International Conference on Mathematics, Science and Education 2017 (ICMSE2017)

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Preface

It is a very great privilege for Faculty of Mathematics and Natural Science (FMIPA) Universitas Negeri Semarang to host the 4th International Conference on Mathematics, Science, and Education (ICMSE 2017) in Semarang, Central Java, Indonesia on 18-19 September 2017. We are honored to have the opportunity to work with Indonesian Chemical Society, Indonesian Physical Society, Indonesian Biology Society, Association of Computer Science Higher Education, Indonesian Mathematical Society, and Indonesian Educator Science in this forum. In 2017, our theme of "Roles of Mathematics and Science Research in Supporting Growth of Sustainable Natural Resources-based Industries" celebrates the annual conference to provide a platform to the researchers, experts and practitioners from academia, governments, NGOs, research institutes, and industries to meet and share cutting-edge progress in the field of mathematics, natural science, and science education. Also, this event provides an opportunity to enhance understanding of relationships between knowledge and research in the scope of Mathematics, Biology, Chemistry, Physics, and Science Education.

The committee of ICMSE 2017 would like to express the sincere gratitude to the keynote speakers and all authors of the contributed papers in the conference proceedings. Moreover, would like to thank the expert reviewers for reviewing the manuscripts. We also highly appreciate the assistance offered by many volunteers in the preparation of the conference and the proceedings, and of course, to the sponsors assisting in funding this conference.

The committee selected 205 papers from 253 papers and reports findings presented in this forum to be published in **Journal of Physics: Conference Series (Institute of Physics Publisher)** indexed in some databases, including the Conference citation index, Scopus, Inspec, Chemical Abstracts Service, and Astrophysics Data System. We hope that this program will expand the mutual understanding and respect in stimulating research in Mathematics, Science, and Education; share research interest and information, and create a form of collaboration and build a trust relationship. We are delighted to be able to show the world what recent developments in the field of Mathematics, Natural Science, and Science Education through this fruitful program.

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Improving pedagogic competence using an e-learning approach for pre-service mathematics teachers

Improving pedagogic competence using an e-learning approach for pre-service mathematics teachers

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Abstract. This article reported a classroom action research that was aimed to improve student's pedagogic competence during a course namely Methods of Mathematics Instruction. An asynchronous e-learning approach was provided as supplementary material to the main lecture. This e-learning consisted of selected references and educational website addresses and also facilitated online discussions about various methods of mathematics instructions. The subject was twenty-six pre-service teachers in the Department of Mathematics Education, Yogyakarta State University, Indonesia, conducted by the researchers. The research completed three cycles, where each cycle consisted of plan-action-reflection. Through observation, documentation, and interview, it was concluded that asynchronous e-learning might be used to improve pedagogic competence when direct instruction is also applied in the classroom. Direct instruction in this study provided review, explanation, scheme, and examples which could be used by students to select relevant resources in the e-learning portal. Moreover, the pedagogic competence improved after students accomplished assignments to identify aspects of pedagogic instruction either from analyzing videos in e-learning course or simulating in the classroom with direct commentaries. Supporting factors were enthusiasm, discipline, and interactions among students and lecturer that were built throughout the lectures.

1. Introduction

Department of Mathematics Education at the Yogyakarta State University (YSU), Indonesia has objective to graduate mathematics teacher candidates (i.e., pre-service teachers) who are competent in four domains: pedagogic, social attitude, exemplary personality and professional [1]. These four domains of competency refer to the national standard of teachers [2]. In this department, pedagogics competency is specifically taught in a three-unit course named Methods of Mathematics Instructions. Commonly, this course was given using lecture method where students met the lecture regularly in a classroom. Using this conventional method, it often was found students were mentally unprepared to attend the learning material, hesitated to ask/answer, and under-performed in the following course such as peer-teaching practicum. Enthusiasm and internal motivations to obtain pedagogic knowledge independently were unlikely shown. Considerably, it might be said this lecture method did not fully support students to improve student's knowledge about the content of the pedagogic skills as well as provide a good example of teaching practice.

It is important that instruction should facilitate not only the development of cognitive and meta-cognitive but also social skills [3]. Cognitive skills are the ability to gain understanding, construct knowledge, and use them to identify problems, solve problems, explain and elaborate solutions. Metacognitive that is a skill to monitor their prior knowledge is useful to develop independent learning. It scaffolds learners knowing their level of achievement, identifying weak areas of learning and developing self-regulation [4]. Social skills involve the ability to interact interpersonally, externalize ideas, discuss problem solutions in small groups, and also communicate with others mutually. These skills may be learned when teachers give the opportunity to students to work on ill-defined problems, discuss and present the results to the classroom [5]. Obviously, these skills are not facilitated in such conventional lecture method where information flows in a one-way direction.

Furthermore, information and communication technology (ICT) has been applied in classrooms by many educators. An example of ICT based teaching is called *e-learning* [6]. This may be used as a supplement of regular classroom lecture in an asynchronous strategy [6], complementary with other learning media when designed thoughtfully [7, 8] and has been shown improving self-regulatory learning skills [9].

The university (where the research was conducted) in fact has supported the application of e-learning in the classroom and campus environment [10]. A classroom action research provides a tool to see and evaluate the implementation of the innovative method [11] and to prove the theory. More importantly, since it is critical that the pre-service mathematics teachers should master pedagogic knowledge and competence pedagogically [12, 13], improvement of the lecture of Methods of Mathematics Instructions becomes urgent. Therefore, the authors, who were also the course convenor, applied action research in the course focusing on whether the student-centered instructional procedures can improve student's pedagogic knowledge and how far students could obtain the pedagogic knowledge utilizing the asynchronous e-learning strategy.

2. Theoretical background

2.1 Pedagogic Competence

Pedagogy is often understood as the knowledge of teaching, covering not only how to develop instructional strategies, resources and curricula, but the mathematics content and especially the pedagogic-mathematics knowledge [12, 13]. Teaching needs preparation on the learning material, media, tools and technology, strategies in delivering these based on the structure of the knowledge and instructions that satisfy student's existing knowledge to guarantee smooth cognitive process [14]. Comprehensive understanding of pedagogic knowledge will considerably assist teachers.

Pedagogic knowledge may be categorized into conceptual (or declarative/factual) knowledge and also procedural knowledge when it comes to planning the lesson [4, 18]. Acquiring this knowledge can be proposed either using a direct or indirect approach [14-16]. The direct approach is used when teachers facilitate students with explicit instructions, enable students to directly acquire the knowledge from the given information, either using modeling, step-by-step guidance, guided questionings, or worked-example [14, 16, 17]. On the opposite, an indirect approach is used when information is provided implicitly to students. Students, usually in small groups, are expected to discover the knowledge grounding on the activity of problem-solving provided by the teacher. The later is often called as discovery learning or problem-based learning [14-16].

2.2 Asynchronous E-learning

Electronic learning (frequently called e-learning) has been developed since the network technology is invented. It does not have to be distant learning, but a technology supported learning, such as by computer programs [6]. According to the mode of teacher-student meetings, it is known synchronous e-learning (virtual class) and asynchronous e-learning. Nevertheless, the activity in the e-learning should refer to instructional strategies that promote meaningful learning [6, 7, 19], which means teachers should analyze learner characteristics, design the presentation of the learning material and conduct e-learning in accord with students cognitive level, needs, and motivations.

Implementing asynchronous e-learning may be similar to having a flipped classroom or blended teaching method, depending on the presentation of the e-learning. This new way of teaching attempts to embrace students in independent yet active learning [20, 21].

3. Methods

A classroom action research [11, 22] was conducted to study the improvement of pedagogic competence of pre-service teachers at the Department of Mathematics Education, Yogyakarta State University. The research was collaboratively organized among six lectures (the researcher), not only to employ them as the planner, observer but also evaluator during research. This research activity may be similar to a professional development program, namely lesson study [23-25].

Using the Kemmis and Taggart's action research model, there were three steps in every cycle of the lesson: plan, act and observe, then reflect. Plannings involve the analysis of the learning material, preparation of activity in the classroom and the e-learning. Then in the acting and observing, one of the lectures (authors) conducted the lesson and the others observed and documented the lesson activity. The observation sheet was adopted [26] that was focused on student activity and interactions during learning. During reflecting, the researchers discuss what work and did not, how the pedagogic knowledge was facilitated, how much students perform their new knowledge. The focus of observations is elaborated in Table 1 below.

Table 1. Focus of classroom observation

No.	Part of activity	Focus
1.	Opening	Readiness to present in classroom
		Internal motivation to actively attend the activity
2.	Main activity	Interactions among students
		Interactions between students and lecturer
		Content relevancy of students questions/commentaries
		Efforts students try during presenting their learning results
3.	Closing	How conclusion is withdrawn

The data was collected by written assignments and oral presentations and were particularly used to describe the improvement of the pedagogic knowledge.

4. Result and Discussion

Three cycles of classroom action research are reported. The main objective of the research was to see the improvement of pedagogic knowledge when asynchronous e-learning is implemented. In this research, the learning processes conducted classically supported by e-learning to finish the assignments outside the classroom. The assignments were discussed in group, and the results were presented in class.

4.1 Description of Cycle 1

In the first cycle, the learning was conducted by giving the freedom for students to choose various articles in e-learning portal provided as presentation sources. Using direct learning approach, the students received explanation and example directly so that they could understand the pedagogic aspects of learning.

(1) **Plan**, the first meeting was filled with discussions regarding course descriptions, *learning outcomes* expected, the lecture material which has been run, learning schemes, student characteristics, problems faced and action plans. (2) **Do**, lecture at this stage was conducted in three times 'do(s)'. At each 'do', lecturer provided an initial review of the previous lecture, and then there were two groups of students presented the results of their understanding through *e-learning* and discussion group. (3) **See**, the following is a summary of observations of the 'do' step about the lecture in cycle 1 is the seating was set as the letter U, where all students and lecturer facing the front of the class (whiteboard) and a lecturer position was in the middle of students. This setting facilitated group presentation to the class, as shown in the photo below.

Figure 1. U-shape seatings

The results obtained from student learning through e-learning and presenting in the class were said not satisfactory yet. A large part of the students still only understand the aspect of the approach/method / strategy at a fundamental level, the study of philosophy.

Based on the result of reflection question, the student left comments in one of the e-learning portal (online forum) and interviews with students; it might be concluded that the students do not understand the pedagogical competence yet.

(a)

(b)

Figure 2. (a) Students had presentations and discussions, (b) the lecturer gives confirmations

4.2 Description of Cycle 2

In the second cycle, students examined the pedagogical aspects of learning recorded by video. Recording of the videos of mathematics learning was provided in the e-learning portal followed by numerous articles on mathematics education. Students were given the task to identify the pedagogical aspects and to present the results.

(1) **Plan**, the results of 'see' in cycle one was used to draw up action plan and lectures in cycle 2. Cycle 2 was carried out in succession after the end of cycle 1 (without pause or inserts lectures instead). Based on the results of previous 'see', the following was planned for the cycle 2. (2) **Do**, just as in the first cycle, the second cycle was carried out three 'do(s)'. At each 'do', lecturer gave a preliminary review of the results of previous lectures, as planned that is expository explaining about learning development schemes. (3) **See**, the following is a summary of observations and *lesson study* team discussions about the results of the implementation of the course in cycle 2. The setting of seating remained the same as in the first cycle, which is U-shaped with a lecturer position in the middle of the students. Based on the result of 'see', it can be reflected that e-learning is a good strategy in the lecture for a given task because it can stimulate students to look for the source of active learning.

4.3 Description of Cycle 3

In the third cycle, students developed pedagogical competence that has been owned by direct involvement in the planning of learning mathematics, simulating and reflecting. The results showed that compared with the reflection of the previous lecture, with this strategy there are more aspects that can develop pedagogical competencies.

(1) **Plan**, the results 'see' in the cycle two was used to draw up action plan and lectures in cycle 3. The action taken was aimed at developing the pedagogical competence of students through planning an educational mathematics learning and carrying out the "mini" *lesson study* or learning simulations. (2) **Do**, three times of 'do(s)' undertaken in this third cycle. In any 'do', there is one group that organizes learning planned. Topics taken by these three groups are comparison and scale (Grade VII), the area of the irregular shape (Grade VII) and system of linear equations of two variables (Grade

VIII). (3) **See**, in this stage is a summary of observations about the results of the implementation of the course in the cycle 3.

To sum, the implementation of the instruction covered in three learning cycles as described above, the enthusiasm of students in learning was great. This supported the readiness of the students in learning. Also, the U-shaped seating with a lecturer position in the middle of the students supported the interactive communication between the lecturer and students.

5. Conclusion

The e-learning in this classroom action research consisted of a collection of selected learning material that can be accessed by students outside the classroom using their study time and pace. The implementation of the asynchronous e-learning was found improving the pedagogic knowledge facilitated to acquire independently by students, in addition to the explicit instructions given in the classroom. The e-learning provided a learning source which motivated students to explore their knowledge of pedagogy. During classroom learning, students were provided with a direct review of their learning results, explanations, cognitive scheme, examples and some guided questions. The mathematics pedagogic competence improved considerably when students were learning from videos of teaching.

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