



The effectiveness of utilizing the productive pedagogies framework as a reflection instrument in teaching and learning of mathematics

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Abstract

Many students have struggled to comprehend why they were required to study mathematics, which was viewed as a challenging subject. The condition caused by teaching of mathematics has not led to students understanding why they need to study mathematics. In this regard, it is important to enable all students to realize why they study mathematics, then encourage them to learn mathematics with pleasure. Furthermore, the teachers can evaluate how effective their efforts are and reflect on the results of implementing the efforts. This study explored the feasibility of utilizing the Productive Pedagogies framework as a reflection instrument in the teaching of mathematics. Four teacher-participants were included in this action research. Data were collected during the research cycles using classroom observations, focus group discussions, in-depth interviews and completed by teaching reflection. The purpose of the study was to examine how teachers managed their mathematics classes by utilizing the elements of the Productive Pedagogical framework. Furthermore, the teachers evaluated their performance and reflected on the achievement of utilizing the framework in their lessons. They then used the results to better prepare for the next lessons. The study concluded that after the teachers utilized the framework in their mathematics teaching, they were able to: promote better teaching by applying different points of view; do self-assessment and reflect on their teaching; and develop peer feedback among their peers. In addition, the teachers used the reflections toward the lessons to help them improve the standard for their upcoming lessons.

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Introduction

Mathematical competence has been described as one of the primary competences of the 21st century for individual satisfaction, enterprising citizenship, social participation and employability (Parveva et al., 2011). As a consequence, mathematics must be mastered by

everyone. School is one of the parties that must be responsible for this. In line with this issue, mathematics is needed in preparing students to face digital society in the future (Gravemeijer et al., 2017). While mathematical competence is an essential factor to improve citizenship chances, sadly, students are struggling in learning mathematics. In other words, there is a gap between the importance of mathematical competence as the main competence in facing the challenges of the 21st century and the not yet optimal implementation of mathematics learning

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so that students' mathematical competence potential mostly has not been empowered. To cover this gap, applicable efforts are needed so that mathematics learning can take place more effectively so that it can instill and grow student's' mathematical competence more productively.

The importance of mathematics within society and the current disconnection of mathematics education with the lives of students has resulted in a movement that is concerned both with providing equitable access for all students to learn effectively and in helping students to be protagonists, with respect to changing their world in ways that are more socially just (Ball, 2008). This movement is concerned with the intellectual demand placed on all students, the relevance of the mathematics taught to their lives, the level of support provided to students and recognition of students' differences. The Productive Pedagogies framework was developed because of this movement so that teachers can improve the quality of teaching and learning, in general, and in teaching of mathematics, in particular. The Productive Pedagogies framework was built upon a large body of research related to the production of socially equitable student learning outcomes (Ladwig et al., 1999). Through its elements, the framework provides a list of characteristics that have been found to be related to effective teaching.

As a teaching framework, the Productive Pedagogies framework considers the acquisitions of knowledge as the mechanism of how new knowledge is gained. The framework suggests that the performance of the acquisition of knowledge is related to the information acquisition, processing, interpretation and recall, which are all processes related to knowledge creation. Currently, some of the dominant learning views in Indonesia still include the knowledge transfer paradigm that is usually done by teachers to their students (Azra, 2002; Zulfikar, 2009). The framework shows that knowledge acquisition performance is related to information acquisition, processing, interpretation and recall, which are all processes related to knowledge creation. This shows that the introduction of the phases of acquiring, processing, interpreting, and retrieving information is a phase of acquiring knowledge on the one hand and learning as a transformation process on the other. Although it has not been widely fulfilled or used, this paradigm shift has begun to occur in Indonesia (Armanto, 2002; Sembiring, Hadi, & Dolk, 2008; Zulfikar, 2009). The Productive Pedagogies framework, utilized in providing analysis, is designed in its form on the philosophy of constructivism. Constructivism, one of the learning philosophies, claims that learners study by deliberately generating meaning rather than just obtaining knowledge (Hoban, 1997).

Regularly, learners develop knowledge on the basis of their own experiences and previous knowledge. The essence of what is created can vary for other learners, although they are learning in one and the same classroom (Simon, 2008). Thus, learning is a personal task, so it is impossible that two students leave a classroom with identical experience (Sutton et al., 1996). The nature of the personally constructed meaning of an individual is strongly affected by his or her storing thought and beliefs (Gunstone, 1995). Consequently, learners' knowledge constructions are shaped by their own sight as well as by the essence of the process of learning and also teaching.

Teaching of mathematics is considered to be a field that concerns many people around the world, notwithstanding the relevance of mathematics to students' contextual condition, Indonesia being no exception. Many previous researches have indicated that education in mathematics remains inherently detached from the lives of students and unrelated to students' necessity (Schmidt, 2011). Hence, Parveva et al. (2011), revealed that mathematics lesson is frequently viewed as complicated and abstract, both at school and within the broader society, concerning a large number of procedure and formulas which seem separated from others. Therefore, it seems essential to understand what defines successful teaching of mathematics (Anthony & Walshaw, 2007).

Crucial parts of the teaching and learning process have been used in mathematics education, including the important ways of improving the educational standard, the degree to which teaching affects learning and growth of teachers' competence (Hightower et al., 2011). As the key figure in the teaching process, mathematics teachers play an important role in order to provide adequate expertise, skills and tools to improve their students' ability to be a professional mathematics learner (Anthony & Walshaw, 2009a). Related to this, there is an increasing awareness in recent years that teachers are considered as one of the most significant variables in student achievement (Carey, 2004). According to Hayes et al. (2006), successful teachers are needed to encourage adequate student outcomes and their practices to improve student learning.

In line with the above opinions, Anthony and Walshaw (2009b) stated that mathematics teachers perform an important task in a strategic function to promote productive teaching and learning. Previous studies have shown that various factors influence how to prepare qualified teachers, namely, building students' interpersonal relationships, increasing capacity and self-confidence, promoting students' academic demands and providing students with opportunities to acquire knowledge productively (Slade, 2002). This is in line with student expectations of demanding

teachers who are enthusiastic, friendly, supportive and loving, so it can be concluded that students want educators who create relationships and encourage them to do strong and excellent work (Rowe, 2003; Slade, 2002).

According to Camp (2011), the relationship between a teacher and a student is generally defined as a formalized interpersonal association between an authority figure and subordinate who interact on nearly a day to day basis. Therefore, teachers should build positive personal relationships among students in order to enhance students' chances of academic success. A great teaching of mathematics not only relies on the teachers' skills and proficiency, but is also supported by their understanding to perform teaching the subject and comprehend how students learn. Both processes are important if teachers focus on the needs of their students (Parveva et al., 2011).

Furthermore, Parveva et al. (2011) stated that effective mathematics teaching relies largely on teachers' expertise. Since teaching is a dynamic activity, the instructor must regularly assess the efficacy of his teaching as a learning facilitator. In addition, to increase the standard of their instruction, the outcome of their assessment should be used. Four overarching dimensions are included in the Productive Pedagogies framework, namely: intellectual quality, connectedness, supportive classroom environment and recognition of difference.

Intellectual quality should allow and encourage an exhaustive mathematical learning (Education Queensland, 2001). By recognizing and solving real life problems, the connectedness dimension applies new information to the context knowledge of students and their lives outside the classroom (Education Queensland, 2002). The supportive classroom environment takes into account social justice (Education Queensland, 2001). The acknowledgement of the dimension of difference is correlated with explaining how the performance of students from deprived sociocultural backgrounds can be systematically enhanced. Therefore, the main purpose of this study was to investigate the effectiveness of utilizing the Productive Pedagogies framework as a reflection instrument for improving the quality of teaching and learning of mathematics.

Reagan et al. (2000) revealed that when a teacher is involved in deliberate reflection, such may lead to formulating new strategies for changing behavior in the classroom. According to Brookfield (2004), without reflection, teachers run the continual risk of making poor decisions and bad judgments. As such, reflection in teaching and learning is very important because they are the evidences of a teacher's performance which is in line with what the Productive Pedagogies Framework has proposed. To complete the purposes of the study, the

following research questions were posed. After the teachers utilize the elements of the Productive Pedagogy framework in teaching mathematics, are they able to: promote better teaching by applying different points of view; do self-assessment and reflect on their teaching; and develop peer feedback among their peers?

Methodology

The research approach used in this study helped teacher-participants to perform the process of their teaching of mathematics by utilizing the Productive Pedagogies framework as well as explore the efficacy of the framework as a reflection instrument to evaluate students' learning outcomes during the three cycles of action research, which took place within four weeks. Before utilizing the framework in their classes, all the teacher-participants attended a five-day workshop to comprehend the overview of the research and the Productive Pedagogies framework. Moreover, before performing the lessons and exploring the framework, the teachers were expected to create lesson plans by applying the framework. They used the lesson plans to assess the degree to which the goals were met and, critically, the efficacy of the teaching framework used to achieve them. Furthermore, they evaluated their performance in the implementation of the mathematics teaching and reflected on the achievement of utilizing the elements of the framework in the lessons. The results of the evaluations and reflections were then used to prepare for the next lessons so that they were better.

Participants

The research involved four teacher-participants in grade 7, two teachers from one urban school and two teachers from one rural school. This research was conducted at two separate schools in West Bandung District, West Java, Indonesia, with one school in an urban area and one school in a rural area. The urban school was categorized as a public school, which was easy to access and equipped with sufficient facilities. The rural school was a private school, equipped with insufficient school facilities and funded from a social foundation.

Data Collection

The data were obtained during the three cycles of action research. The data were collected by using classroom observations, focus group discussions and in-depth interviews. All teacher-participants were observed during 80 to

90 minutes for two or three lessons in a week. The teachers' activities were also recorded on video and noted in teaching reflection during the observation time. In addition, in order to reinforce the findings, the teachers were also interviewed in both focus group discussion and in-depth interview after the teaching activities were carried out to review and discuss the implementation of their lesson plans.

Data Analysis

Throughout the research, data were analyzed and interpreted when the study was carried out and commenced while the data was being collected. After being observed in their lesson and interviewed, teachers were asked to reflect on their teaching and wrote in their reflective journal. After all data were collected, all recorded results were transcribed by the researcher and verified by teacher-participants. The data during classroom observation, which included video and field noted, were classified and analyzed regarding to the Productive Pedagogies framework and research objectives. The researcher got data of teachers' perspective about the framework's dimensions and elements from focus group discussions; the contribution of the elements of the framework for improving the quality of mathematics teaching from in-depth interviews; teachers' experiences related to utilizing the elements of the framework in their mathematics teaching from reflective journals. Analyzing and interpreting data were ordered from explore and coding, represent and report, and validate the accuracy.

Results and Discussion

The necessity for teachers to focus on their instruction by evaluating the level to which they had accomplished their objectives and the success of the teaching methods they had used was a significant feature of utilizing the Productive Pedagogies framework in their teaching process. After every lesson, these sessions were held and included the researcher and teacher-participants. The researcher recorded three instances of teacher reflections during classroom observations conducted before the implementation of the mentioned framework. Two participant teachers, T_1 and T_2 , commented on both of these occasions on their own. Both teachers commented on one and two lessons, respectively. The teaching which was implemented during delivery of the lesson was the subject of the three reflections. The overall study of their lessons was to strengthen their teaching. The results showed that teachers were given a specified guide by utilizing the twenty components of the Productive Pedagogies framework in the preparation and during the

reflection of lessons, which they could use to make decisions about how they could develop their lessons. The process of teaching and learning of mathematics at the time of this study was predominantly teacher-oriented, in which teachers frequently dictated what students needed including formulas and other procedures during teaching and learning activities (Hadi, 2002).

The classroom observations of the lessons were an important part of the reflection process. It should be noted that none of the teachers had encountered being watched before the implementation of the Productive Pedagogies framework. The initial observations suggested that the teachers, particularly at the beginning of the lessons, were quite stilted in their delivery, suggesting that teachers were aware of the existence of the observers and thus became slightly confused. Nevertheless, when the observation activities assumed as regular activities and were conducted twice a week, the participant teachers found it easier to implement the framework and were no longer bothered by the existence of the observers at the end of the first cycle period. T_2 reflected that the sight of others resulted in her becoming clumsy and insecure when the teaching process was observed for the first time. Eventually, all teacher-participants adapted to that condition and relaxed when teaching was observed during the following classroom observation.

Utilizing the Framework to Develop Lesson Plans

As masterly teachers, the four teacher-participants were habitual in arranging lesson plans, yet the latest lesson plans which were developed before the implementation of the Productive Pedagogies framework was implemented. The latest lesson plans, arranged utilizing the framework, were somewhat distinct from the previous lesson plan they had been using based on the teaching and learning goals with the curriculum. In addition, the latest lesson plans also identified performance quality criteria, related to the outcomes of learning, and designed the strategies of teaching they would utilize. The teachers used the concept of the Productive Pedagogies framework for each lesson plan to assist them in understanding why and how to manage their teaching.

It was necessary to explicitly outline the teaching goals for the topic before deciding the teaching methods that would be used (including the range of student performance) in depth, defining the success parameters and clearly specifying the anticipated criteria for student performance for the different stages of the lesson involved. If the expectations were obviously defined, the teacher-participants would agree in executing the lesson and the teaching methods they utilized to accomplished them.

These tasks concentrated on facilitating students in improving their knowledge through demonstration, student discussions and problem solving activities. Since considering the teaching methods, teachers would directly utilize the tasks, activities and assignments to present them in front of their students. In the case of T_1 , she determined to utilize small groups of students consisting of four to five students regarding the profession of their parents. T_1 could provide each of the groups with a different problem, posing the problem which related to the learners' contextual experience. When the teachers felt comfortable in utilizing the Productive Pedagogies framework in the development of their learning, they would reflect on their experiences for the development of further learning that was better than their previous experience.

Utilizing the Framework on the Lesson

After each lesson, the teachers commented on their teaching using the usual lesson plans, then compared them with the latest lesson plans which referred to elements of the Productive Pedagogy framework. At first, because this was not something they had done before, teachers were often uncomfortable sharing their teaching with others. However, at the end of all cycles of the action study period, teacher-participants realized that it was not so difficult to focus on their teaching as they had thought at first. They were mostly happy to do so. To this end, T_2 articulated the perspectives of other teachers when he said, "although the process of reflection is time-consuming, it allows us to pay attention and assess our own teaching to create a better lesson in our next teaching session".

A variety of steps were involved in the reflection sessions. The first step was to analyze what the students had done and the degree to which the lesson goals were accomplished. This opening phase was prominent because it allowed the teachers to recognize that the expertise of students was not measured by if the students communicated or presented, but by the degree the students mastered such in accordance with the curriculum-specific and required competencies. When the teachers had assessed the performance of the students, they would have reflection sessions analyzing the efficacy of their teaching toward individual components in the context of the Productive Pedagogies framework in highlighting the lesson objectives. These sessions included two focus areas, the process of teaching and learning, and the techniques and methods of teaching which were utilized.

In turn, reflection process on the teaching strategies and lesson involved each dimension and component of the Productive Pedagogies framework. This stage included reviewing the components utilized in the lesson plan. The reflection time also tried to establish how well teachers

applied the elements of the Productive Pedagogies framework. Thus, the structure of reflection provided substantial ways which teachers might reflect from various perspectives on their teaching. For example, T_1 felt in her reflection that the latest lesson was the most successful part of teaching because before moving on to more difficult topics, the students had experienced a degree of success. However, during the reflection, T_1 realized, when reflecting on the substantive discussion aspect, she had not totally accomplished this component.

Generalizations about the concepts were made. Teachers were offered the chance to assess their strengths and weaknesses within the context of pedagogy by utilizing reflection instrument after implementing the Productive Pedagogies framework. The teachers were capable of analyzing the lesson from a particular viewpoint with the utilization of the elements of the framework. The teachers were able of evaluating their lessons comprehensively and regularly in this way. As one of the teachers (T_1) mentioned, "to establish a better performance in my next lesson, I need to focus on my teaching".

The degree of teachers' accomplishment, in terms of implementing the Productive Pedagogies framework, was quantified for each teacher and varied. T_1 claimed as the most successful in implementing the elements of the framework., T_4 performed the lowest improvement in utilizing the elements of the framework. Regardless of the different degrees of success in utilizing the framework, it was noted that, after three cycles of action research, all four teacher-participants made improvements in performing their teaching. The overall action research led to the appearance of three major effects that indicated the effectiveness of utilizing the Productive Pedagogies framework, including promoting classroom interactions, improving relevance of the lesson to the real world and encouraging social justice in mathematics education.

Conclusion and Recommendation

The study concluded that after the teachers utilized the elements of the Productive Pedagogies framework in their mathematics teaching, they were able to: promote better teaching by applying different points of view; do self-assessment and reflect on their teaching; and develop peer feedback among their peers. In addition, the teachers used the evaluations toward the lessons to help them improve the standard for their upcoming lessons. In short, utilizing the Productive Pedagogies framework in teaching and learning of mathematics is effective as a reflection instrument in improving the quality of the next mathematics lessons.

Based on the conclusions, the researcher proposes the following recommendations: introducing the Productive

Pedagogy framework carried out over a longer period of time to provide teachers with a deeper understanding of its dimensions and elements of the framework as well as its implementation; providing more opportunities for teachers to observe and practice elements of the Productive Pedagogies framework, thereby helping them to understand the framework more deeply and apply it to their teaching; and supporting teachers to develop and carry out critical self-reflection in every teaching and learning process they do based on the dimensions and elements of the Productive Pedagogies framework.

Conflict of Interest

There is no conflict of interest.

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