academicJournals

Vol. 9(6), pp. 164-172, 23 March, 2014
DOI: 10.5897/ERR2013.1700
ISSN 1990-3839

http://www.academicjournals.org/ERR

Educational Research and Reviews

Full Length Research Paper

Effects of lesson study on science teacher candidates' teaching efficacies

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Received 18th December 2013; Accepted 14th March 2014; Published 23 March 2014

The aim of this study was to investigate the effects of the lesson study process on science teacher candidates' teaching in terms of lesson plan content, pedagogy and classroom management based on expert, peer and self-evaluations. The participants of this case study consisted of 16 teacher candidates in elementary science education in their fourth year of school. Participants conducted a three-phase lesson presentation, and each phase was observed and commented on by experts, peers and the lecturers. All evaluations indicated positive changes in terms of lesson planning and design, creating a positive learning environment, engaging students with meaningful content, and assessing student learning.

Key words: case study,lesson study, science education, teacher education.

INTRODUCTION

Whether they realize it or not, teachers are key agents of change when it comes to educational reform, particularly with regard to teacher professional development (National Council of Teachers of Mathematics, 1991; Guskey, 2000). According to the literature, the principles of a solid, well-rounded curriculum do not always align with current teaching practices, which has prompted a shift encouraging teachers to take control of their own development in order to be successful (Konting, 1997).

The way a teacher teaches is rooted in his or her knowledge and beliefs (Putnam and Borko,1997). Shulman (1987) addressed this knowledge base by paying special attention to pedagogical content knowledge, which is used by teacher to guide their actions in a contextualized setting. This setting allows a teacher's interpretations of the subject matter while facilitating student learning (Shulman, 1987; Wilson, Shulman and Richert, 1987). The better a teacher understands a topic, the more likely she or he will be able to enhance conceptual understanding and guide problem solving, as well as improve student performance (Fennema et al., 1996). While teachers could increase this knowledge base independently, Ball and Cohen (1999) have argued that this knowledge can be increased through a collaborative community of teachers working together to design learning tasks. They suggest that a learning environment should be created in which teachers can discuss and analyze students' learning with each other, which parallels Vygotsky's theory of socio-cultural learning. Lesson study is one such practice that increases knowledge while working with peers. Lesson study began in Japan (Fernandez, 2002) and has been practiced in the US since 1999 (Stigler and Hiebert, 1999). This method of professional development allows teacher to examine their

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practices together (Lewis, Perry and Murata, 2006), as they identify a problem and study using lessons and evaluations established with their colleagues (Fernandez and Yoshida, 2004; Lewis et al., 2006). Teachers incurporate their daily work into their development by exploring and improving their pedagogical content knowledge (Fernandez, 2002; Lewis et al., 2006). Lewis, Perry and Hurd (2009) established a theoretical model for lesson study grounded in case studies. In this model, teachers' knowledge and beliefs, professional community and learning resources are developed by (a) determining long-term goals for student development, (b) studying curricula and standards, (c) adapting standards to classroom needs, (d) creating lessons that define a teacher's role and anticipates student thinking, (e) collecting data related to student activities and (f) discussing results with peers to assess goal achievement. Cumulatively, these components cover four stages: investigation, planning, research and reflection.

Literature has shown that science classrooms are one of many areas that can benefit from the lesson study approach, both for teachers and teacher candidates. Lewis and Tsuchida (1998) have explained that lesson study transcends simply improving classroom practices; it encourages teachers to link activities to broader educational goals, as they explore a variety of curricula and perspectives. Lesson study can also improve content knowledge, classroom management and teaching technique. In Japan, educators believe lesson study can even influence educational policy (Lewis and Tsuchida, 1998). Above all, lesson study guides teachers to address what students are doing and thinking during class. While an experienced teacher may be able to predict student responses and adjust teaching to fit, a new teacher may not be prepared to handle unexpected insight, unanticipated misconceptions, or even common errors. Lesson study allows new teachers to consult with veterans about both usual and atypical student responses before facilitating a lesson in the classroom.

Moreover, collaborative discussion of lesson plans and student work can increase content knowledge and the ability to see from another's perspective (Chazan, Ben-Chaim and Gormas, 1998; Jacobs, Franke, Carpenter, Levi and Battey, 2007; Sherin, 2002; Warfield, Wood and Lehman, 2005). More specifically, Dotger (2011) conducted a study in science education graduate students that demonstrated its value in improving discussions and learning about earth sciences. Rearden, Taylor and Hopkins (2005) also found that lesson study led to a greater awareness of relationships between mathematics and science. Maguire, Myerowitz and Sampson (2010) applied lesson study to studying osmosis and diffusion in cells, finding evidence that it improved effective teaching and debunked misconceptions regarding the content.

In addition, lesson study can lead to positive changes by including more hands-on experiments or in-dept discussion, both of which affect student learning (Saito, Harun, Kuboki and Tachibana, 2006). Saito, Hawe, Hadiprawiroc and Empedhe (2008) found that faculty members who used lesson study transformed their teaching styles from didactic to collaborative, but support was the key in maintaining lesson study as a daily teaching and learning practice. Cerbin and Kopp (2006) further proposed a model of lesson study in the college classroom to investigate how teachers can use it to improve teaching practices.

Drawing from the above literature with a focus on lesson study, the current research aimed to investigate changes in science teacher candidates' teaching processes in terms of content of lesson plans, pedagogy and classroom management based on expert, peer and self evaluations.

METHODOLOGY OF RESEARCH

The methodology adopted was case study, in which a researcher can examine a single setting, subject, depository of documents, or specific event (Meriam, 1988; Stake, 1994). The case being examined was an investigation of the effects of lesson study on teacher candidates' teaching processes.

Sample of Research

The participants of the study consisted of 16 elementary science education teacher candidates in their fourth year at university. All students voluntarily participated in the study. Demographics were collected through a questionnaire developed by the researcher and checked by an expert before administration. According to the results, ages ranged from 21 to 23 with an average of 21.6. Twelve participants were female, while 4 were male. The average grade point (GPA) was 3.07 (4.0 scale). All participants had teaching experience of four hours a week in an elementary school during their third years of college. In general, their experience with science education was limited to the college course Methods of Teaching Sciences; activities in this course mostly consisted of learning and discussing the science teaching program and individual lesson presentations..

Instrument

Four instruments were used to collect data in the current study. First, a demographics questionnaire asked about teacher candidates' age, gender, GPA, teaching experiences (if any), science education activities and coursework. The second instrument was the teaching practices, Skills,and reported satisfaction with performance rubric developed by Marble (2007). This rubric includes four relationship domains: lesson planning and design, creating a positive learning environment, engaging students with meaningful content, and assessing student learning. Next, a lesson observation form was developed by the researcher and checked by an external expert. The form included three open-ended questions for teacher candidates who observed lesson presentations:

1. What are your comments about the lesson plan?
2. What are your comments and recommendations about lesson presentation?
3. What are your comments and thoughts about evidences regarding students' learning?

The final instrument was a single question, open-ended survey developed by the researchers and checked by an external expert. It

Table 1. Lesson study procedures

Steps	Duration
Collaboratively planning the lesson plan	3 weeks
Seeing the lesson plan in action	1 week
Discussing the lesson plan	1 week
Revising the lesson plan	1 week
Teaching the second version of the lesson	2 weeks
Sharing reflections about the second version of the lesson	1 week
Teaching in a real classroom	4 weeks
Sharing reflections about the third version of the lesson	1 week

stated, “Please evaluate your own teaching in terms of lesson plan design, your content knowledge, and your pedagogical knowledge.”

Procedures

Lewis (2002) described five characteristics of lesson study necessary for success: (a) lessons are planned collaboratively over a period of time, (b) taught lessons are observed by other teachers, (c) lessons intend to bring to life a particular goal or vision of learning, (d) lessons are recorded, and (e) lessons are discussed and shared with others. Consequently, the current study was designed with eight steps (see Table 1).

Step 1: Collaboratively planning the lesson plan. The participants formed their own lesson study (LS) groups of four, making four total groups. Each group chose a topic in Biology from the official elementary science and technology teaching program (MoNE, 2005). Next, each group collaboratively planned a 40-minute lesson for teaching the chosen topic through the 5E learning cycle. Finally, each group planned a schedule for subsequent meetings to complete their lesson plan and activity sheets.
Step 2: Seeing the lesson plan in action. During the fourth and fifth weeks, one participant from each group taught the 40-minute lesson to peers in the teaching room while being observed by experts and remaining group members.
Step 3: Discussing the lesson plan. Following each lesson, peers and three experts provided comments and suggestions to improve the lesson plan, activity sheets and teaching technique.
Step 4: Revising the lesson plan. After discussion, the groups planned a schedule for subsequent meetings to revise their lesson plan and activity sheets based on comments and suggestions.
Step 5: Teaching the second version of the lesson. During weeks 7 and 8, the same participant from each group taught the second version of the lesson. The lesson was observed alongside the revised lesson plan and activity sheets. After the lesson, further comments and suggestions were made.
Step 6: Sharing reflections about the second version of the lesson. During week 9, the groups met to revise their lesson plans and activity sheets for a second time based on feedback before real classroom application.
Step 7: Teaching in a real classroom. During weeks 10 to 13, the same participant from each group taught the third version of the lesson in a real classroom environment. The lesson was recorded by a designated partner and evaluated by the experts and other group members. After the lesson, the peers and researcher provided additional feedback.
Step 8: Sharing reflections about the third version of the lesson. During week 14, the groups met to revise their lesson plans and activity sheets for the final time.

Data Analysis

During each cycle of lesson planning, three experts from the field of science education observed student teachings and work through data collected from the instruments. All experts held doctoral degrees, had publications in the related field, and had teaching experience. The data from the open-ended question were evaluated by the experts through content analysis, while the data obtained from teaching practices, skills and reported satisfaction via the performance rubric were analyzed by means of descriptive statistics.

RESULTS OF RESEARCH

Lectures prepared and led by the teacher candidates were evaluated by experts, peers and the candidates themselves. Results will be presented under related subheadings.

Expert Evaluation

Table 2 presents the results obtained through the analysis of the satisfaction scale scores (grades by experts) of the groups. The presentation of the Musculoskeletal System group was found to be partly adequate in the first lecture and adequate in the second in terms of creating an integrated science lesson plan connected to the standards and of developing detailed, explicit, and focused lesson plans. On the other hand, the dimensions of providing clear instructions and handouts and managing lesson pacing and transitions were found to be adequate in both lectures; there was a slight improvement from the first lecture to the second. Both lectures were partly adequate in terms of effectively manipulating materials to create a positive learning environment. The lectures were assessed according to the following three dimensions in terms of engaging students in deliberately meaningful content: using effective questioning strategies, providing opportunities for collecting and analyzing data, and structuring discussions to support meaning making. Despite improvement in the second lecture, the teacher candidate improvement in the second lecture, the teacher candidate was only found to be partially adequate in

Table 2. Experts' Evaluations of the Lectures

		Musculoskeletal System		Germ Warfare		Respiratory System		Circulatory System	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Lesson Plan and Design	Creating integrated science lesson plans connected to standards	1.33	2.00	1.33	1.67	0.00	1.33	0.67	2.00
	Developing detailed, explicit, and focused lesson plans	1.33	1.67	0.67	1.67	0.00	1.33	0.67	1.67
Creating a Positive Learning Environment	Providing clear instructions and handouts	1.67	2.00	0.33	1.67	1.00	1.33	0.67	1.67
	Managing lesson pacing and transitions	1.67	2.00	0.67	1.67	0.33	0.67	0.00	1.67
	Effectively manipulating materials	1.00	1.33	0.67	1.33	0.67	1.67	0.00	1.33
Engaging Students in Deliberately Meaningful Content	Using effective questioning strategies	0.67	1.00	0.00	1.33	0.00	1.00	0.00	1.67
	Providing students opportunities to collect and analyze data	0.67	1.33	0.00	1.00	0.00	1.00	0.00	1.00
	Structuring discussions to support meaning making	1.00	1.33	0.00	0.67	0.00	0.67	0.00	2.00
Assessing Student Learning	Creating opportunities for students to demonstrate their understandings	1.00	1.67	0.67	1.67	1.00	1.00	0.00	2.00
	Using student data to assess overall success of instruction	0.67	1.00	0.00	1.33	1.00	1.00	0.00	1.00

Note. 0.00 – 0.66 = Inadequate; 0.67 – 1.33 = Partially Adequate; 1.34 – 2.00 = Adequate

these dimensions. Finally, while the dimension of using student data to measure overall success of instruction was detected to be partly adequate in both lectures, the dimension of creating opportunities for students to demonstrate understanding was only partially adequate in the first lecture but adequate in the second.

The next group covered Germ Warfare from the Systems in Our Body unit. While the dimension of creating integrated science lesson plans connected to standards and developing detailed, explicit and focused lesson plans was found to be partly adequate in the first lecture, it was adequate in the second. Among the sub-dimensions of creating a positive learning environment, providing clear instructions and handouts was found to be inadequate during the first session and adequate during the second. Similarly, managing lesson pacing and transitions improved from partially adequate to adequate across the two presentations. On the other hand, effectively manipulating materials was partially adequate during both. The group was found to be inadequate in the first lecture in terms of using effective questioning strategies, providing students opportunities for collecting and analyzing data, and structuring discussions to support meaning making. Criticism tied to this assessment included, "(Students) should check whether answers are correct or not by themselves," and "Students were not allowed to make an analysis." The second lectures were partially adequate in terms of the same dimensions. As seen in Table 2, the dimension of assessing student learning was evaluated in two sub-dimensions: (a) creating opportunities for students to demonstrate their understanding and (b) using student data to assess overall success of instruction. For the former, the first lecture was partly adequate and the second lecture was adequate; the latter improved from inadequate during the first teaching to partially adequate during the second.

An analysis was conducted on the satisfaction scale administered for the group lecturing on the Respiratory System within the Systems in Our Body unit. Here, the dimensions of lesson plan and design were determined to be inadequate in the first lecture, based on comments such as, "There was nothing about the acquisition of cognitive process skills," and "It says 'acquisition is to be designed,' but it has already been designed." In the second lecture, these dimensions were partly adequate. The dimension of providing clear instructions and handouts was found to be partly adequate in both lectures. The dimension of managing lesson pacing and transitions was determined to be inadequate in the first lecture but partially adequate in the second. One observer explained, "It was not compatible with the plan. It was the digital story which was used first." The first lecture was partially adequate in terms of creating a positive learning environment in the dimension of

Table 3. Peer Evaluation of the Lectures

		Germ Warfare		Respiratory System		Musculoskeletal System		Circulatory System	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Creating integrated science lesson plans connected to standards		1.14	2	0.5	1.75	1.83	2	1.6	2
Student-Centered Instruction		0.4	1.3	0.9	1	1.44	2	0	1.18
Being in line with the learning method	Engage	1.25	2	0.8	1.5	1.66	2	2	2
	Exploration	1	1.3	1.2	1.5	1.6	1.5	1.5	2
	Explanation	2	2	1	2	1.6	2	1	1
	Elaboration	1	2	1	1	2	2	1	1
	Evaluation	1	2	1	1	1.4	1.5	1	1
Material Adaptation	Effectively manipulating materials	1	2	1.25	1.25	1.85	2	1.6	2
	Its alignment with the content	1	2	-	1	1.75	1.5	1	1
Teaching efficiency	Content knowledge	1	2	0	1	1.5	2	1	2
	Pedagogical knowledge	1.8	1.8	1.3	1.4	1.71	2	1.4	2
Using student data to assess overall success of instruction	Student examples	-	-	-	-	2	2	-	2
	Students' responses to the questions	2	2	-	1	2	2	-	1.5
	Students' participation	2	2	1.25	2	-	1.6	-	1.5

Note. 0.00 – 0.66 = Inadequate; 0.67 – 1.33 = Partially Adequate; 1.34 – 2.00 = Adequate

effectively manipulating materials, as explained by the comment, "It might have been so, if the same material had been provided for all students, but it was not." The second lecture was detected to be adequate in terms of creating a positive learning environment. While the dimensions of using effective questioning strategies, providing students opportunities for collecting and analyzing data, and structuring discussions to support meaning making were inadequate in the first lecture, they were partly adequate in the second. Finally, both sub-dimensions of assessing student learning were found to be partly adequate in both lectures.

The third group lectured on the circulatory system as covered in the systems in our body unit. The first lecture was determined to be partly adequate in terms of creating integrated science lesson plans connected to standards and developing detailed, explicit and focused lesson plans, but the second lecture was adequate. The dimension providing clear instructions and handouts was found to be partly adequate in the first lecture but adequate in the second. While the dimensions of managing lesson pacing and transitions, using effective questioning strategies, effectively manipulating materials, and providing students opportunities for collecting and analyzing data were determined to be inadequate in the first lecture, the first two of these dimensions were adequate in the second, while the others were partially adequate. The dimensions of structuring discussions to support meaning making and creating opportunities for students to demonstrate their understanding were found to be inadequate in the first lecture but determined adequate in the second. The dimension of using student data to measure overall success of instruction in terms of assessing student learning was detected to be inadequate in the first lecture but partly adequate in the second.

Peer Evaluations

When reviewing peer evaluations, the first and second lectures of each group were analyzed within themselves and tabulated (Table 3).

The first lecture on Germ Warfare was found to be partly adequate in terms of the dimension of creating integrated science lesson plans connected to standards. Student statements support this finding, such as, "Some

of the concepts indicated in acquisitions were conveyed wrongly," and "Since microbes could not be seen with eye, video method was a good choice, but not enough for acquisition." The dimension of creating integrated science lesson plans connected to standards became adequate in the second lecture. As one observer indicated, "Content was lectured in such a way that students could understand it." While the subject of the respiratory system was considered inadequate in the first lecture in terms of creating integrated science lesson plans connected to standards, it was found to be adequate in the second lecture. The statement, "The subject was independent from the acquisition. It could have been better if the lecturer had taken the acquisition as basis more" is an example supporting the inadequacy of the first lecture, while the statement, "Content contained few information deficiencies," supports the partial adequacy of the second lecture. On the other hand, both the Musculoskeletal System and Circulatory System lessons were determined to be adequate in terms of the dimension of creating integrated science lesson plans connected to standards in both lectures. The statement, "Lesson plan was implemented fluently in accordance with the subject" supports these findings about the musculoskeletal system, while the statement, "It was an acquisition-oriented presentation, but there was information deficiency" which indicates the findings about the circulatory system. In addition, the comment, "Lesson contained fine arrangements in accordance with 5E model." was made about the second circulatory System lecture, demonstrating its adequacy.

The first lectures on Germ Warfare and the Circulatory System were found to be inadequate in terms of student-centered teaching. As on observer noted, "I think the active participation of students in lesson may provide better conditions." Further comments are more explicit: "The lecture appeared to be teacher-centered to me somewhat," "Teacher was in the forefront," and "Students could have been more active." However, with regard to the second lectures, an observer stated, "The lecture was teacher-centered in the beginning, but then it became student-centered towards the end." In this dimension, both second lectures on the musculoskeletal system and respiratory system showed a slight improvement. The comment, "Lesson was made student-centered, which prevented students from getting bored and made the learning process entertaining," supports this finding.

Another dimension of evaluation was compatibility with the phases of the teaching model used in the presentation. The first phase, or the engage phase, of the first lectures on germ warfare and the respiratory system were considered partly adequate. Regarding germ warfare, one observer stated that the "engage phase appeared to be deficient somewhat." The second lectures were deemed adequate in terms of the engage phase. The comment, "Engage phase was interesting, but the digital story used was not good enough," supports this finding. The engage phase was deemed adequate in both lectures on the circulatory system and musculoskeletal system, which is supported by two statements about the first lecture: "Attention getting was fine in the engage phase," and "The mind map used in the beginning was nice." The comment, "It was good that foreknowledge was tested in the beginning," indicates the above-mentioned finding about the second lecture.

The explore phase was determined to be partly adequate in the first lecture on the subjects of germ warfare and the respiratory system, while it was deemed as partially adequate and adequate, respectively, during the second lectures. The comment, "However, I think more effortful activities should be arranged for the explore phase," is evidence of the above-mentioned finding for the respiratory system. A supporting comment for the second lecture on germ warfare is as follows: "I think it could have been more effective if some activities had been carried out or students had been used in the explore phase." On the other hand, both lectures on the circulatory system and musculoskeletal system were found adequate. One observer stated, "It was good that students saw the heart in the explore phase."

The explain phase was considered adequate in both lectures on germ warfare and the musculoskeletal system. One supporting statement is as follows: "I think the balloon experiment conducted and the game played in the explore phase achieved the goal." While the first lecture on the subject of the Respiratory System was deemed partly adequate, the second lecture was adequate. The explain phase remained partially adequate in both lectures on the subject of the Circulatory System.

The elaborate phase was found partly adequate in the first lecture on germ warfare, but it was detected to be adequate in the second lecture. Some supporting statements in this matter are as follows: "The examples and the analogy table provided were fine," and "The digital stories and videos used during lecture were effective for understanding the subject." On the other hand, that phase was determined to be partly adequate in both lectures on the Respiratory System and Circulatory System. That phase was found to be adequate in both lectures on the subject of the Musculoskeletal System. Some supporting comments for this dimension are as follows: "The examples provided in the elaborate phase were fine," and "The example given by Hediye about calcification suffered by her grandfather through digital narration provided in the elaborate phase shows that we can face such a problem in our real lives, too."

The evaluate phase was found to be partly adequate in both lectures on the Respiratory System and Circulatory System. Similar comments were made in this matter. Some examples are, "Evaluate phase could have been extended more," and "Evaluate phase was deficient." The comment, "Evaluation ended with question-answer and mind map. Some other things could have been included," further supports the above-mentioned finding for the

Table 4. Self-Evaluation of the Lecturers for Their Own Teachings

		Germ Warfare			Respiratory System			Circulatory System			Musculoskeletal System		
		1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Creating integrated lesson plans connected to standards		1	2	3		2	3		1		3	3	2
Student-centered instruction						2	3	1	2	2	1	2	1
Being in line with the learning method	Engage	1	2	3				2	2	3	2	2	3
	Exploration	1	2	3				2	2	3	2	3	3
	Explanation	2	3	3							2	3	2
	Elaboration	2	3	3				1	2	3	2	2	2
	Evaluation	2	3	3				1	2	3	3	3	3
	Overall	1	2	3	1	2	3	1	2	3	1	2	
Teaching efficiency	Content knowledge				1	1	2				3	3	3
	Pedagogical knowledge				1	2	3		2		3	3	2

Note. 1 = inadequate, 2 = partially adequate, 3 = adequate

second lecture on the circulatory system. Both lectures of the musculoskeletal system group were determined adequate. On the other hand, the first lecture for germ warfare was considered partly adequate, while the second was found to be adequate.

While the dimension of effectively manipulating materials was deemed partly adequate in the first lecture on germ warfare, it was determined to be adequate in the second lecture. The same dimension was found to be partly adequate in both lectures on the respiratory system, while it was graded as adequate for the circulatory system and musculoskeletal system groups. The comment, “More materials could have been used to ensure learning,” was put forward for the first lecture on the circulatory system, referring to its partial adequacy. “It was good that the heart was brought as a real material,” and “Interrelated visual materials provided during the presentation were fine,” support the adequacy of the second lecture.

The presentations that were inadequate in terms of content knowledge in the first lectures were partly adequate in the second lectures. In addition, those presentations which were partly adequate in terms of content knowledge in the first lectures were adequate in the second lectures. The comments, “Teacher had imperfect topic knowledge,” and “Presentation was good, but teacher did not have much content knowledge” were made for the first lecture on the Circulatory System, while another observer indicated, “I do not think teacher provided imperfect information” for the second lecture on the same subject.

The dimension of pedagogical knowledge was mostly deemed adequate in the first lectures in a way similar to other dimensions; it became adequate for all groups in the second lectures. A similar tendency was evident in the dimensions of using student data to assess overall success of instruction. Two comments support this finding for germ warfare's first lecture: “Presentation was fine. Teacher had some difficulty in summing up the subject because of excitement,” and “Lecturer had some deficiencies because of excitement. The lecturer adjusted his tone of voice perfectly, which enabled him to make a good presentation.” About the second lecture, the comment was made, “Teacher had a good command of the lesson during the presentation.” The statements, “Students gave unique answers,” and “Students dealt with their worksheets by themselves” are indicators of learning from the second lecture on germ warfare.

Self-Evaluations

Table 4 presents the self-evaluation scores of the lecturers. The evaluations made by the lecturer on germ warfare show his opinion that the first lecture did not reflect the 5E model exactly. However, he made the following comment about the second lecture: “I think I reflected the acquisition onto 5E model well.”

The lecturer indicated the inadequacy of the engage phase of the first lecture by saying, “The questions asked in the beginning did not cover the entire subject,” and “The pictures showed to students contained naming likely to cause misconception.” The lecturer felt that these deficiencies were later eliminated: “We corrected them, removed wrong misnaming, and prepared new questions for the second lecture.” On the other hand, the lecturer

found himself inadequate in terms of the explore phase of the model. However, he said that all these issues were resolved during the third, internship lecture. The lecturer further stated that the digital story that was considered inadequate in the explain phase of the first lecture was improved in the second lecture. They used video in the elaborate phase during the first lecture but not the second: “In the first lecture, we presented students a video about cleaning materials and hand cleaning for elaborating purposes. However, in the second lecture, the video was replaced by analogy.” The lecturer stated that the first lecture was partly adequate, but the second and the third lectures were adequate in terms of evaluation.

The evaluations made by the lecturer on the respiratory system show his opinion that he was inadequate in almost all dimensions in the first lecture. He attributed this rating to the fact that he had not prepared for the lesson sufficiently and that he had experienced some communication gaps with his group. According to the lecturer, there were mistakes in terms of acquisitions, and he had insufficient content knowledge. During the lecture at school, the only problem was about timing, which resulted from communication problems with the teacher. He made the following comment: “I think the lecture at school was better than others.”

The student who covered the circulatory system stated that motivation was generated in the engage phase in the first lecture, and he considered this stage partly adequate. The second lecture was also scored as partly adequate because he got excited in the beginning. In brief, the lecturer felt that he had some deficiencies in the phases of learning model in the first two lectures. Otherwise, he explained that he learned how to use time effectively and manage a classroom during the real lecture. He mentioned that students were not active in the first lecture, so an attempt was made to make them more so in others.

The student who lectured on the musculoskeletal syst em thought that he was adequate in terms of assessment and compatibility with the plan in the first lecture, but he was only partly adequate during the third lecture. During the final lecture, he considered his presentation adequate in terms of many phases; however, he found the lecture partly adequate in the elaborate phase. He attributes the reason to the deficiencies in the digital stories used. The lecturing student indicated that he had some problems during the lecture at school: activities took longer than planned, students sitting in the rear of the classroom could not actively participate, and there was an inconvenience about time management. Some comments of the lecturing student in this matter are as follows: “Students were not able to complete the activity in a short time. I noticed that some students had difficulty. I tried not to ignore the wrong answers given by students to the questions, so I explained the true information to them, which took quite a long time,” and “I failed to activate those students who were sitting in the rear section of the classroom during the lesson.”

DISCUSSION AND CONCLUSIONS

The aim of this study was to investigate the effect of the lesson study process on science teacher candidates’ teaching in terms of the content of the lesson plan, pedagogical aspects, and classroom management based on the expert, peer, and self-evaluations. The results obtained through this study were limited by the data coming from the 16 teaching candidates and the data collection tools.

Among the results of the study was that the experts’ evaluations indicated a positive change in teacher candidates’ teaching in terms of lesson planning and design, creating a positive learning environment, engaging students with meaningful content, and assessing student learning. Similarly, Marble (2007), who conducted a lesson study model with science teachers, also showed dramatic improvements in lesson design and delivery, management of the learning environment, quality of students’ engagements with meaningful content, quality of assessments, and generation of student data. Although it was not evident in this study, Chiew and Lim (2003) also indicated that LS improved the teacher candidates’ content knowledge besides their pedagogical content knowledge.

Moreover, peer evaluations of the teacher candidates also indicated improvement in terms of lesson planning and design, creating a positive learning environment, engaging students with meaningful content, and assessing student learning. These results were not unexpected, since the literature provides examples showing that lesson study improves the content of lessons and develops teaching skills (Alvine, Judson, Schein and Yoshida, 2007). According to Dotger (2011), among the benefits of the LS approach, the greatest was the regular forum LS provided for teacher candidates to explore their ideas about teaching by defining a context for practice and constructing a structure for new discourse. Lesson study also increases teachers’ experience levels by allowing them to learn from the experience of others, which, in turn, improves the content of the lessons.

Finally, the results of the current study highlighted that the teacher candidates own evaluations of their teaching implied improvement in lesson planning and design, creating a positive learning environment, engaging students with meaningful content, and assessing student learning. Being in line with the current results, Fernandez and Robinson (2006) found that LS approach helped the prospective teachers to value the opportunity to apply in practice what they were learning in theory. Moreover, peer feedbacks allowed them to think differently about teaching after engaging in LS. Similarly, in a study conducted with mathematics and science teachers, Ono and Ferreira (2010) revealed that the teachers who were involved in lesson study benefited from the approach and

improved their lessons. Moreover, Saito et al. (2006) revealed that the lesson study process improved the academic base of lessons and affected the structure positively by the introduction of experiments or manual activities and discussions.

The results obtained from this study will be beneficial for educational policy makers to consider implementation of the lesson study approach by means of seminars and in-service education applications. Moreover, integrating the lesson study process inside teacher education programs will also contribute to preparing future teachers. Further studies investigating the implementation of the lesson study approach in different education levels and areas of expertise will reinforce the results of the current study. In conclusion, an acknowledgement occurs about limitations in making any generalizations from the results of the current study which was designed as case study and included a limited number of participants who contributed through self-report questionnaires.

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