The instructional media used conveys interesting information	3	3	4	4	4
Candidate uses instructional media effectively and efficiently	3	3	3	4	4
Candidate involves students in media utilization	3	3	4	4	4
D. Learning challenges and engage					
Grow student activity in learning	3	3	4	4	5
The candidate responds positively to student activities	3	4	4	5	5
Facilitating the interaction of teachers, students, and learning resources	3	3	3	4	4
Shows open behavior against student response	3	3	4	4	5
Shows an interpersonal relationship conducive	3	3	4	4	4
Fostering the joy and enthusiasm of students in learning	3	4	4	5	5
E. Assessment of process and learning outcomes					
Monitoring the progress of learning	3	3	4	4	4
Conduct an assessment suitable to the competency	3	4	4	5	5
F. Language usage					
Using verbal language clear and fluently	3	3	4	4	4
Using written languages well and smoothly	3	3	4	4	4
Inform messages with appropriate styles	3	3	4	4	4
Closing activities					
Reflecting on learning by engaging students	3	3	3	4	4
Create summaries by engaging students	3	3	3	4	4
Implement follow-up	3	4	4	5	5

Skills of preservice teachers when implementing the lesson plan in a suitable category with a score above 3 (in scale 0 - 5). Teaching skills increase from the 1st cycle to the last cycle (5th cycle). The lesson plan is done well by the model teacher. The model teacher tries to show that the learning activities that have been designed can be implemented. The obstacles arising from each learning process are revised and improved on the next. For preservice teachers, lesson studies can examine candidate efforts to conduct instruction (Parks, 2008; Sims & Walsh, 2009).

A general review based on the study results, we argue that lesson study was able to develop teaching skills for science teacher candidates in designing a lesson plan, instruction skills, and developing knowledge about the subject matter. Student candidates have the opportunity to build their professionalism because lesson study recognizes changes in beliefs about teaching and learning; allows time and opportunities for planning, reflection, and feedback to report successes and failures; and enables the participation of teachers (Clarke, 2007). Furthermore, the primary purpose of lesson study was: 1) to gain a better understanding of how students learn and teachers teach; 2) to obtain specific outcomes that are beneficial to other teachers in carrying out learning; 3) to improve systematic learning

through collaborative inquiry; and 4) build a pedagogical knowledge, that a teacher can draw knowledge from other teachers.

The implications of this research for education and teacher training programs were that lesson study can be included in the lecturing curriculum that teaches teaching skills. Lesson study promoted collaborative learning among educators to formulate a lesson plan, implementation, and evaluation of learning. Through lesson study, educators should be able to develop an understanding that can make students learn actively. Thus, it was expected to improve the quality of learning.

Conclusion

The study results show that the lesson study implementation can develop the skills of teaching science teacher candidates. Students can carry out activities collaboratively in building the ability to design learning, practice learning skills, and reflect on learning outcomes. Learning practices can be adequately implemented according to a predetermined plan. Based on the strengths and weaknesses in the implementation of learning, students can reflect on developing further learning designs. Based on the results of this study, it can be recommended that lesson study be used as a professional development program for science teacher candidates.

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