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A case of a preservice middle school mathematics teacher's planned and enacted formative assessment strategies

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The study presents one case from a larger study that investigated how preservice middle school mathematics teachers planned formative assessment and how they enacted planned assessment in a real classroom. The lesson plan prepared by the participant, pre- and post-interviews with her, and observations of her lesson constituted the data of the study. Findings indicated that the participant used most of the formative assessment strategies unintentionally and in a superficial way. She was unaware that peer- and self-assessment were some of the formative assessment strategies. She mostly asked questions with short answers, not engaging students to discuss the lesson content. She also provided mainly procedural feedback on the task and processing of the task levels. She had time management problems which led her to make changes in the planned formative assessment strategies.

Keywords: Preservice mathematics teachers, planned formative assessment, enacted formative assessment.

Introduction

Formative assessment, assessment for learning, is one of the ways of gathering information about students' learning progress in day-to-day classroom practices. This information is commonly used by teachers to make instructional decisions to improve students' performance and shape their learning. However, students also have the opportunity to involve in this process by regulating their thinking and learning to see where they are and decide on how to reach there (Black & Wiliam, 2009).

Wiliam and Thompson (2008) proposed a framework for formative assessment in a classroom context. The framework includes five key strategies: (A) Clarifying and sharing learning intentions and criteria for success; (B) Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding; (C) Providing feedback that moves learners forward; (D) Activating students as instructional resources for one another; (E) Activating students as the owners of their own learning. It also promotes one "big idea" that evidence of learners' understanding can be used to adjust instruction according to their needs (Wiliam, 2007).

Engaging learners in learning intentions and clarifying success criteria prior to completing an assignment provide learners with a clear idea of where they are going. To support this strategy (A) teachers may share statements focused on the learning rather than the activity or give students the opportunity to analyze their work as they proceed through the activity using explicitly written criteria and promote a discussion about the quality (Leahy et al., 2005; Wylie & Lyon, 2015). Strategy B requires the use of questioning and observing students' learning process to develop meaningful classroom discussions which elicit evidence of students' understanding. Teachers may use questions to prompt students' thinking, uncover their misconceptions and adjust instruction to meet learning needs (Leahy et al., 2005). Learners' interactions and cooperation for classroom activities (Strategy

D) and being responsible for their own learning (Strategy E) can be supported by classroom activities that encourage students to reflect on their learning, such as writing or sharing their current understanding of concepts at the end of the lesson or assessing each other's work, may support both strategies (Wylie & Lyon, 2015).

Providing feedback, strategy C, is an integral part of the formative assessment. It is useful when it aims to improve students' participation in the task and facilitate their learning (Black & Wiliam, 1998). Hattie and Timperley (2007) distinguished feedback and identified four major levels of feedback: (1) *Feedback about the task* (FT) includes feedback about how well a task is being accomplished or performed. This level of feedback may also include directions to acquire more; (2) *Feedback about the processing of the task* (FP) concerns the learning processes requiring understanding or completing the task; (3) *Feedback about self-regulation* (FR) addresses the way students monitor, direct and regulate actions toward the learning goal; (4) *Feedback about the self as a person* (FS) includes positive or negative evaluations and affect about the students. Hattie and Timperley (2007) argued that each level has a different effect on students' learning; FS is the least effective, whereas FR and FP are more influential in terms of mastery of the task. FT is also powerful if the task information is useful to improve the processing of the task and self-regulation.

Formative assessment has a significant role in students' learning. Teachers are expected to know how to plan and enact formative assessment strategies and use information gathered through the assessment process (Wiliam, 2007). However, the previous study revealed that preservice mathematics teachers (PMT) made little or no benefit from formative assessment strategies in the lesson plans (Kaplan-Can & Haser, 2019). Besides, teachers may have difficulty practicing these strategies since implementing these interconnected strategies simultaneously in a short period of time is very demanding and complex work. Research revealed that external factors such as conceptions and beliefs about the value of formative assessment, misconceptions about the meaning of it, shortage of time, or the lack of efficient professional development on assessment are barriers to integrating it into their teaching practice (DeLuca et al., 2012). Hence, teacher education programs have a significant role in training PMTs to increase their awareness of the formative assessment strategies and capabilities of planning and using them and breaking their barriers to implement them in classrooms. On the other hand, teacher education models have some challenges in promoting preservice teachers' developing conceptions and practices of assessment (DeLuca & Johnson, 2017). Thus, more studies should be conducted to have information about PMTs' knowledge and skills and how to support (preservice) teachers' development of formative assessment.

This study aimed to investigate how PMTs plan formative assessment and enact planned assessment in a mathematics classroom with a focus on one PMT. The differences between planned and enacted formative assessment and their possible reasons were also discussed. Research questions that guided the study are (a) "What are the preservice middle school mathematics teachers' formative assessment strategies they integrate into a lesson plan?" and (b) "How do preservice middle school mathematics teachers enact planned formative assessment strategies in a real classroom?"

Methods

For this study, one mathematics lesson taught by a PMT (Ada) was purposefully sampled from a larger qualitative study. The original study included 12 5th- and 6th-grade mathematics lessons taught by 12 PMTs in middle schools. Ada was selected because she did not teach the content; instead, she prepared tasks related to the content (decimals, percentages, and fractions), which students have already known, and students solved the tasks with the guidance of the PMT. Since this lesson aimed to assess students' learning instead of teaching a concept, it could allow information about students' understanding by using several formative assessment strategies.

Participant and context

Ada was a fourth-year PMT studying in a four-year middle grades (grades 5-8) mathematics teacher education program at a public university in Türkiye. The program offered an instructional principles and method course that focused on writing observable and measurable objectives and preparing a lesson plan that included beginning, middle, end, and assessment sections. In the measurement and assessment course, PMTs were taught formative, summative, and diagnostic assessment, validity and reliability terms, the development process of assessment items with rubrics based on objectives, and elementary statistics. PMTs were introduced to mathematics teaching methods and materials in mathematics teaching courses. They were expected to prepare lesson plans related to that week's content every week. Hence, Ada was familiar with the lesson plan format and experienced in preparing lesson plans. In the practice teaching course, PMTs were required to prepare and implement at least two lesson plans for their teaching practice in the practice school. The study data were collected within the scope of that practice teaching course, meaning that Ada had already completed the other stated courses successfully. During the data collection process, she was an intern teacher for two months and was not aware of the aim of the research until the post-interview.

Data collection and analysis

Data of the study were collected within the scope of the practice teaching course. Ada was expected to prepare and enact a lesson plan in her practice teaching school. Her mentor teacher asked her to prepare a lesson plan for 5th-grade students for the objectives: "Students will be able to make addition and subtraction with decimals", "Students will be able to compare decimals, percentages, and fractions", and "Students will be able to find the percentage of a number". The teacher had already taught these topics, and students practiced the topics. He wanted Ada to solve tasks and observe whether students had gained the objectives.

First, Ada prepared the lesson plan. The first author examined the plan and conducted the pre-interview to clarify how she planned to use formative assessment strategies. Ada implemented the lesson plan in one class hour. Implementation was observed and audio recorded. Recordings were transcribed, and some class excerpts were selected and asked Ada during post-interview to understand the purpose of her questions and answers to the students. Post-interview also included questions to clarify her views about the formative and summative assessments and their usage. The study's data comprised the lesson plan, pre- and post-interviews, and class observations.

The data were analyzed through content analysis. Ada's expressions implying formative assessment practices were categorized under the five strategies in the formative assessment framework (William & Thompson, 2008). Her feedback types were investigated considering Hattie and Timperley's (2007) identification of feedback levels. The peer review was utilized to ensure the categorization.

Findings

Ada's lesson plan consisted of the beginning, middle (including an activity sheet), end, and assessment parts. The activity sheet was made up of 8 tasks. The first four tasks were closed-ended and related to addition and subtraction with decimal numbers and ordering them. Task 5 was about calculating the percentage of natural numbers. In tasks 6 and 7, students were asked to do operations with decimals, percentages, and fractions. Task 6 was true/false, while task 7 was a mathematical problem. In task 8, students were expected to draw the simplest fractions and find the secret image.

The lesson plan had statements that referred to formative assessment practices. In the beginning part, Ada indicated that the teacher tells students what they will learn at the beginning of the lesson (Strategy A) and reminds students of equivalent fractions, decimals, and percentage concepts. Even though reminding the previous knowledge implied Strategy B because the teacher might remind the previous knowledge by asking questions and creating a discussion environment, no specific question or action was indicated in the lesson plan. In the middle part, she emphasized what she expected students to do for each task. Besides, she indicated that students will solve the tasks individually, and then they will share their answers with their peers (Strategy D and E). For each task, students will come to the board and show how s/he solved it (Strategy D). She also underlined that the teacher would help students who could not understand and solve the task. This implied that she planned to activate Strategy C to make students focus on and think about the tasks. In the end part, Ada wrote that the teacher asks students if they have any question and summarize the lesson. This can be an opportunity to understand students' level of learning and give feedback (Strategy C) to promote their learning. Students can also use this opportunity as self-reflection about their learning (Strategy E). In the assessment part, Ada wanted students to write a journal about what they did and learned in the lesson. Writing a journal could be a final self-reflection and assessment (Strategy E) and help the teacher judge where to begin in the next instruction (Big idea).

In the pre-interview, Ada explained that she would tell students what they will learn at the beginning of the lesson (Strategy A) because "if they do not know what they will do and learn, they go where the wind takes like a ship without a route". Ada did not state any words that implied creating a discussion environment while reminding the previous knowledge. She emphasized how she planned to use Strategies B, C, D, and E as follows:

While they are solving the tasks, I will observe students as much as possible. I will try to understand whether they are in communication and who did or did not solve the tasks (*Strategy B*).. If students cannot solve the tasks, I help them. I give them a clue (*Strategy C*). If their friends solve the tasks correctly, I can tell them, "get help from your friend", since it takes time to pay attention to what students do one by one. (*Strategy D*). However, if both of them cannot solve the task, I give them clues. Or I solve it, I do not know (*Strategy C*). ... Finally, students who could

solve the tasks will come to the board and solve them. There will probably be students who do not understand the solution way. I will explain to them again how we do it (*Strategy D, E, and C*).

She also emphasized the “big idea” of formative assessment in the pre-interview. She explained how she would use the feedback she gathered through the above process and the journal she planned to ask students to write at the end of the lesson.

Ada: I can get feedback about my lesson plan and activity. Students’ reactions can show me if the tasks are too easy or too difficult. I can get feedback about if the activity is entertaining, if students get bored, or if it is helpful to work with their peers.

Researcher: How do you use this feedback? How does the feedback you gather help you?

Ada: It will work for my future activities. I try to make the next ones more interesting or suitable for students’ level. I can use it to criticize my teaching skills or see what they understand or do not.

Ada reflected on her views about the implementation process of the lesson plan in the post-interview. She expressed that before the implementation, she thought that tasks might not be enough and added two more tasks: one was about displaying fractions on a given number line, and the other was about operations with decimals. The implementation was not like what she expected. She had to skip most of the tasks and could not ask students to write a journal because of the time limitation. At the beginning of the lesson, she explained to students what the activity was about, which could be considered a way of clarifying learning intentions (*Strategy A*). Ada reminded the previous knowledge on the board and frequently asked questions that required students to give short answers for the next step in a procedure. A discussion environment to elicit evidence for learning was not observed either at the beginning or throughout the lesson. She provided feedback to the students only at the task level or processing of the task level (*Strategy C*). An excerpt related to demonstrating how to make addition with decimal numbers (*for the operation $16.02+8.3$*) on the board was as follows:

I will line up the dots (in decimal numbers). Let me add it here. There is a hidden zero here, right? It does not matter when I write zero on the right side. (She put the zero). I can add it now. You already know we do subtraction by lining up the dots, right? (*FP-Strategy C*).

After recalling the previous knowledge, she wanted students to do the activity task by task. When students finished working on the stated task, Ada wanted a student to solve the task on the board. While students were working individually, she walked around the class and asked them if they needed help. She mostly gave students feedback about the task itself and the processing of the task (*Strategy C*) while observing them. Some feedback examples were “you probably made a mistake, check it”, which is also a way to activate students as the owners of their learning (*Strategy E*), “count the units first, how many parts did we divide the number line into?”, “pay attention to the denominators; they all have different denominators”. During the interview, she expressed that almost all students made calculation errors, and a few students could find the correct solution to the tasks related to the operations with decimals. However, she did not prefer to create a discussion environment about the possible reasons for students’ mistakes. She also did not encourage students to help each other to activate them as instructional resources for one another as planned. Instead, she wanted students to compare their solutions with the solution on the board to see their mistakes (*Strategy E*). She explained the reasons for the discrepancy between planned and enacted strategies as follows:

I wrote to the lesson plan that “discuss with your peer”, but I was unsuccessful in classroom management. I had to walk around quickly, so I could not say what I wanted. I wrote [these in] the lesson plan theoretically, but everything is different in the class. I tried to help them one by one, but it was very time-consuming.

In one class hour, students could solve the first two tasks related to operations with decimal numbers, the task added later related to displaying fractions on the number line, and the last task asking to draw the simplest fractions and find the secret image. For this reason, she indicated that she could only observe students’ learning in some objectives. According to her, students knew how to add and subtract with decimals since they raised their hands, and they always confirmed Ada when she asked, “did you understand?” Ada could not enact the journal since she did not have time. In the interview, she emphasized that she would like to implement the journal to have information from all students about whether the tasks were easy, difficult, or suitable for their levels.

As the answers to the questions in the post-interview about formative and summative assessment, she explained that summative assessment focuses on the product and is used for grading students. Students can be observed individually with summative assessment, which helps to see “whether the students can get to the point where I want them to do” (Ada). According to her, formative assessment is used to have information about whether students understand the topic and to monitor their progress. She indicated that she used questioning and observation (Strategy B) as formative assessment, and the journal would be another tool to see students’ learning. She thought that both assessment types were necessary. “Formative assessment gives feedback to the teachers while summative assessment feeds back to the students and gives information to the parents about students’ level of learning” (Ada). Moreover, she thought she learned how to use assessment theoretically but did not have the opportunity to practice them in the teacher education program.

Conclusion

Table 1 shows Ada’s planned and enacted formative assessment strategies in a task-solving classroom environment. Ada could differentiate between formative and summative assessments in the post-interview. However, she used many formative assessment strategies unintentionally and superficially due to some external factors, such as time limitations, as suggested by DeLuca et al. (2012). Besides, she was unaware that peer- and self-assessment were among the formative assessment strategies.

Table 1. Planned and enacted formative assessment strategies

Strategy	Planned Sub-strategy	Enacted Sub-strategy
(A)	Clarifying the topic of the lesson	Clarifying the activity
(B)	Observation (mentioned only in pre-interview (PIo))	Observation Questioning (Questions with short answers, not leading to the discussion)
(C)	Providing feedback (in the type of giving a clue/answer- PIo)	Providing feedback (in the type of FT and FP)
(D)	Collaborative learning (getting help from the peer-PIo)	-
(E)	Self-assess their work (comparing their answers with the correct ones) Lesson review Writing a journal	Self-assess their work (comparing their answers with the correct ones written on the board) Checking their work to find mistakes

She benefited from strategy A and clarified what the activity was about to direct students toward the lesson goal. She walked around the class as she planned while students were working individually. However, it was a very quick look that she could not observe and get feedback about students' progress deeply. The reason for that might be preparing an activity with many tasks aiming to assess the same content and not having enough time to pay attention to students' responses. Ada neither stated in the plan that she would create a discussion environment nor did she create it in the real class. She asked questions, which generally required yes/no answers, especially to remind students of previous knowledge. On the other hand, mathematics discussions are crucial for assisting students in developing conceptual understanding and engaging in participation in mathematical practice that helps build mathematical literacy and proficiency (Shaughnessy et al., 2021). Moreover, sharing ideas by show and tell, as students did in this case, is inadequate for generating collective thinking that promotes learning (Kazemi & Stipek, 2001). Therefore, Ada seemed to miss opportunities to provide more meaningful learning for students in her teaching.

Ada provided feedback on the task and processing of the task levels. However, feedback should focus on regulatory metacognitive processes to help reduce the discrepancy between current and intended learning (Harks et al., 2014). Her feedback was procedural since it included correcting calculation steps or showing the solution procedure. The reason for procedural feedback might be solving exercise-type of tasks (Stovner et al., 2021). Solving such tasks and not creating a rich discussion atmosphere might have affected the type of feedback provided.

When Ada realized she would not have enough time to implement the lesson plan, she first changed the lesson flow and desisted from peer- and self-assessment. Although she planned to create a collaborative learning environment and give opportunities for self-assessment, she did not allow students to assess and comment on their own and each other's work in the real classroom due to not losing classroom management. She also could not manage time, most probably due to her lack of teaching experience in a real classroom environment, and this influenced her formative assessment practices. This finding supported the idea that external factors can barrier (preservice) teachers' assessment practices (DeLuca et al., 2012). Although the study data were limited to one lesson observation, this experience showed us that even though PMTs know formative assessment strategies theoretically, they need to increase their capacity to implement these strategies. Since the time and classroom management skills of PMTs directly influence the assessment strategies used, PMTs are required to practice their assessment and teaching skills. Hence, it can be recommended that teacher education programs offer practice-based courses emphasizing the theoretical background. Since spending considerable time in real classrooms may improve PMTs' skills in formative assessment, conducting a longer-term study investigating how PMTs' planned and enacted formative assessment strategies evolve when they start teaching in schools can also be suggested.

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