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Investigating sources of pre-service teachers' self-efficacy for preparing and implementing mathematical tasks

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The goal of this study was to understand pre-service teachers' self-efficacy beliefs for preparing and implementing mathematical tasks and to explore which sources of self-efficacy they wighted and interpreted when judging their capabilities as a result of attending a mathematics teaching methods course designed with a focus on mathematics teaching through tasks. Nine pre-service teachers participated in this study and they were interviewed at the end of the methods course. Findings revealed that methods course provided opportunities for mostly vicarious experiences and physiological states sources, and participants were feeling highly efficacious to prepare mathematical tasks, but they had doubts about their capabilities to implement tasks effectively.

Keywords: Mathematical tasks, pre-service teachers, self-efficacy, sources of self-efficacy.

INTRODUCTION

Learning mathematics with understanding requires active student involvement in the process of learning through problem solving where students solve problems, evaluate and explain their solutions, make connections among concepts, create and use different representations of mathematical ideas, and communicate their mathematical thinking (National Council of Teachers of Mathematics [NCTM], 2000). Because problem solving is the center of this learning process, the problems (i.e., mathematical tasks) that are presented to students mainly determine the quality of learning environment in classroom and the level of students' understanding (Stein, Smith, Henningsen, & Silver, 2009). A mathematical task is a problem (or a set of problems) "the purpose of which is to focus students' attention on a particular

mathematical idea" (Stein, Grover, & Henningsen, 1996, p. 460). As research showed, to prepare and implement challenging tasks which promote students' higher-order thinking skills, teachers should have the required knowledge (Sullivan, Clarke, & Clarke, 2009). However, having necessary knowledge not always guarantee successful performance because self-efficacy is a strong determinant of performance (Bandura, 1997).

Researchers have reported that teachers' self-efficacy beliefs, or teachers' beliefs in their capabilities to bring about students' learning and achievement (Tschannen-Moran & Woolfolk Hoy, 2001), have the power to influence their instructional behaviors, attitudes toward teaching, their classroom management, as well as their students' motivation, achievement, and self-efficacy (Caprara, Barbaranelli, Steca, & Malone, 2006; Pajares, 1992; Woolfolk, Rosoff, & Hoy, 1990). When teachers hold strong efficacy beliefs, they spend more time with students who have difficulty in learning and try to improve their teaching; teachers with doubts in their capabilities, on the contrary, tend to experience burnout, job dissatisfaction, and leave the profession (Caprara, Barbaranelli, Steca, & Malone, 2006; Klassen, & Chiu, 2010). Thus, it is essential that teachers have strong beliefs in their capabilities to prepare mathematical tasks and enact them effectively with students.

Because of its crucial role in effective teaching, teachers' self-efficacy beliefs were studied in various domains, such as science and mathematics. However, studies were mostly focused on inservice teachers' self-efficacy (Klassen, Tze, Betts, & Gordon, 2011). Since efficacy beliefs are most likely to change during skill development (Bandura, 1997), it is important to study

pre-service teachers' self-efficacy and find ways to help them develop strong beliefs in their capabilities through teacher education programs. According to Bandura (1997), self-efficacy is developed through four different sources: Mastery experiences, vicarious experiences, social persuasions, and physiological states. Mastery experience, also the most powerful source of self-efficacy, is the information gained from personal performances where success boosts self-efficacy and failures undermine it. Vicarious experience refers to the information gained from observing or comparing oneself with model's performances. Model similarity determines the effect of this source on self-efficacy, the greater the assumed similarity is, the more persuasive the model's success or failures are. Social persuasion is the feedback received from others about personal capabilities. Finally, physiological states such as stress, anxiety, and mood during performances provide information for self-efficacy development (Bandura, 1997).

In order to help pre-service teachers build strong efficacy beliefs, it is necessary to understand factors that serve as sources for their self-efficacy. However, there is a lack of research on these sources because researchers have often been interested in exploring correlates and outcomes of teachers' self-efficacy (Klassen, Tze, Betts, & Gordon, 2011). Based on hypothesized sources of self-efficacy (Bandura, 1997), there were a few quantitative attempts (e.g., Poulou, 2007) which failed to examine the predictive power of each of the four self-efficacy sources. The quantitative nature of these studies did not allow for the exploration of which sources could be provided by teacher education programs, either. A qualitative approach, on the other hand, can contribute more to our knowledge of how factors related to teacher education program operate through sources for pre-service teachers' self-efficacy. This way, teacher educators can also be provided with a clear guideline for improving their programs to support self-efficacy of future teachers.

Concerned with the gap in the literature on sources of pre-service teachers' efficacy beliefs, this study was designed as an attempt to explore sources of pre-service elementary mathematics teachers' self-efficacy in the context of a mathematics teaching methods course. The focus of this study was on pre-service teachers' self-efficacy beliefs for preparing and implementing mathematical tasks, which was defined

as their beliefs in their capabilities to prepare (select, adapt, modify, or create) challenging mathematical tasks and enact these tasks in classrooms effectively.

METHOD

The present study was aimed at exploring sources of pre-service teachers' self-efficacy for preparing and implementing mathematical task after completing a mathematics teaching methods course. In order to reveal the insights of pre-service teachers upon enrolling in the methods course, qualitative case study method was employed. The context of this case study was Elementary Mathematics Education Program, more specifically, the methods course offered by this program at a large public university¹ in Ankara, Turkey. Nine out of 46 junior pre-service teachers studying in this program constituted the cases.

The methods course

As a part of Elementary Mathematics Education Program, pre-service teachers were required to enroll in the mathematics teaching methods course in their third year. This two-semester-long methods course was designed to help pre-service teachers learn to teach mathematics through challenging mathematical tasks, as well as to use and prepare manipulatives and integrate technology in mathematics education. The focus of this course was on both the Elementary Mathematics Curriculum (Ministry of National Education, 2013) covered in Turkey and NCTM Principles and Standards (NCTM, 2000). Methods course was taught by an associate professor for 14 weeks per semester and took place twice a week. On every Monday, there was a meeting for lectures on a chapter from the textbook, *Elementary and Middle School Mathematics: Teaching Developmentally* (Van de Walle, Karp, & Bay-Williams, 2010). Pre-service teachers were expected to read assigned chapters every week before attending lecture meetings. There were also several unannounced quizzes prior to these meetings. Two to three questions related to the weekly subject were asked in each quiz. After this two hours of theoretical study (i.e. lectures), on every Wednesday, there was a lab meeting for pre-service teachers' presentations of tasks they prepared about that week's topic. They worked in groups of 5–6 to create tasks and enact their tasks in the lab with their classmates. The instructor was giving feedback on

1 At this university, English was used as the medium of instruction.

each group's work, following their implementations. Pre-service teachers were expected to provide feedback to their peers as well. There were also a midterm and a final exam.

Participants

Nine junior pre-service teachers accepted to participate in this study. Eight of the participants were women and one was man. Required courses pre-service teachers had to complete throughout the program included mathematics content courses (e.g., calculus, analytic geometry), courses related to educational sciences such as educational psychology and classroom management, as well as Turkish, English, and basic physics courses. Elective courses on mathematics education were also offered by both Elementary and Secondary Mathematics Education programs. Participants were going to enroll in field experience courses in their last year as senior pre-service teachers.

Data collection and analysis

Data were collected through semi-structured interviews which were mainly guided by a list of questions prepared for pre-service teachers to gain an understanding of their perceived efficacy beliefs (e.g., *How confident are you in your capabilities to prepare challenging mathematical tasks effectively?*) and to provide deep information about the sources of their self-efficacy (e.g., *Which components of methods course made you feel confident about your capabilities to prepare challenging mathematical tasks effectively?*). The first author joined class meetings throughout the methods course to build trust with participants and interviewed participants at the end of the second semester of methods course. Each interview lasted around 30 minutes. Interviews were first audio-recorded and then transcribed by the first author as well.

Data were coded through constant comparative analysis method (Merriam, 2009), and data analysis process was two-fold. First, data related to participants' efficacy judgments for preparing and implementing tasks were coded. *Self-efficacy for preparing tasks* and *for implementing tasks* were the two categories used in this part of analysis because participants regarded their efficacy beliefs for preparing and using tasks separately. Then, data related to the efficacy-relevant information which participants referred to when judging their capabilities were

coded using hypothesized sources of self-efficacy (Bandura, 1997). That is, *mastery experiences* (when participants talked about the efficacy-relevant information gained through their own performances, like in group work), *vicarious experiences* (when vicarious learning occurred, like through observing peers' presentations), *social persuasion* (when participants mentioned the effects of feedback, like the feedback they received from the instructor on group work), and *physiological states* (when emotions and mood of participants were perceived as sources of self-efficacy, like having fun while creating tasks) were the categories used for coding the sources of participants' self-efficacy beliefs. Subcategories were created regarding components of methods course (i.e. lectures, group work, peers' presentations, feedback on group work, textbook, unannounced quizzes). A mathematics education researcher participated in coding process. A coding sheet was generated and both researchers (the first author and the coder) coded a randomly selected interview transcript. When results of each researcher's codes were compared, a 92% coder agreement was reached.

FINDINGS

Findings revealed that participants completed the methods course mostly with high sense of efficacy for preparing and implementing mathematical tasks. More specifically, 8 of the participants expressed strong self-efficacy for preparing tasks (e.g., "At this point, I feel really really efficacious because, like I said, we have activities about almost every subject in the curriculum, we prepared all of them," Participant 8 [P8]) and one expressed moderate self-efficacy ("I feel so-so [confident], I cannot claim that I can prepare real good activities," P5). Five participants were feeling strongly efficacious for implementing tasks, whereas 4 of them had doubts about their capabilities to implement tasks effectively (e.g. "I wish we had more chance to implement [tasks], so, like I said, I have doubts about putting [tasks] into practice," P1). Participants who were concerned about possible classroom management issues and felt the need for real classroom practices expressed less confidence in their capabilities to implement tasks than their counterparts.

Findings regarding the sources of pre-service teachers' self-efficacy showed that participants used efficacy-relevant information provided by all four

hypothesized sources of self-efficacy as a result of their enrollments in the methods course.

Mastery experiences

The methods course was found to support participants' efficacy development by providing mastery experiences through lectures, group work, and unannounced quizzes. Participants expressed two ways of mastery experiences that lecture hours provided. First, the instructor used questioning method where questions were aimed at promoting participants to explain how they would enact tasks from the textbook with their future students and to generate ideas for (accommodation or modification of) those tasks. This method nurtured participants' thinking to enhance and master their knowledge for preparing and implementing mathematical tasks, and participants' successful performances boosted their self-efficacy. Second, the expectations of the instructor from participants affected the level of effort they put forth, and the amount of effort participants expended influenced their self-efficacy.

As a source of mastery experience, participants expressed positive effects of working as a group to design mathematical tasks and implement those tasks in class during lab hours. However, one participant had problems with her group members and she didn't believe that group work contributed to her efficacy development.

When judging their capabilities, participants referred to their performances in unannounced quizzes they had to take before lectures. Findings showed that these quizzes operated through mastery experience source for participants' efficacy beliefs.

Vicarious experiences

Vicarious experiences as another source for self-efficacy of participants were provided by lectures, group work, peers' presentations, and the textbook. The effect lectures created on participants' self-efficacy was perceived as vicarious experience source, where the instructor was transmitting her knowledge and skills. The instructor's lecturing with an emphasis on the features of challenging mathematical tasks and "tips" to use such tasks effectively in classroom context were believed to positively affect participants' efficacy development.

Group work was regarded as a different vicarious experience source. Working as a group was perceived as a more positive influence than working on a task alone, for it gave participants the chance to learn from each other vicariously.

As findings revealed, participants viewed their peers' presentations in the lab as a learning source which contributed to their self-efficacy vicariously. Their peers were also models to whom participants referred when judging their own capabilities. Thus, peers created the opportunity for social comparison. When participants compared themselves with their counterparts, they mainly focused on competent ones. Such successful examples motivated participants to do better.

Additionally, the textbook was perceived as a symbolic model for learning and operated through vicarious experience source. Reading prior to lecture hours also increased participants' understanding from lectures. Participants stated that they could benefit more from lectures, since they were prepared for the class. Participants appreciated the quality of the book, too; yet they experienced trouble with reading it. First, the book was written in English and it required extra time to finish reading a chapter than reading any text written in Turkish. Second, participants thought the second semester's readings were longer and more complicated, which took more time to complete reading assigned chapters and caused them struggle to understand. Thus, participants sometimes did not even finish reading before attending lectures.

Social persuasions

Feedback on group work which participants received during methods course operated through social persuasion source for participants' self-efficacy. At the end of each group's presentation in the lab, pre-service teachers and the instructor provided feedback about each group's work. These feedback (i.e. evaluative feedback) contained information about their capabilities and were perceived as a way of self-assessment. Among the three sources of feedback (i.e. the instructor, group members during group work, and peers during lab hours), the instructor was found to be the most effective because, with her knowledge and experiences, she was more credible. However, participants thought the instructor was being judgmental from time to time.

In addition to feedback provided during lab hours, participants regarded lectures as a social persuasion source. Recall that participants uttered the difficulty of reading long and complicated chapters. Thus, they believed that readings should be supported by lectures, since they sometimes misinterpreted the information in the textbook or sometimes "didn't even understand what the book was saying" (P3). This way, lectures worked as corrective feedback, a social persuasion source for self-efficacy which helped participants learn from their mistakes and improve their knowledge.

Physiological states

Findings showed that the methods course provided physiological states source for participants' efficacy beliefs through group work, peers' presentations, feedback on group work, textbook, and unannounced quizzes. First, group work operated through physiological states source, and participants interpreted their emotions and mood during preparing and implementing tasks when judging their capabilities. Participants mostly enjoyed working together in a group to create and present tasks. On the contrary, one participant uttered that she felt anxious when presenting tasks in the lab, but she was still confident that she would enact tasks with her future students effectively because she believed she would feel more comfortable with students.

Participants expressed positive affective states like having fun when working on peers' tasks, too, but they got bored and showed reluctance to participate when they were assigned to low quality tasks. According to Bandura (1997), positive moods enhance self-efficacy and negative emotions lower it. Since participants did not experience negative emotional arousal (e.g. getting sad, angry, or stressed), it could be asserted that peers' presentations mostly contributed to participants' self-efficacy.

The feedback received from the instructor were perceived as a negative influence for some participants. Like mentioned earlier, there were participants who thought that the instructor could be judging and criticizing. Therefore, when preparing tasks, some participants were affected negatively from the instructor's criticism and either doubted their capabilities or experienced negative arousal (e.g. anxiety).

As a physiological states source, reading the textbook caused boredom for one participant. She explained that she was bored with reading in English.

Even though unannounced quizzes were viewed as a "push" for studying for lectures and in turn actively participating on Mondays, they also caused stress and anxiety. When participants didn't have time to complete reading assigned chapters or when they failed to understand ideas presented in the textbook, they felt distressed because these quizzes were added up to overall grades.

DISCUSSION

In this study, the aim was to investigate sources of pre-service elementary mathematics teachers' efficacy beliefs for preparing and implementing mathematical tasks. In addition to detecting which sources pre-service teachers relied on to construct their efficacy beliefs, this study was an attempt to define components of methods course which predicted pre-service teachers' self-efficacy. Findings revealed that methods course provided all four sources for self-efficacy beliefs of pre-service teachers. That is, various components (i.e., lectures, group work, peers' presentations, feedback on group work, textbook, and unannounced quizzes) of the course operated through different sources and contributed to the development of pre-service teachers' efficacy beliefs. When compared to other sources of self-efficacy, components of methods course mostly operated through vicarious experiences and physiological states sources for self-efficacy. It could be that participants weighted these two sources of self-efficacy more than mastery experiences, since their mastery experiences were limited to group work, involvement in lectures, and unannounced quizzes.

An important finding was that lectures had the power to operate through mastery experiences for pre-service teachers' efficacy judgments, when the instructor used questioning method in her lectures. Participants of this study mainly perceived lecture hours as a vicarious experience source, like one would expect because lecturing is the transmission of knowledge and skills (Bandura, 1997) from the instructor to pre-service teachers, but the instructor was able to take this further by using questioning method. Questioning promoted participants' thinking and generating ideas about preparing and

using mathematical tasks, and participants relied on experiences gained through cognitively enacting and verbally sharing their ideas. Teacher educators then should design courses where pre-service teachers are encouraged to actively participate in lectures and share their thoughts on preparing and implementing tasks.

Modeling is a strong influence on self-efficacy (Bandura, 1997), and findings showed that participants gained vicarious experiences through models similar to them (i.e. peers), the instructor as a competent model, and the textbook as a symbolic model. Therefore, teacher educators should promote vicarious learning of pre-service teachers from each other, which might be achieved by letting them work in groups or asking them to evaluate peers' tasks and give feedback. Classroom discussions might also create the environment for pre-service teachers to contribute to peers' learning. Teacher educators should also share either their own experiences or other teachers' experiences on preparing and implementing tasks, by using video recordings for example, to provide pre-service teachers with various vicarious learning opportunities. The quality of textbook used is also found to be an important issue that teacher educators should take into account. Task samples in the textbook and clear and detailed information proposed there can help pre-service teachers gain experiences vicariously and contribute to their efficacy development. Reading chapters as a requirement of methods course, as findings showed, might enable pre-service teachers to benefit more from the lectures. Thus, it is important to motivate them do the readings prior to lectures. One way of providing such motivation could be unannounced quizzes, like findings showed. Yet, quizzes might cause stress and anxiety, if pre-service teachers have difficulty in completing reading assignments. Choosing a textbook easy to read and understand might prevent pre-service teachers from experiencing negative affective states.

Findings also revealed the crucial role of physiological states in the development of pre-service teachers' efficacy beliefs. Even though participants talked about mainly positive emotions and moods, when faced with criticism, they experienced negative affect. Bandura (1997) stated that "moderate levels of arousal heighten attentiveness and facilitate deployment of skills" (p. 108). Teacher educators, therefore, should

be cautious in controlling the level of arousal pre-service teachers' experience. Creating a classroom environment in which pre-service teachers will feel comfortable and voice their thoughts without being criticized can boost their self-efficacy.

Upon completing methods course, almost all of the participants (8 out of 9) regarded themselves strongly efficacious for preparing tasks, whereas only 5 of them expressed high level of efficacy for implementing tasks. Participants stated that they had doubts about classroom management and in turn they didn't express strong efficacy for implementing tasks. From this aspect, the lack of mastery experiences in actual classroom contexts might have caused lower level of development in pre-service teachers' self-efficacy. As Bandura (1997) asserted, mastery experience is the most powerful source of self-efficacy. Thus, offering fieldwork experiences as a part of methods course might help pre-service teachers to benefit more from this course.

The importance of this study is its attempt to describe how methods course provided sources for pre-service teachers' self-efficacy than simply defining which sources pre-service teachers used to develop their efficacy beliefs, as in previous research (e.g., Poulou, 2007). However, because this study is limited with 9 pre-service teachers, examining sources of pre-service teachers' self-efficacy with a larger sample can reveal how different elements of methods course support pre-service teachers' efficacy development. One way of achieving this can be using open-ended questions, and findings of this study might help researchers with the design of such questions.

Longitudinal studies can also show how pre-service teachers construct their efficacy beliefs over the time of methods course and the ways sources for their self-efficacy interact. Such an approach can also disclose the influence of other courses and experiences pre-service teachers engage in outside of methods class.

Considering the power of physiological states on self-efficacy, a broader approach to the investigation of pre-service teachers' efficacy beliefs as perceptions of competence (e.g., Coppola, Di Martino, Pacelli, & Sabena, 2012) and the role of emotions on the construction of self-efficacy can illuminate the pathways to support future teachers' beliefs through teacher education programs.

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