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REDESIGNING PRESERVICE MATHEMATICS TEACHER'S LESSON PLAN BY USING PRODUCTIVE PEDAGOGIES FRAMEWORK

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Abstract

This paper aims at describing an innovative course which encourages presevice teachers to reflect on their quality of instructional plan as well as its implementation within a field teaching experience and to redesign lesson plan based on the four dimensions of the productive pedagogies framework. The participants were 25 Mathematics preservice teachers who were studying at Mathematics education program at an educational university in Indonesia. The course started from implementing a lesson plan designed in the field teaching experience, continued with a reflective practice discussing about the conformity of the lesson plan designed with the four dimensions of productive pedagogies, and ended with revising of the lesson plan based on the reflective practice activity. Some improvements regarding productive pedagogies components for redesigning lesson plan have been produced by the preservice teachers. However, some were hardly revised due to factors of students, particularly dealing with higher order thinking in redesigning lesson plan. This study suggests to use productive pedagogies as tools to evaluate and implement teachers' instructional plan to confirm its consistency and the real practice.

Keywords: Preservice mathematics teacher, Productive pedagogy, Lesson plan design.

1. Introduction

Reforming pedagogy in Mathematics education has been gaining much attention by educators around the world. To address such attention, educators such as Bature [1], Chinnappan [2] have employed the so called 'productive pedagogies' as tools to evaluate the quality of teaching held by either teachers or preservice teachers. Productive Pedagogy is a framework for reflection on teaching that aims at

improving students' intellectual reasoning, making teaching and learning more connected to students' daily lives, and addresses the concerns of equity support.

Productive pedagogy stresses on the interrelated aspects of teaching and learning. In particular, we utilize the conceptual work of productive pedagogies that is encouraged by pervasive practice of such pedagogies and the external supports of particular professional learning community [3]. By exploring the productive pedagogies deliberated by teachers, students' learning and teachers' teaching performance could be enhanced within its assessment and pedagogical practices. Current research by Alsharif and Atweh [4, 5] suggested that productive pedagogies were used as framework to improve Preservice Teachers' practices during their field experience. Preservice teacher is student teachers before they have undertaken any teaching. They focused on one dimension of productive pedagogies such as intellectual Quality dimension and its observation on teaching practice. There is still a need for using all elements of productive pedagogies framework for reflection on the preservice teachers' teaching practice. This is due to the need for preservice teachers to have a better opportunity to integrate theory and practice when they are introduced to reflection on teaching practice directly using productive pedagogies framework [6]. Also, this is to encourage teacher education programs in helping preservice teachers to reflect on and analyse their own teaching practices in order to improve their skills of teaching [7]. Thus, we studied about developing pre-service Mathematics teachers' knowledge and ability to come with better lesson plan design with productive pedagogies framework as tools toward effective teaching.

The preservice teachers' understanding was also investigated by through several lesson plans they had developed and had implemented in their teaching internship period. We adapted 20 elements of productive pedagogies constructed by a team of educators from Queensland University and written by Lingard et al. [8] for the exploration. The exploration of the pre-service teachers' understanding was not only towards the productive pedagogies framework but also through the tasks developed. We therefore devised a syllabus of the course of Development of Instructional Material II that accommodates students to develop their lesson plan for effective teaching with regards productive pedagogies framework. In this course, students also do some reflections on the developed lesson plan in the period of teaching internship program. The exploration drew on the task that was developed in their preservice Mathematics teachers' responses and understanding on each element on the four dimensions of productive pedagogies framework as well as through their works on lesson plans about how they implement the elements of productive pedagogies framework.

2. Productive Pedagogy

The concept of productive pedagogy was utilized by Queensland School Reform Longitudinal Study (QSRLS) commissioned by Department of Education Queensland [9]. It is defined as a balanced theoretical framework enabling teachers to reflect critically on their work. The concept of productive pedagogy was developed out of the research in both conceptual and empirical terms [8]. The framework could assist teacher to do reflection on current classroom practices for getting better design curriculum and learning experience. Besides, it could help in structuring the observation in classroom so that the evaluation of quality of teachers' practice emerged.

There are four dimensions of the productive pedagogies frameworks, i.e., intellectual quality, connectedness, supportive classroom environment, and recognition of difference. Those dimensions consist of twenty elements of attributes which are potentially observable within any classroom level. Intellectual quality is considered as the first dimension. The rational is that some students do not achieve high academic performance because school does not always require students to perform work of high intellectual quality. There are six elements of intellectual qualities, i.e., higher order thinking, deep knowledge, deep understanding, substantive conversation, knowledge as problematic, and meta language. Several studies related to elements of intellectual quality were undertaken. For instance, as reported by Oakes et al. [10], the main reason for the unsuccessful students in achieving high academic performance was that schools did not always require students to perform work in high intellectual quality.

Meanwhile, Newmann et al. [11] described that students' academic performance increased while performing high intellectual quality. The second dimension of productive pedagogies is connectedness. It consists of knowledge integration, background knowledge, connectedness to the world, and problem based curriculum. By the elements of the connectedness dimension, students can be engaged with real, practical, or hypothetical problems that connect to the world beyond the classroom that is also linked to students' prior knowledge. Lingard et al. [8] found that connectedness dimension was also correlated with students' academic performance. The dimension of supportive classroom environment can provoke students to influence the teaching activities and consider the expectation of the achievement. Mills and Goss [12] suggested the creation of supportive classroom, in which students are given a chance for their voice in the classroom in order to have some say within various units of works. Finally, the dimension of recognition of difference regards students to consider a range of cultures, respect others and create a sense of community. There are some problems with regard valuing diversity such as whose diversity are worthy of support and whose are not.

3. Method

This study is a descriptive study that used a qualitative approach. The work was conducted in the course of Development of Instructional Material II at Department of Mathematics at Universitas Negeri Surabaya (Unesa) which is one of teachers' training university in Indonesia. This course is a continuation of teaching internship program that was followed by all preservice teachers. The participants were 25 pre-service Mathematics teachers who already had experience in designing lesson plan as well as implementing it in the classroom during the teaching internship period in year 2015. Figure 1 shows the learning trajectory of the offered course that was conducted.

In the learning process of Development of Instructional Material II, the productive pedagogies framework was introduced and discussed. All participants said that the initial lesson they developed were based on their experience, the knowledge gathered from innovative teaching course and other sources. In the first activity, lecturer explained about productive pedagogies framework with several examples on each component. To be more specific, we provided a table consisting of the elements of productive pedagogies and its description. We gave opportunity to all pre-service Mathematics teachers' participants to read it before further discussed in class. When listening to the explanation of productive pedagogies,

teacher participants could pose question and shared their understanding of the elements of productive pedagogies framework.

By this activity, the participants were hoped to gain their knowledge about productive pedagogies. Afterwards, in next session, all participants shared their Mathematics lesson design and their experiences include the challenge during teaching internship program. One group of participants shared about the variety/heterogeneity of students, which come from different ethnic and race such as students from Papua (East of Indonesia) as well as oriental people. By this explanation, students would like to point on cultural knowledge in the recognition of difference component. They also shared that students were actively engaged in the class discussion by aggressively posed question but some were also still shy in communicating their ideas. By that presentation, pre service teachers' participants try to connect what the presented with the productive pedagogies framework without saying the term. By this activity, teachers could learn from others about the real practice situation at different school and they might also pose question include the productive pedagogies. Within the presentation session, other pre-service teachers posed question about the authentic teaching situation in school as well as whether some components of productive pedagogies were implemented within the lesson design.

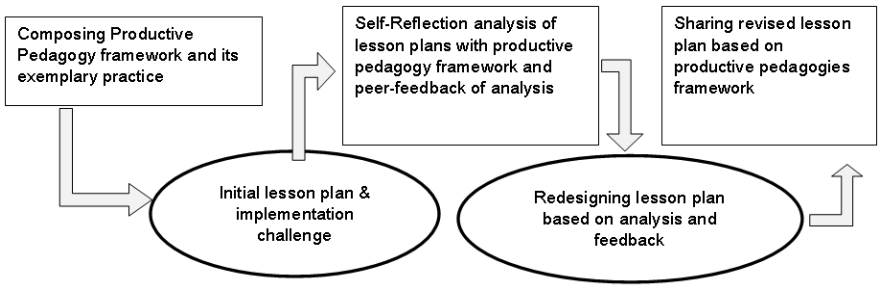

Fig. 1. Learning trajectory of the offered course.

Another activity was reflective practice, in which lecturer gave opportunity to all preservice teacher participants to analyze their own lesson design and also give feedback to their peers' lesson design with regards to productive pedagogies elements. The focus of the feedback related to productive pedagogies component. By providing feedback, teachers did peer and self-reflective practice toward teachers' lesson design. Beside the feedback, teachers organized the analysis of detail activity with the framework of productive pedagogy in a table. The entire lesson analyses were presented for whole class and discussed within community of practice. After the reflective practice, teachers were allowed to revise their lesson plan if it was necessary for better Mathematics teaching.

4. Results and Discussion

All activities that were followed by all teacher participants lead them to work actively. Within the classroom discussion, all preservice teachers' participants shared their experience in implementing their teaching design in the teaching internship. It was found that most of teaching practices implemented were direct instruction and some did group discussion. When preservice teachers shared their

analysis, they used productive pedagogies components as framework for their analysis. Most of teacher participants analyzed their lesson plan and agreed that it was hard to apply all 20 elements of productive pedagogies in redesigning in their lesson plan. Within sharing and discussion on lesson design as well as reflective practice we obtained some facts related teachers' understanding.

For the dimension of intellectual quality, based on the teachers' perceptions, substantive conversation and deep knowledge are the components that mostly appeared in their lesson plan. However, the length of discussion would be added since they thought that the elaboration of Mathematics' idea was better come from students through more discussion. The discussion or interaction would be among students and between teacher and students in the modified lesson plan. Beside, related to higher order thinking, most of pre-service teachers claimed that it was hardly found in their initial lesson plan since they just gave routine problems to their students. For them, the differentiation of higher order thinking and lower order thinking was referring to the routine or non-routine problem given. In addition, there was also teacher who thought that higher order thinking related to word problem given that lead to Mathematics modelling. There was no one who considered teaching strategy that was related to opportunity given to students to analyze, synthesize, generalize until arrive at conclusion and interpretation of Mathematics content [13]. By using components of productive pedagogies that is elaborated with explanation and example activity, preservice teachers analyzed their initial activity and proposed the revised one. Table 1 shows one exemplary analysis from pre-service teachers.

Table 1. Exemplary analysis of lesson plan.

Component	**Initial activity**	**Revised activity**
Higher order thinking	Teacher posed application problem in finding determinant of matrix ordo 3x3 with cofactor expansion strategy. Problem : Find the determinant of matrix A below with the first row as minor in cofactor expansion $B = \begin{pmatrix} 1 & 2 & 0 \\ 3 & 1 & 1 \\ 1 & 4 & 2 \end{pmatrix}$ → ***First row as minor*** $\begin{vmatrix} 1 & 2 & 0 \\ 3 & 1 & 1 \\ 1 & 4 & 2 \end{vmatrix} =$ $1\begin{vmatrix} 1 & 1 \\ 4 & 2 \end{vmatrix} - 2\begin{vmatrix} 3 & 1 \\ 1 & 4 \end{vmatrix} + 0\begin{vmatrix} 3 & 1 \\ 1 & 4 \end{vmatrix}$	A question is added - Analyze whether the determinant is the same if we use the second row as minor? Explain it and write your finding!

When teachers analyzed the lesson plan, they considered the component of deep knowledge. For them, deep knowledge was related to the connection of the content with the previous concept. There were also teachers who overlapped the deep knowledge with social support component based on their peer feedback. Deep knowledge was considered as letting students propose questions when they do not understand Mathematics, which is a part of social support. One of teacher was also

provided suggestion of her peer about the possible revised activity related to Mathematics. This is presented in Fig. 2.

2. Buktikan dan jelaskan bahwa:

$$\begin{bmatrix} 3a & b & 2c \\ 2c & 3a & b \\ b & 2c & 3a \end{bmatrix} = 27\,a^3 + b^3 + 8\,c^3 - 18\,abc$$

For number 2, students could be asked to explain the reasoning why the equation hold

Fig. 2. Peers' suggestion to the revision of problem posed in the lesson plan.

Another component in intellectual quality called substantive conversation was fully understood by teachers. They applied dialogue with students that were not fully controlled by teachers. For example, in the lesson design, students were given opportunity to discuss the solution of Mathematics realistic problem and share their finding and understanding to whole class and other can react to their explanation. They were also asked to make summary and conclusion about their finding to their teacher and classmates. By this modified activity, dialogue between teacher and students as well as among students appeared.

The connectedness dimension became the most applicable dimension in teachers' lesson plan design. There are four components of Connectedness dimension, such as knowledge integration, background knowledge, connected to the world, and problem-based curriculum. Those components could be identified by teachers within their lesson plan design. For example, in the knowledge integration, teachers tried to make a big connection topic in Mathematics, such as linear programming with equality and inequality and drawing graphic representation through discussion. For the connectedness to the world, teacher considered to relate Mathematics content and real life situation. The exemplary of connectedness dimension was elaborated in apperception and motivation in the redesigned lesson plan as shown in Fig. 3.

For problem based curriculum, teachers tried to connect it with problem based learning teaching approach. Furthermore, the supportive classroom environment dimension can be seen by teachers need to ensure that their students influence the nature of the learning activities [14]. Regarding this description, a teacher gave exemplary activity for the student direction component as giving opportunity to create problem and solve it themselves. Other represented their understanding of this component as students did exploration of the Mathematics concept and they were asked to use their finding such as Mathematics formula to solve Mathematics problem. Regarding the task given to students, teachers identified academic engagement related to the group activities created for students. However, the explicit quality performance criteria and self-regulation were not described within the teachers' analysis of lesson plan.

In terms of the dimension of recognition of difference, it is considered as ensure students know about and value a range of cultures, create positive human relationships, respect individuals, and help to create a sense of community [15]. This dimension could not be obtained from teachers' analysis of their lesson plan. However, some of them shared their understanding of components of this dimension

when they shared their experience in their internship program. A school employed a foreigner teacher and students respect him who has different culture. In addition to it, the teachers feel that the Mathematics content and the way of Mathematics teaching that he experienced in his home country was very different with Indonesia curriculum. In this situation, he kept valued the different culture and also honors it.

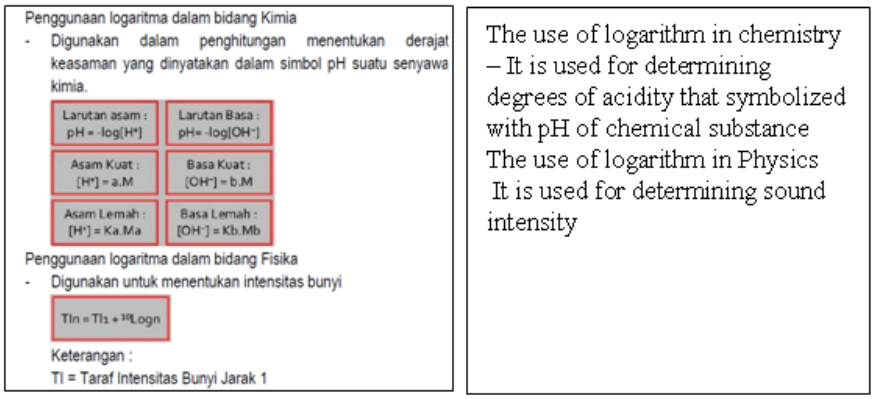

Fig. 3. Exemplary of dimension connectedness to the world in redesigned lesson plan. Figure in the left is the sample in Bahasa Indonesia, whereas figure in the right is the meaning translated in English.

Furthermore, based on the teacher's explanation, the component of inclusivity which deliberates attempts to ensure that students from diverse background are engaged in learning was hardly found in the lesson plan. Teachers considered that this component was only related to inclusive students instead of students' diverse backgrounds, experiences and abilities. The result of this paper clearly showed that the productive pedagogies framework enabled preservice teachers to redesign their mathematics lesson plan based on initial analysis with productive pedagogy component within classroom discussion. Most of the teacher participants analyzed their lesson plan and agreed that it was hard to apply all 20 elements of productive pedagogies in redesigning in their lesson plan. Within sharing and discussion on redesigning lesson plan, preservice teachers were engaged in reflective practice activity.

5. Conclusion

The use of productive pedagogy within the syllabus for pre-service teachers would deliver some benefits. It enabled pre-service teachers to reflect critically on their lesson design to see whether the teaching and assessment support the dimension of productive pedagogies. Peer feedback activity was also useful since it was linked to the possible activity that represent productive pedagogies component, the quality of Mathematics content presented within the lesson, and the students' participation in the lesson.

References

1. Bature, I.J. (2014). *Productive pedagogies for reforming secondary school Mathematics classroom practice in Nigeria.* A published thesis (Curtin University). Retreived from http://hdl.handle.net/20.500.11937/346.

2. Chinnappan, M. (2006). Using the productive pedagogies framework to build a community of learners online in mathematics education. *Distance Education*, 27(3), 355-369.
3. Louis, K.; Kruse, D.; and Marks, H.M. (1996). Schoolwide professional community, in F. Newmann and Associates (Eds) *Authentic restructuring schools for intelectual quality*, pp. 179-203. San Francisco: Jossey-Bass.
4. Alsharif, K.; and Atweh, B. (2010). *Gaps in understanding and implementing connectedness in mathematics eaching by Saudi student teachers*. Paper presented at the Australian Association Research in Education. Melbourne. https://www.aare.edu.au/10pap/2525AlsharifAtweh.pdf
5. Alsharif, K.; and Atweh, B. (2012). Productive pedagogies as framework to improve preservice teachers' practices. *The International Journal of Learning*, 18(4).
6. Llinares, S.; and Krainer, K. (2006). *Mathematics (student) teachers and teacher educators as learners.* Handbook of research on the psychology of Mathematics education: Past, present and future, In Gutiérrez, A.; and Boero P. (Eds.), page 429-459.
7. Morris, A.K. (2006). Assessing pre-service teachers' skills for analyzing teaching. *Journal of Mathematics Teacher Education*, 9(5), 471-505.
8. Lingard, B.; Hayes, D.; and Mills, M. (2003). Teachers and productive pedagogies: Contextualising, conceptualizing, utilizing. *Pedagogy, Culture and Society*, 11(3), 399-424.
9. Curriculum Innovation Branch Education Queensland. (2002). *A guide to productive pedagogies: Classroom reflection manual.* The State of Queensland (Department of Education).
10. Oakes, J.; Gamoran, A.; and Page, R.N. (1992). Curriculum differentiation: Opportunities, outcomes, and meanings. In Jackson, P.W. (Ed.), *Handbook of research on curriculum*, pp. 570-608. New York: Macmillan.
11. Newmann, F.N. (1996). *Authentic achievement: Restructuring schools for intellectual quality*. San Francisco: Jossey-Bass.
12. Mills, M.; and Goos, M. (2007). *Productive pedagogies: Working with disciplines and teacher and student voices*. Annual conference of the Australian Association for Research in Education.
13. Haristiani, N.; and Firmansyah, D. B. (2017). Android application for enhancing Japanese JLPT N5 kanji ability. *Journal of Engineering, Science, and Technology*, 12, 106-114.
14. Mills, M.; Goos, M.; Keddie, A.; Honan, E.; Pendergast, D.; Gilbert, R.; Nichols, K.; Renshaw, P.; and Wright, T. (2009). Productive pedagogies: A redefined meyhodology for analysing quality teacher practice. *The Australian Educational Researcher*, 36(3), 67-87
15. Ekawati, R.; Kohar, A. W.; and Hartono, S. (2017). Experts' notion and students' responses on context-based mathematics problem. *Journal of Engineering Science and Technology* (*JESTEC*), Special Issue on AASEC'2016, 10, 53-64.