Preservice Middle School Mathematics Teachers' Development in Formative Assessment

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The study was conducted to investigate preservice middle school mathematics teachers' professional development in formative assessment practices they plan to implement in classrooms. Basic qualitative research method was employed in this study. Incomplete and Improper Lesson Plan Task developed by the researchers was implemented to 47 2nd year, 37 3rd year, and 27 4th year preservice middle school mathematics teachers. Findings of the study indicated that participants who took measurement and assessment course and methods of teaching courses (3rd year and 4th year preservice teachers) emphasized integrating formative assessment strategies more than 2nd year preservice teachers. None of the participants mentioned to give opportunity to students to assess themselves or provide feedback to the students in order to enhance their learning. 3rd year and 4th year preservice teachers were also more successful in detecting the improperness of the lesson plan.

Keywords: Preservice mathematics teachers, formative assessment, professional development.

Introduction

Formative assessment is used to collect evidence about students' current level of understanding a concept and their learning progress. Hence, it does not serve for certifying students' competence (Black & Wiliam, 1998). Formative assessment provides information to both students and teachers about their performance and instruction (Sadler, 1989). Any assessment is formative if this information is used as an evidence to make necessary changes in the teaching ways and strategies to meet students' learning needs and to promote their learning (Black & Wiliam, 1998; Wiliam, 2007). Wiliam and Thompson (2008) suggested a formative assessment framework shown in Table 1 considering peer-teacher-learner interactions and three instructional processes; *where the learners are in their learning*, *where they are going* and *what needs to be done to get them there* as underlined in Ramaprasad's (1983) definition of feedback.

	Where the Learner is Going	Where the Learner is Right Now	How to Get There
Teacher	Clarifying and sharing learning intentions and criteria for success	Engineering effective classroom discussions and tasks that elicit evidence of learning	Providing feedback that moves learners forward
Peer	Understanding and sharing learning intentions and criteria for success	Activating students as instructional resources for one another	
Learner	Understanding learning intentions and criteria for success	Activating students as the owners of their own learning	

Table 1: Framework relating strategies of formative assessment to instructional processes (Wiliam & Thompson, 2008, p.63)

The framework consists of five key strategies and it has one *big idea* that evidences of students' processes can be used to make adjustments in instruction in line with students' needs (Wiliam, 2007). According to the five key strategies: Teachers need to clarify and share learning intention and success criteria with the learners in order to provide them with an understandable picture of the learning targets (Wiliam, 2007). In this way, learners can comprehend the meaning of the lesson objectives and be aware of what they are supposed to do in order to achieve learning targets. Sharing success criteria or rubric with the learners is also crucial with regard to formative assessment because whether the learners grasp the success criteria need to be ensured before expecting good performance from them (Moss & Brookhart, 2009). Additionally, teachers need to reveal learners' current level of knowledge so that they can adjust their instruction according to students' needs and plan further instructional steps (Black, Harrison, Lee, Marshall, & Wiliam, 2003). Teachers can elicit students' learning by engineering effective classroom discussion through asking qualified questions and observing students' learning progress (Schachte, 2009).

Feedback has a crucial role in formative assessment especially when it is used to improve learners' performance (Wiliam, 2007). Providing feedback to the students can increase their participation to the tasks and facilitate their learning (Black & Wiliam, 1998). Being responsible for their own learning improves students' ability to judge themselves and effectiveness and quality of learning (Panadero, Jonsson, & Botella, 2017). Learners' communications and interactions in the classroom activities and lesson content are also essential for formative assessment (Moss & Brookhart, 2009) because they improve learners' motivation, make them cooperative workers (Sadler & Good, 2006) and increase their achievement.

Achieving quality in evidences collected about students' current level of understanding depends on carefully planned formative assessment practices. Based on Tyler's (1950) linear-relational model of instructional planning, teachers are supposed to decide how to evaluate students' learning and how they will make inferences from learning outcomes before instruction begins (as cited in Campbell & Evans, 2000). Hence, lesson planning is a significant process in the implementation of qualified formative assessment practices.

Knowing how to plan and implement formative assessment is crucial for teachers and for preservice teachers. Hence, teacher education programs need to train preservice teachers to increase their awareness of the significance of formative assessment and capabilities of planning and implementing formative assessment in their classrooms efficiently. Therefore, how teacher education programs train preservice teachers on formative assessment needs to be investigated.

The current study aimed to investigate preservice middle school mathematics teachers' (PST) professional development in formative assessment they plan to implement in classrooms. More specifically, the research question guided to the study was "How does PSTs' formative assessment practices change as they progress in middle grades mathematics teacher education program?" This question was sought by exploring PSTs' performance on a task where they were expected to realize the lack of formative assessment practices and suggest practices to improve the task. The nature of the mathematical tasks was not the focus of the study.

Methodology

Basic qualitative research method (Merriam, 2009) was employed in this study in order to reveal PSTs' professional development in formative assessment they plan to implement in classrooms. The formative assessment framework given in Table 1 guided the researchers in the preparation of the data collection instrument and analysis of the participants' responses.

Participants and Context of the Study

Participants of the study were 111 PSTs (47 2nd year, 37 3rd year, and 27 4th year PSTs) enrolled in four-year middle grades (grades 5-8) mathematics teacher education program at a public university in Turkey. The program offers mathematics and introductory education courses in first two years. Instructional principles and methods course is offered in the fall; measurement and assessment course is offered in the spring semester of the second year. PSTs take mathematics teaching courses in the third year while school experience and practice teaching courses are offered to them in the fourth year of the program.

Instructional principles and method course focuses on how to write observable and measurable objectives and prepare a lesson plan which includes beginning, middle, end, and assessment sections. Measurement and assessment course focuses on different assessment types including formative assessment and the development process of assessment instruments with rubrics based on objectives. In methods of teaching courses, PSTs are introduced basic principles of mathematics teaching, teaching methods and materials. Every week, they are expected to prepare a lesson plan including assessment part related to that week's topic and discuss these plans in terms of classroom activity and lesson flow. There is not specific emphasis on how PSTs plan to carry out assessment part of the plan in this course. Within the context of school experience course, PSTs are expected to observe their mentor teachers' instruction. They are required to prepare lesson plans for their teaching practice for at least two class hours in practice teaching course and to implement at least one of these plans in the practice school. Data of the study were collected in the fall semester which means that 2nd year PSTs have not completed measurement and assessment course yet, 3rd year PSTs have only been offered one mathematics teaching course and 4th year PSTs have not taken practice teaching course yet.

Instruments and Data Collection

Data were collected through a task which consists of an incomplete and improper lesson plan and a case where PSTs pretended being in-service mathematics teachers implementing this lesson plan. Lesson plan aimed to cover three 6th grade objectives related to equivalent fractions and included a group work activity sheet. Fractions concept was chosen since it forms a basis for other content areas (Siegler et al., 2012) and PSTs had fractions tasks in all mathematics education courses. The plan was incomplete because any wording that imply formative assessment strategy as stated in Table 1 was excluded from the lesson plan. It was improper since one of the three lesson objectives was immeasurable and unobservable, there was not any activity or question related to one other objective, there were inconsistencies between objectives and questions in the assessment part, and there was no rubric for the questions in the assessment part. Moreover, the structure of the questions

in the assessment part was weak since they were true-false questions which were limits gathering feedback about students' learning. Task also included four questions guiding PSTs to suggest formative assessment strategies to strengthen the lesson plan. Expert opinions of three in-service mathematics teachers who graduated from the same teacher education program, three teaching assistants who often gave feedback to PSTs' lesson plans and one mathematics education researcher were obtained in order to ensure the content related-evidence of validity. They were asked to comment on if the questions were qualified to elicit PSTs' formative assessment strategies they preferred to integrate in a lesson plan. Pilot study of the task was also conducted with three recent graduates of the same program as they completed the same courses with the targeted PSTs to finalize the data collection instrument. The modifications included directing phrases were added to questions related to the strength and weakness of the lesson plan in order to keep PSTs in focus.

During the task implementation, PSTs were expected to realize the incompleteness and improperness of the lesson plan, write the strength and weakness of the plan considering the lesson design, mathematics content, objectives and assessment part of the lesson plan. They were also asked to suggest some ways to improve the plan in line with weaknesses they found. Participants gave written answers to the questions; they did not implement the lesson plan in a real classroom environment.

The task was implemented in the courses taken by 2nd year, 3rd year, and 4th year PSTs. Preservice teachers who attended the courses were asked if they would like to participate in the study. The researchers explained that their interest was about how PSTs would redesign the given lesson plan which they would conduct in a real class setting. Participants of the study completed the task between 40-60 minutes. Data were analyzed through content analysis. PSTs' formative assessment practices were categorized based on the framework in Table 1. PST's expressions which implied formative assessment were grouped under the five strategies indicated in the formative assessment framework. Participants' comments related to the improperness of the lesson plan were also examined considering improperness criteria indicated above. Peer review strategy was utilized in order to ensure the categorization.

Findings

Incompleteness of the Lesson Plan

Findings of the study indicated that there was an increase in the emphasis on integrating formative assessment strategies in the lesson plan as the students progressed in the program. However, participants did not address all formative assessment strategies together in any year level. For instance, participants did not mention using the strategy "activating students as the owners of their own learning" (self-assessment). Besides, "activating students as instructional resources for one another" strategy (peer-assessment) was integrated into the lesson plan by only two 2nd year PSTs from the total of 111 participants. This shows that 3rd or 4th year PSTs did not propose to integrate self- and peer-assessment strategies in the lesson plan. Participants also did not make any comment about the integration of the "providing feedback that move learners forward" strategy to the lesson plan.

A total of 21 PSTs suggested asking questions for "engineering effective classroom discussions". Six percent of the 2nd year (n=3), 22% of the 3rd year (n=8), and 37% of the 4th year (n=10) PSTs recommended to include question-answer part in the lesson plan. 2nd and 3rd year PSTs made general comments about the necessity to include the questions: "questions that will guide the teacher during the implementation of the lesson plan and students' possible answers to these questions need to be added to the lesson plan" (3rd year PST-3P16). On the other hand, most of the 4th year PSTs specified the part of the lesson plan where they would include the questions and explained the reasons why they needed to include them. Some 4th year PSTs also exemplified these questions. For instance, one of them, 4P27, criticized the lesson plan and improved it as follows:

> First of all, at the beginning of the lesson plan, questions such as "What is the meaning of the fraction?", "What do numerator and denominator mean?" need to be asked in order to activate students' previous knowledge.

A few participants also emphasized the necessity to include classroom observation to be able to "engineer effective classroom discussion" in the lesson plan. Four percent of the 2nd year (n=2), 11% of the 3rd year (n=4), and 7% of the 4th year PSTs (n=2) suggested observing students while they were studying on the activity in order to elicit their learning. According to them "the teacher could observe each student while they were studying on the activity individually. In this way, assessment of students' progress would be easier" (3P26).

Six percent of the 2nd year (n=3), 11% of the 3rd year (n=4), and 15% of the 4th year PSTs (n=4) recommended to include some sentences which may imply the clarification of learning intentions in the lesson plan. For instance, one of the 2nd year PSTs, 2P8, suggested to "give more information to the students related to the lesson content at the beginning of the activity." She thought that "giving information about the activity would lead to an increase in the number of students who successfully finished the activity" (2P8). On the other hand, not any participants gave suggestion to include success criteria in the lesson plan for neither the classroom activity nor the questions in the assessment part.

Improperness of the Lesson Plan

Findings of the study showed that participants who took measurement and assessment course and methods of teaching courses were more successful in detecting that there was not any activity in the lesson plan related to one of the lesson objectives. While only 11% of the 2nd year PSTs (n=5) noticed this improperness, 32% of the 3rd year (n=12) and 30% of the 4th year (n=8) PSTs underlined this improperness and indicated that "students cannot achieve the objective at the end of the lesson" (3P20) "since there were not any activity or question in the lesson plan related to it" (3P3). Although some PSTs realized that there was an inconsistency between the objectives and lesson content, less number of PSTs discerned the inconsistency between objectives and questions in the assessment part of the lesson plan in any year level. Six percent of the 2nd year (n=3), 22% of the 3rd year (n=8) and 15% of the 4th year (n=4) PSTs noticed that questions in the assessment part were not sufficient and qualified to understand whether the students achieve the all objectives of the lesson. Another criterion for the improperness of the lesson plan, immeasurable and unobservable lesson objective, was detected more by 2nd year PSTs. While only one 4th year PST (4%) and three

3rd year PSTs (8%) realized this improperness, six 2nd year (13%) PSTs addressed the improperness and emphasized that "objectives need to be measureable. In the contrary case, how we can understand that students achieve the objectives?" (2P43).

Almost all participants made comments about the weak structure of the questions in the assessment part in all year levels; however, they proposed different reasons. In general, participants criticized the type of the questions, true-false questions, since students have 50% chance to answer the question correctly. They also indicated that "asking only this type of question was not sufficient to assess students understanding of equivalent fractions" (4P26). Almost half of the 4th year PSTs (44%, n=12) suggested to include questions about modeling the fractions in the assessment part of the lesson plan. Some PSTs also recommended to ask students explain the reasons for why they gave "true" or "false" answer to the questions. For instance, 4P10 explained her reasoning in suggesting these kinds of open ended questions in this way:

> Questions asking students draw some models could have been included in the assessment. Or, students could have been asked to explain why they preferred to answer the question as "true" or "false". Only in this way, a teacher can elicit students' misunderstandings or misconceptions.

Especially 3rd year PSTs underlined the fact that the questions in the assessment part did not assess all lesson objectives and they suggested to include question which were designed to assess all lesson objectives in the assessment part of the lesson plan (22%, n=8). Only two 2nd year PSTs emphasized that the assessment part of the lesson plan needs to be graded. However, none of the participants mentioned the necessity to include the rubric for the questions in the assessment part which was one of the reasons for the improperness of the given lesson plan.

Discussion and Conclusion

Finding of the study revealed that PSTs seemed to make little or no benefit of formative assessment strategies which could be utilized to enhance students' learning process. None of the participants preferred to integrate self-assessment strategy into lesson plan and only two 2nd year PSTs mentioned the necessity of peer assessment. The reason for not addressing these strategies might be the preservice teachers' thoughts that students were not able to assess their peers' and their own performances objectively (Wiliam, 2007). They might also perceive assessment as only their responsibility since they believed that only they would have expertise to assess students' learning (Sadler, 1989). PSTs also did not refer to provide feedback to students. This might be due to the nature of the data collection instrument. Since students' possible responses were not provided to the participants, they might not need to give feedback to students in order to enhance their learning.

Questioning and observing are the most used methods for gathering information about students' progress (Antoniou & James, 2014). Although more 3rd and 4th year PSTs suggested to include questions and observation in the lesson plan, the number of participants who took attention to these strategies was very limited. This little emphasis on including questions in the lesson plan might be due to the fact that PSTs though that they did not need to write questions in the lesson plan since they would keep them in their mind. However, when the questions were written before the instruction began, teachers could have an opportunity to explore particular strategies for increasing students' attention to the key mathematical concepts (Black et al., 2003). Moreover, the reason

more 3rd and 4th year PSTs suggested to include question in the lesson plan compared to 2nd year PSTs might be that they had more experience on the preparation of lesson plan and conducted more discussion of classroom activity in the lesson plan and lesson flow. Since 4th year PSTs also had opportunity to observe their mentor teachers' instruction in school assessment course, they might have specified the part of the lesson plan where they would include the questions and they explained the reasons why they needed to include them. Moreover, PSTs did not reflect explicitly on making observation while students were working on the class activity. Similarly, teachers have been reported to focus mainly on the learning product and did not monitor students' learning processes in their plans (Ruys, Van Keer, & Aelterman, 2012).

Findings of the study also indicated that not many participants were able to detect the improperness criteria of the lesson plan in general. Participants who took measurement and assessment course and methods of teaching courses were more successful in detecting the inconsistency between both objectives and classroom activity, and objectives and questions in the assessment part. However, still the number of PSTs who detected this improperness was very low. Although ensuring the consistency between objectives-classroom activity and objective-plan's assessment is one of the basic concerns that should be taken into account in lesson planning (Moss & Brookhart, 2009; Ruys, Van Keer, & Aelterman, 2012), and necessity of consistency between those has been emphasized especially in instructional principles and method, and measurement and assessment course, such limited number of participants who emphasized on this feature was unanticipated. Additionally, more 2nd year PSTs detected one of the other reasons for the improperness of lesson plan, immeasurable and unobservable lesson objective, than 3rd and 4th year PSTs. Since 2nd year PSTs recently have learnt how to write lesson objectives in instructional principles and method course, they might have been aware of this improperness. This might also show that 3rd and 4th year PSTs have not internalized why the objectives were supposed to be measureable and observable through their university education despite the strong emphasis on these characteristics.

Majority of the PTSs (regardless of their year levels) were able to detect the improperness of the assessment part resulting from the structure of the questions. Participants mainly proposed that they could not know if the students achieved the objectives or not with true-false type questions. Especially 4th year PSTs proposed to add different types of questions to the assessment part. The reason for suggesting to include question in the assessment might be due to their awareness of the requirement of the alignment between objectives and the questions in the assessment. Additionally, participants did not specify any success criteria or rubric for the assessment part of the lesson plan. The nature of the questions in the assessment part might be the reason for omitting the success criteria. PSTs might not need to include any rubric for the scoring since the questions were in true-false type. Another reason for not including rubric in the lesson plan might be PSTs' thoughts about the usage of assessment. They might have preferred not to score students' work and use it for formative purposes.

Although instructional principles and method, and measurement and assessment course provided necessary knowledge to the PSTs about formative assessment, PSTs had difficulty in integrating intended formative assessment strategies in the given lesson plan. PSTs who took methods of teaching courses and school experience course (3rd and 4th year PSTs) were more successful than 2nd

year PSTs in detecting incompleteness and improperness of the lesson plan. Preparing lesson plan, having opportunity to discuss it with their peers in methods of teaching courses and observing mentor teachers' instruction in middle schools in school experience course might help PSTs to see the whole picture of the lesson plan in terms of the usage of formative assessment strategies. Also having these experiences might provide PSTs to criticize the lesson plan with different perspective.

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