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Factors that pre-service elementary teachers perceive as affecting their motivational profiles in mathematics

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Abstract The purpose of this study was to examine the sources that pre-service teachers (PSTs) use when they construct their self-efficacy beliefs and learning goals, which compose their motivational profiles. Pre-service elementary teachers (n=22) with different motivational profiles participated in narrative interviews designed to examine retrospectively their past experiences in mathematics and the effect of those experiences on their motivational profiles. Results reveal that participants relied on multiple sources to construct their efficacy beliefs and goals, including past performance, vicarious experiences, verbal persuasions, career goals, and the fit between participants' views of mathematics and the nature of mathematics in their classes. While some of these factors have been identified by previous research, the contribution of the current study is to extend this research to a new population and to elaborate on these factors. Results also help refine and extend our knowledge of PSTs' motivation and suggest ways that teacher educators could influence PSTs' motivational profiles.

Keywords Prospective teachers · Mathematics · Self-efficacy · Learning goals · Motivation · Teacher preparation

1 Introduction

The purpose of this study was to examine the sources that pre-service teachers (PSTs) use to construct their self-efficacy beliefs (their beliefs about their mathematics ability) and learning goals (their reasons for learning mathematics). PSTs' self-efficacy beliefs and learning goals are important because students who hold certain beliefs about their mathematics ability and certain goals and reasons for doing mathematics may actually learn more mathematics than their peers (see, e.g., Chen, 2003; Gutman, 2006; Wolters, 2004). Thus, by paying attention to and possibly influencing PSTs' self-efficacy beliefs and goals, teacher educators may be able to help PSTs learn a deep level of mathematics and

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mathematics knowledge for teaching (Hill, Rowan & Ball, 2005) in their mathematics content courses for teachers. To do this, teacher educators need to know how these beliefs and goals develop over time. Unfortunately, little work has been done on the development of PSTs' mathematics self-efficacy beliefs and learning goals. Thus, the goal of this study is to examine retrospectively how PSTs' mathematics self-efficacy and learning goals develop in the contexts of K-12 education, teacher education, and outside-of-school experiences.

1.1 Motivational profiles

I use the definition of Hulleman, Durik, Schweigert and Harackiewicz (2008) of motivation as "a motive (e.g., wish, intention, drive) to engage in a specific activity" (p. 298). Multiple researchers have studied many areas of motivation (for a review, see Graham & Weiner, 1996). In this article, I focus on two areas of motivation: (1) expectancy theory and (2) reasons for engagement. Expectancy theory concerns individuals' beliefs about their competence and their likelihood of success or failure (Eccles & Wigfield, 2002). Reasons for engagement concerns why individuals engage in certain tasks or events (Eccles & Wigfield, 2002). In this article, I examine one construct of expectancy theory, self-efficacy beliefs, and one construct of reasons for engagement, learning goals, to provide one possible picture of PSTs' motivation to learn mathematics.[1]

Mathematics self-efficacy beliefs are beliefs about one's ability to succeed in mathematics (Bandura, 1977). Mathematics learning goals are reasons for learning and doing mathematics; multiple learning goals can be held concurrently (Midgley, Kaplan & Middleton, 2001; Van Yperen, 2006). In the literature related to mathematics learning, most studies examine three types of learning goals: (1) mastery goals, where a person learns for understanding and mastery of the material; (2) performance-approach goals, where a person learns for good grades, praise, or looking good in front of peers; and (3) performance-avoidance goals, where a person learns to avoid failing, criticism, or looking bad in front of others (Ames, 1992; Midgley et al., 2001). Research suggests there is a direct relationship between high mathematics self-efficacy (a strong belief in one's ability to succeed in mathematics) and mastery goals (Middleton, Kaplan & Midgley, 2004). This relationship provides a rationale for studying mathematics self-efficacy and learning goals together. In this article, I will call PSTs' mathematics self-efficacy beliefs and learning goals taken together their motivational profiles (examples of four possible motivational profiles are given in Table 1).[2]

1.1.1 Why motivational profiles?

Motivational profiles are important because research suggests they may influence students' learning of mathematics. In particular, the most productive motivational profile for promoting learning appears to be high mathematics self-efficacy and mastery learning goals. Research examining non-PST populations (little work has examined the PST population) has shown higher mathematics self-efficacy and mastery learning goals predict greater mathematics performance than other levels of self-efficacy and other learning goals

[1] There are other theories concerning expectancy theory and reasons for engagement (e.g. Eccles et al. expectancy-value model (Eccles et al., 1983)). The similarities, differences, and relationships between the different theories are not yet completely reconciled and are beyond the scope of this article.

[2] The four motivational profiles provided in Table 1 are simply examples I created. There are many different possible motivational profiles.

Table 1 Four possible motivational profiles, based on the definitions of self-efficacy and learning goals

Example	Mathematics self-efficacy	Mastery goals	Performance-approach goals	Performance-avoidance goals
Students who believe they are good at mathematics and are learning for understanding, not for grades or to avoid failing	High	High	Low	Low
Students who believe they are bad at mathematics and are learning to get a good grade and avoid looking bad at mathematics in front of peers	Low	Low	High	High
Students who believe they are good at mathematics and are learning mathematics in order to understand it and receive a good grade in it	High	High	High	Low
Students who believe they are bad at mathematics and who are learning mathematics to avoid failing	Low	Low	Low	High

(Chen, 2003; Gutman, 2006; Wolters, 2004). While performance and learning are not the same, performance is often used as a proxy measure for learning. Because multiple studies using different performance measures have shown students with high mathematics self-efficacy and mastery learning goals perform better than other students, it is probably reasonable to assume that high mathematics self-efficacy and mastery learning goals promote learning. High mathematics self-efficacy and mastery learning goals may promote learning because they influence mediating variables such as effort, persistence, and interest that in turn influence students' learning (Navarro, Flores & Worthington, 2007; Wolters, 2004). This research suggests that in their mathematics content courses for teachers (hereafter, referred to as "content courses"), PSTs with productive motivational profiles (high mathematics self-efficacy and mastery learning goals) may learn more mathematics and mathematics knowledge for teaching than other students.

1.1.2 How motivational profiles develop over time

If teacher educators understood how PSTs' motivational profiles developed over time, it might be possible for them to encourage PSTs' to develop more productive motivational profiles. For example, if teacher educators knew that verbal encouragement from teachers could influence motivational profiles, we might be able to use verbal encouragement to help PSTs' motivational profiles become more productive. Unfortunately, little research has been conducted on the development of PSTs' self-efficacy and learning goals. However, research with other student populations provides an initial framework for how motivational profiles could develop in the PST population (see Fig. 1, described in greater detail below).

In particular, research suggests mathematics self-efficacy may be influenced by four factors. First, mathematics self-efficacy may be influenced by past performance; students with successful past mathematics experiences may come to feel they are better at mathematics (Lopez & Lent, 1992; Usher, 2009). Mathematics self-efficacy may also be influenced by verbal persuasions, statements from others that attempt to convince someone of his or her abilities. Encouraging verbal persuasions may raise a students' self-efficacy while discouraging persuasions may lower it (Usher, 2009). Third, vicarious experiences may influence mathematics self-efficacy (Usher, 2009). Vicarious experiences occur when a student observes others performing an activity and then makes judgments about his or her

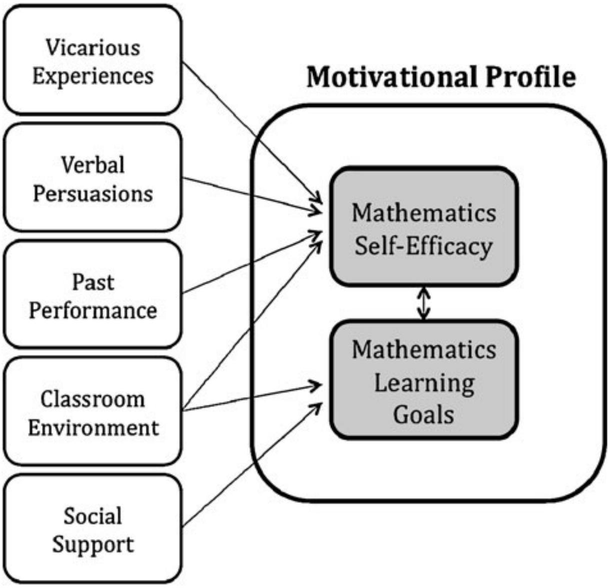

Fig. 1 Factors that affect the development of PSTs' motivational profiles, based on previous research

own ability based on these observations (e.g., "Wow, he makes that math look easy. I bet I can do it.") (Bandura, 1977). Vicarious experiences may also include social comparisons, where students come to feel better or worse about their own mathematics abilities by comparing them with others' mathematics abilities (e.g., "Wow, I can do that problem better than him. I must be pretty good at math.") (Pietsch, Walker & Chapman, 2003). Finally, classroom environment may influence mathematics self-efficacy. Specifically, research, including research with PSTs, suggests a course based on a constructivist approach to learning that incorporates group work, the use of investigation, and a push for mastery and deep conceptual understanding, can raise students' mathematics self-efficacy (Dorman, 2001; Harkness, D'Ambrosio & Morrone, 2007).

Research suggests mathematics learning goals may be influenced by two factors. First, classroom environment may influence learning goals. In particular, research suggests challenging tasks, methods of questioning, and classroom goal structure may encourage the development of mastery goals (Cocks & Watt, 2004; Morrone, Harkness, D'Ambrosio & Caulfield, 2004; Wolters, 2004). In a study of PSTs in particular, Morrone et al. (2004) showed that when instructors structured their dialog and classroom discourse in order to support higher-order thinking, many of the PSTs developed mastery goals. Mathematics learning goals may also be influenced by social support and encouragement from parents, peers, and friends (Cocks & Watt, 2004; Summers, 2006). This support may take the form of goals that parents or peers emphasize. In particular, if parents emphasize mastery goals, their children may then more likely to develop mastery goals for themselves; if parents emphasize performance-approach goals, their children could be more likely to develop performance-approach goals for themselves (Friedel, Cortina, Turner & Midgley, 2007).

Because much of the research looking at factors that may influence mathematics self-efficacy and learning goals have been done separately (studying only mathematics self-efficacy or only learning goals), the relationship between some of the factors is unclear. For example, it seems likely that there is a relationship between social support (a source of learning goals) and verbal persuasions (a source of self-efficacy). Because these relationships are not well understood, in this study, I examined all five possible sources separately to see how they influenced participants' motivational profiles (see Fig. 1).

1.2 Pre-service teachers' motivational profiles

In spite of the probable role of motivational profiles in influencing learning, little of the above research has examined the PST population. PSTs' motivational profiles are particularly important because PSTs will eventually use their own understanding of mathematics and their mathematics knowledge for teaching to teach others mathematics. In addition, pre-service elementary teachers' differ from other populations in that they often have high levels of mathematics anxiety, have relatively low levels of mathematics achievement and conceptual understanding, and are more likely than other students to hold negative attitudes about mathematics (Ball, 1990; Kelly & Tomhave, 1985; Rech, Hartzell & Stephens, 1993). Finally, a majority of pre-service elementary teachers in the USA are female and research suggests females tend to have lower levels of mathematics self-efficacy than males (Betz & Hackett, 1983). Because of this unique background and orientation toward learning mathematics, PSTs' motivational profiles might develop differently from those of the populations previously studied. Thus, it is important to examine if the five factors identified by previous research apply to PSTs and, if they do, in what ways the development of PSTs' motivational profiles differs from the development of motivational profiles in other populations. Moreover, research is needed to determine if other less studied factors influence the development of PSTs' motivational profiles.

In this study, I examined the influence of the five factors identified by previous research on the motivational profiles of one sample of PSTs. I also sought to determine other factors influencing motivational profiles. The research question addressed was:

> What factors do pre-service elementary teachers who have completed three mathematics content courses for teachers report as having affected the development of their motivational profiles?

2 Methods

The goal of this study was to use a narrative approach to examine retrospectively factors that PSTs reported as affecting the development of their motivational profiles. A narrative approach is a qualitative research approach in which the researcher investigates and analyzes participants' stories or narratives, in this case, stories about participants' past mathematics experiences and about their development as learners of mathematics (Kaasila, 2007a; Riessman, 1993). Researchers using this approach argue that individuals use stories to understand themselves and thus studying individuals' stories is a way of understanding the individuals (Drake, 2006). Thus, a narrative approach is a "way of understanding subjects' own constructions of their personal…realities" (Drake, Spillane & Hufferd-Ackles, 2001, p. 3). This approach also allows for the understanding of beliefs as interrelated (Drake et al., 2001). The use of a narrative approach to study mathematics self-efficacy and learning goals is particularly important because the bulk of the research on these two constructs in mathematics education has been quantitative. What little research has been conducted using a narrative approach has examined only self-efficacy and has not focused on the population of PSTs (e.g., Usher, 2009; Zeldin & Pajares, 2000).

A narrative approach can either focus on the content of participants' stories, the form of participants' stories, or both (Kaasila, 2007b). In this study, I focus on the content of participants' stories. As such, my job as a researcher was to "explicate how the person's earlier experiences have influenced his or her past and present mathematical identity" (Kaasila, 2007a, p. 374). Since a narrative approach allows for the understanding of motivational profiles contextualized within participant's experiences and subsequent behaviors (Drake, 2006), this study enriches teacher educators' knowledge of how PSTs' motivational profiles develop.

2.1 Participants

Participants were pre-service elementary teachers enrolled in mathematics methods courses[3] for elementary teachers at a large public university on the East Coast of the USA. At this university, pre-service elementary teachers take three mathematics content courses and one mathematics methods course as well as other education and content courses as a part of their undergraduate degree program. The first two mathematics content courses focus on number and operation in integers and rational numbers while the third course focuses on geometry. All three mathematics content courses focus on both mathematics and mathematics knowledge for teaching, use common lesson plans designed around constructivist learning principles, and place an emphasis on problem solving and the development of conceptual understanding. Upon completion of all coursework, students at this university participate in a semester long field experience with a cooperating elementary school teacher. Assuming PSTs successfully finish these requirements, they graduate and are eligible to be certified to teach elementary school.

One goal of this study was to examine retrospectively (through participants' stories) the perceived effects of the content courses on PSTs' motivational profiles. Thus, students enrolled in the mathematics methods course were chosen to participate because they had recently completed the three mathematics content courses for elementary teachers. I chose participants (n=22, 19 female, three male) purposefully so that the sample would have students with a range of motivational profiles (e.g., participants with different levels of self-efficacy and participants with different types of learning goals). This allowed me to study retrospectively the development of different motivational profiles over time.

I used a survey to choose the participants purposefully. All students enrolled in the mathematics methods course who agreed to participate in research (N=61) took two modified student scales from the Patterns of Adaptive Learning Scales (PALS) (Midgley, Maehr, Hruda, Anderman, Anderman, Freeman et al., 2000). According to the authors, the PALS has been "developed and refined over time… to examine the relation between the learning environment and students' motivation, affect, and behavior" (Midgley et al., 2000, p. 2). Participants took a modified[4] version of the personal achievement goal orientations scale (to measure their learning goals) and a version of the portion of the academic-related perceptions, beliefs, and strategies scale that was related to self-efficacy. Participants responded to questions on a scale between 1 (not at all true) and 5 (very true).

[3] The course instructors and the interviewer (myself) were not the same person. None of the participants were my students at the time of the study.

[4] Modifications included replacing the phrase "in class" with "in my math classes" and the phrases "the work" or "my work" with "math" or "math work." For the revised version of PALS, all subscales were reliable with Cronbach's alphas over 0.8.

2.2 Interviews and analysis

Participants selected based on survey results were asked to participate in two interviews. The first interview took place four or five weeks after the survey and the second interview took place 8 or 9 weeks after the survey. The time between the survey and the first interview allowed me to analyze the survey data and select participants. The time between the first and the second interviews allowed me to begin analyzing the interview data and create case descriptions (see below for more information). Thus, the data collection spanned a total of 9 weeks (out of a 15-week university semester).

My first and primary interview protocol (see Appendix) was open-ended to allow for participants' unique narratives to emerge and semi-structured to ensure each participant was asked about the same ideas. I developed the interview protocol by modifying the narrative protocol of Zeldin and Pajares (2000); this narrative protocol was developed to study the development of adult women's self-efficacy. I modified this protocol so that it focused on both mathematics self-efficacy and learning goals, including all five possible factors of motivational profiles identified from my review of the literature (see Fig. 1), and fitting the population of PSTs.

The first interviews lasted between 30 min and 1 h, and I audiotaped and transcribed them verbatim. In addition, I took notes throughout the interview in order to write down ideas that needed further elaboration or that I wished to return to, allowing me to avoid interrupting participants. I coded the interview data based on the recommendations of Miles and Huberman (1994). Specifically, to align my analysis with my theoretical framework, I developed an initial list of codes based on the five factors identified using previous literature (see Fig. 1). I then revised this code list during initial coding so that it better aligned with my actual data. For example, as my results will show (see below), past performance was more nuanced than just focusing on performance. Thus, I revised my codes to reflect the nuance apparent in my data. During the final stage of analysis, another mathematics education researcher and I double-coded approximately 10% of the data; we resolved all disagreements, making several changes to code definitions to ensure code reliability. I used this revised code list for the final analysis. Using a semistructured interview protocol allowed me to search for recurring phrases and themes and commonalities across participants. This helped me understand how participants' motivational profiles had developed as a result of events in their mathematics narrative.

My second interview was designed to serve as a participant check where I checked my data and my initial conclusions with the participants (Lincoln & Guba, 1985). The goal of a participant check is to identify and minimize any possible biases of the researcher. As such, I was open to revising participants' cases in light of any new data that arose from the second interview. Interviews lasted between 20 and 40 minutes and were audiotaped and transcribed verbatim. During the interview, I gave participants a case description, designed from the data from the first interview and from initial analysis, that summarized participants' mathematics narratives and the ways the events in the narrative affected their learning goals and self-efficacy. I asked participants to elaborate or disagree with anything in the description in order to make it better reflect themselves. Participants' responses to the case description were coded to focus on any changes made (and thus search for ways my initial analysis may have failed to capture participants' profiles accurately). No participant completely disagreed with his or her case description, giving credence to my analysis. In several instances, participants added elaborations to their case descriptions, providing me with more detail about the development of their motivational profiles.

Table 2 Factors that participants reported as affecting their motivational profile

Factor from previous research	Factor from current study	Participants	
		Number	Percent
Past performance	Past performance	22	100
	Past understanding	22	100
	Past effort	16	73
Verbal persuasions	Verbal persuasions	12	55
	Expectations	12	55
Vicarious experiences and social comparisons	Vicarious experiences	15	68
	Social comparison	20	91
N/A	Fit with the nature of the mathematics in content courses	22	100
	Fit with the nature of the mathematics in non-content courses	13	59
N/A	Career goals	22	100

3 Results

The factors that participants perceived as affecting their motivational profile are provided in Table 2 (described in more detail below). Participants described influences on the development of their motivational profiles that confirmed findings from previous research, including past experiences, verbal persuasions, and vicarious experiences. However, the ways in which participants talked about these factors elaborated on the results of previous studies conducted with non-PST participants (see above). In addition, participants identified two factors that were rarely mentioned in the previous literature, career goals, and fit between participants' beliefs about mathematics and the mathematics in their courses.

3.1 Past performance

All 22 participants recalled times when their past performance affected their motivational profile. In line with previous research (see, e.g., Usher, 2009), participants tended to state that negative performance (doing poorly) lowered their self-efficacy and positive performance raised their self-efficacy. For example, Lisa[5] said of her eighth grade mathematics class:

> That made me feel less confident because obviously I got a bad grade and it's not all about…what the grade is. But to me it was like I didn't succeed at it so it made me feel I wasn't good at it. (Interview 2)

The focus on past performance as a factor affecting motivational profiles seemed to occur for participants with a more productive and a less productive profile; even participants who had high self-efficacy spoke about negative past performance as lowering their self-efficacy (though temporarily, their self-efficacy had returned to a high level by the time of the interview).

[5] To protect participants' identities, all names are pseudonyms.

Past performance also seemed to affect participants' learning goals, a result not often mentioned in previous studies. In particular, 12 participants (54.5%) talked about how doing poorly made them worry more about their grades and passing (performance goals) and care less about mastery. For example, Mary said, "Once I saw that my grade was slipping, I just got to a point where I was like, I don't even really care about learning the material" (Interview 1). And Lorelei said, "after the first tests, since I didn't do as well as I would have liked, afterwards I was learning to get the better grades on the tests so that I would pass the class" (Interview 1).

One result of my study is that participants viewed past performance as not just being about performance; participants also focused on understanding and on effort. All participants recalled times when their past understanding influenced their motivational profiles. Participants reported that past understanding led them to hold a more productive profile and lack of understanding led them to hold a less productive profile. For example, Lisa talked about understanding raising her mathematics self-efficacy, saying, "[my math courses]… made me feel good at math because I could definitely see those things and see the concepts that we were talking about" (Interview 1). And, Sandra spoke of how her lack of understanding focused her on performance goals, saying, "[I was] probably more focused on grades… 'cause I didn't have an understanding of the math, I just did it because that's the way they showed it to us" (Interview 2).

Participants also spoke of their past effort as affecting their motivational profiles. For 16 participants (72.7%), the amount of effort they had to exert to achieve their performance or understanding affected their motivational profile, with more effort leading to a less productive motivational profile (because it signaled they were not good at mathematics) and less effort leading to a more productive motivational profile. For example, Leann said, "Up until calculus, stats and calculus, I had always been really well, good at math, I didn't have to study really at all" (Interview 1). And Mary said, one mathematics experience made her feel less confident in mathematics "Because I wasn't… able to do the math as easily, it was harder for me" (Interview 2). It is possible this result is a sign that participants interpreted being good at mathematics as based on fixed ability (thus, effort was a sign that they lacked the fixed ability and could not be good at mathematics).

3.2 Verbal persuasions

Twelve participants (54.5%) recalled how verbal persuasions from others affected their motivational profiles. Verbal persuasions came from either parents (mentioned by seven participants) or teachers (mentioned by ten participants). For mathematics self-efficacy, participants reported that positive verbal persuasions raised their self-efficacy. For example, Carla recalled her mother's verbal persuasions: "My mom sometimes would be like, well, you're pretty good at math" (Interview 1). And, Veronica recalled her teachers' verbal persuasions: "My teachers…always knew that I really liked math and that I was good at it" (Interview 1). For learning goals, participants reported that verbal persuasions from parents and teachers persuaded them to focus on grades (performance goals). For example, Lisa recalled, "my parents basically said that if I don't pass any classes [in college] I have to pay for them. So that made me focus on the grade" (Interview 1). And Margo recalled, "[my third grade math teacher] just was like I really want you guys to do really well on this exam so if you guys all get like an A or a B, I'll dance on my desk" (Interview 1). The link between learning goals and verbal persuasions is particularly interesting given that previous research has focused on support and encouragement as sources of learning goals (Cocks & Watt, 2004; Summers, 2006) but has not specifically focused on verbal persuasions.

Participants also spoke of how the expectations of others served as a type of persuasion that affected their motivational profiles, particularly their learning goals. Twelve participants (54.5%) spoke of instances where expectations affected their motivational profiles. Again, expectations seemed to come either from parents (mentioned by ten participants) or teachers (mentioned by five participants). For example, Sarah spoke of her need to focus on grades saying, "well [my mom] would always expect me to get good grades…if I didn't, she probably wouldn't have really accepted that" (Interview 1). And, Adriane said, "I mean like the teachers who had high expectations of me or my whole class, I guess that kind of did make me want the A [the highest grade] because they had high expectations" (Interview 1).

3.3 Vicarious experiences and social comparison

Fifteen participants (68.2%) spoke of how vicarious experiences from family members affected their motivational profiles, particularly their self-efficacy. Participants recalled how their parents' success in mathematics raised their self-efficacy. For example, Mary said:

> I guess I just saw that [my mom and my brother] were… confident in their math abilities so as a result I guess that rubbed off on me and I was always confident in my abilities. (Interview 1)

And Adriane when talking about her dad who was "pretty good at math" said, "I guess it made me realize that eventually I'd be as good as he was at math [laughs]" (Interview 1).

A different, more common type of vicarious experience that participants reported as affecting their motivational profiles was social comparison. Twenty participants (90.9%) mentioned social comparison as a source of their motivational profile. Participants reported instances where social comparison raised their mathematics self-efficacy (because in comparison to others they felt good at mathematics) and instances where it lowered their self-efficacy (because in comparison to others they felt bad at mathematics). For example, Lisa spoke of an increase in her mathematics self-efficacy after she was put in an accelerated program because this made her feel smart in comparison to her peers. She said:

> I think it really boosted my confidence level to be in this accelerated program because when I got pulled out…to go work on math, I remember being like, ooh, you know, I'm leaving to go and do math stuff… 'cause I'm like a smart kid.
> (Interview 1)

On the other hand, Michelle spoke of times when her self-efficacy decreased because she felt that other students were smarter than she was:

> So everyone who was…in the higher classes were always much, I guess, I don't want to say this, but they were always much smarter than me in a way. Because they just like got it and they like literally made formulas in their spare time and I'm like alright, I don't do that, so. (Interview 1)

The most common source of social comparison was with peers; however, participants also mentioned other sources of social comparison. For example, Sandra compared herself to her mother and her sister, both of whom she considered better at mathematics than she was. She said:

> Growing up with my sister and my mom being good in math I guess it was just, I always knew that there would be someone better at math than I was so… like again with the whole confidence thing. (Interview 1)

3.4 Fit with the nature of the mathematics

At some point, all participants spoke of a lack of fit between their expectations and beliefs about mathematics and the nature of the mathematics in their courses. PSTs often expressed this lack of fit by saying that the mathematics was “different” or “new.” The most common mention of this lack of fit was in relation to the mathematics content courses, where PSTs tended to say the lack of fit caused their motivational profiles to become less productive. For example, Veronica expressed how a lack of fit increased her performance goals: “Well in college I guess I worried about my grades a little more because it was just a different math course that I wasn’t used to” (Interview 1). And Tara spoke of the lack of fit lowering her self-efficacy: “[The content courses were] a huge difference and it just made me realize that I wasn’t that good at math” (Interview 1).

While the most common reaction to the lack of fit in the content courses was a less productive motivational profile, in rare instances, participants spoke of occasions their motivational profile became more productive. For example, Adriane reported an increase in mastery goals, saying, “[In the content courses I placed emphasis] more on interest than the grade ‘cause it was just a whole different kind of math” (Interview 1). Why a new mathematics experience affected motivational profiles differently is unclear from my results. It is possible that students’ interest or effort mediates between their experience with a “new” type of mathematics and their motivational profile. It is also possible that some students are simply more resilient in the face of challenge.

Thirteen of the PSTs (59.1%) also talked about a lack of fit in their mathematics classes before the mathematics content courses. Several sources of mathematics feeling new or different were proofs (“proofs never felt like math to me” (Adriane, Interview 1)), statistics (“I think I struggled with statistics in high school a little bit so I think that made me a little less confident ‘cause it was a different kind of math” (Carla, Interview 2)), Calculus (“it was a new kind of math… it wasn’t geometry, it wasn’t algebra, I mean it was kind of like everything thrown together” (Tara, Interview 2)), and algebra (“the unknown, was like definitely a new thing.” (Liam, Interview 1)). While it is perhaps unsurprising that participants felt a lack of fit in the mathematics content courses (given the purpose of these courses is to focus on conceptual understanding, and thus they are, by design, probably different from PSTs’ previous mathematics classes), my results suggest that many PSTs may experience a lack of fit in mathematics that affects their motivational profiles before they enter their university classes.

In some ways, a lack of fit is related to the previously identified factor of classroom environment (Dorman, 2001). However, previous work has rarely focused on the fit between students’ beliefs about mathematics and their classes. Much of the previous work has instead shown that certain aspects of classroom environment lead to more productive motivational profiles among students (Dorman, 2001). The results of this study suggest instead that what matters is the fit between students’ beliefs about mathematics and how mathematics is taught in their classrooms. Thus, classroom environment alone may not lead to more productive motivational profiles for all students if the classroom environment does not fit students’ own beliefs about mathematics.

3.5 Career goals

Participants reported that their awareness of their career goals led them to hold more mastery goals (and thus a more productive motivational profile). At some point in my interviews, all participants spoke of needing to understand in the content courses in order to eventually be able to teach mathematics to others eventually. For example, Sarah said she was learning for understanding because "like those [classes] are actually important to what I'm going to be doing as a career so it's more important for me to understand it rather than get a grade" (Interview 1). Lisa put it differently, comparing her learning to that of people in other majors:

> I feel like a lot of students… with different majors, like a business major, you can pass the class or not pass the class… but you pass the class because you get the grade. But like in Elementary Ed. you have to re-teach this information to kids, it's not like you're just like learning about it, forgetting about it. (Interview 1)

And, Liam perhaps expressed it best when he said:

> I've said multiple times that I could get a 4.0[6] here, I could get a 2.5 here, it doesn't matter, I'll still come out a teacher, probably. But that doesn't matter if I get a 4.0 or a 2.5 if I don't have a good enough base to teach. I just really need to build up that base knowledge… (Interview 1)

Interestingly, this result was true even for participants who held strong performance goals (based on the survey results). For example, Lisa held strong performance goals but, right after she gave the above statement about Elementary Education versus other college majors, she said she was focused both on grades and understanding in her content course: "I think I still focused a lot on the grade because I knew that I wanted to do well in the class but I really also knew that I had to remember this information and like know, understand it" (Interview 1).

It may also be possible that PSTs' career goals affected their mathematics self-efficacy. One participant in my study spoke of her career goal raising her self-efficacy: "I think that since I realized that I'm going to be in front of a classroom full of students, I'm going to have to be more confident, or at least pretend to be more confident… about math" (Sandra, Interview 1). Unfortunately, my study results do not provide more information about the relationship between PSTs' career goals and their mathematics self-efficacy because when participants spoke about their self-efficacy and their future career, they tended to switch from talking about their mathematics self-efficacy to talking about their ability to teach mathematics (their mathematics teaching efficacy, see Tschannen-Moran, Hoy & Hoy, 1998). This may be a function of the interviews and the nature of the questions, which did not explicitly focus on a link between participants' future teaching and their mathematics self-efficacy. Another hypothesis is that the mathematics PSTs would be teaching seemed obvious to them (since it was elementary school mathematics), so they felt no need to talk about their own confidence with the mathematics and instead switched to speaking of their ability to teach that mathematics. For example, Mary said, "I'm in a second grade room…I can do second grade math" (Interview 2). If this is the case, it suggests participants' mathematics self-efficacy for elementary mathematics is quite high. However, this contradicts the results presented above that suggest participants did struggle with the mathematics in the content courses (which was also elementary level mathematics). If this hypothesis is true, it suggests participants did not associate the elementary mathematics taught in their mathematics content courses with true elementary mathematics. This would further support the result elaborated above that PSTs saw the mathematics in the content courses as fundamentally "different."

[6] At this university, results are measured with a grade point average (GPA) that uses a 4.0 scale (4.0 being the highest score) to summarize all course grades.

4 Discussion

My results show the sources PSTs reported using to construct their motivational profiles. These results build upon previous work (see above) conducted on the development of mathematics self-efficacy and learning goals by examining the PST population using a narrative methodology. Of the five factors identified by previous research (see Fig. 1), participants explicitly named three as sources of their motivational profiles. Thus, one contribution of my study is to extend previous research to the PST population, showing that past performance, vicarious experiences and social comparisons, and verbal persuasions are factors that affect PSTs' motivational profiles in the content courses. This has implications for the design and teaching of the content courses (see below).

Another contribution of my study is to show that the same factors seem to influence the development of both learning goals and self-efficacy. As a result, it is possible that the two constructs develop similarly, even though previous research has mainly studied their development separately. Thus, researchers working in the area of self-efficacy development could learn from researchers in the area of learning goal development and vice versa. In addition, this result confirms that it is reasonable to study self-efficacy and learning goals together.

My study also adds nuance and detail to the previously identified sources of mathematics self-efficacy and learning goals. For example, my work shows how past performance is composed of performance, mastery, and effort and all three may influence students' motivational profiles. In addition, my results show that verbal persuasions can take the form of students' perceptions of the unspoken expectations of their parents or teachers. While this nuance may seem intuitively obvious, little previous research has identified this. This nuance will help teachers and teacher educators better understand how their teaching may affect students' motivational profiles.

A final contribution of this study is to identify and explicate two relatively unstudied factors, a lack of fit between beliefs about mathematics and the mathematics in classrooms and career goals. While it may seem intuitively reasonable that career goals and fit (or lack of fit) are sources of self-efficacy and learning goals, there is a limited body of empirical research that has explicitly identified these factors.

4.1 Limitations

Several limitations of my study need to be addressed. First, my study relied on participants' narrative. While this allowed me to study students' motivational profiles contextualized within their experiences (Drake, 2006), it means that my data are based on participants' recall, which was sometimes limited or less detailed for early mathematics experiences (before high school). That said, when participants did recall an early event, it is likely because it was in some way important to them; thus, it may be a strong factor in the development of their motivational profile. Although there may be other factors of motivational profiles that participants' did not recall, this limitation likely means that the factors participants did recall were strong factors in the development of their motivational profiles.

A second limitation is that my work looked at change over time based on participants' recall, not by using a longitudinal methodology. While this was an important methodological choice both for practical reasons and because of the nature of narrative data, it means this study cannot determine the causality of events. For example, we cannot say career goals caused a more productive motivational profile; an unknown third factor (e.g., interest) may have influenced both awareness of career goals and motivational profiles.

Another limitation is the possible overlap between sources of motivational profiles. Since the study of self-efficacy and learning goals come from different bodies of literature, their sources are distinct and the relationship between these sources is not well understood. Given previous research suggests there is a direct relationship between self-efficacy and learning goals (Middleton et al., 2004), it seems reasonable for researchers to begin to reconcile the sources of these two different constructs, as this study has done. However, a complete reconciliation is beyond the scope of this article. Future research is needed to further examine and reconcile relationships between the sources of mathematics self-efficacy and learning goals.

Finally, because the goal was to be open to participants' narratives and the unique factors they might bring up as sources of their motivational profiles, the open-ended, semi-structured protocols were not designed to focus specifically on certain relationships. Thus, some relationships were difficult to sort out based on the available data (e.g., the relationship between teaching efficacy, mathematics efficacy, and career goals). Future research could further examine these relationships.

4.2 Future research

Future research using alternative methods could study the factors identified in this study to further develop our knowledge of how PSTs' motivational profiles develop over time. A longitudinal study that examined PSTs' motivational profiles throughout the content courses would be particularly helpful, given it would address some of the limitations mentioned above.

Future work is also needed on career goals and the fit between the nature of the mathematics and students' beliefs about mathematics. Particularly, work could look at these factors in different populations of PSTs (perhaps at different stages in their teacher education programs or in programs where PSTs do not take three mathematics content courses) and in other populations (e.g., engineers who have strong career goals).

Finally, future work could examine the relationship between career goals and self-efficacy as the results of the current study do not provide much information about this relationship. It remains an open question why participants switched to speaking of teaching efficacy instead of mathematics self-efficacy when talking about their future careers. If, as I conjectured, participants saw the mathematics they would be teaching as obvious and easy, then it is interesting that the fit with the mathematics in the content courses played such a large role in the development of their motivational profiles. It may be that because the mathematics in these courses was taught at a deep level with a focus on conceptual understanding that participants saw it as "new" and "different" while at the same time they saw the elementary mathematics they would be teaching as easy. Future work could further explore these relationships.

4.3 Implications

One goal in studying the development of motivational profiles is for teacher educators to learn potentially to help PSTs develop more productive motivational profiles. Thus, it is important to consider how the results of this study could help teacher educators. My results suggest several ways for teacher educators to help PSTs develop more productive motivational profiles. For example, teacher educators could emphasize career goals starting in the first mathematics content course, continuously drawing attention to the fact that PSTs are learning mathematics in order to teach it to others. Teacher educators could also explicitly address PSTs' beliefs about and expectations of mathematics during the content courses in order to decrease any lack of fit that PSTs might feel and avoid lowering PSTs' motivational profiles.

It is important to examine the ways PSTs construct their motivational profiles since these profiles play a role in how much mathematics and mathematics knowledge for teaching PSTs learn from their mathematics content courses. Awareness of the factors that affect the development of these profiles can help teacher educators both encourage PSTs to develop productive profiles and discourage PSTs from developing unproductive profiles.

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Appendix

Interview One Protocol

1. Could you describe yourself to me as a mathematics student? What should I know about you?
2. If you had to sum up all your experiences doing mathematics in five events, what would they be?
3. How would you describe your feelings and emotions about mathematics?
4. How did other people influence your experiences as a mathematics student?
5. How did your classes influence your experiences as a mathematics student?
6. People have different reasons for doing mathematics. Some people say that they do mathematics more to earn a grade and others say that they do mathematics to make sense of it. Which of these two do you think more describes you: learning for a grade or learning to make sense of the mathematics? Why?
7. Did interactions with other people influence your attention to (grades/ interest)? If so, how?
8. Did your classes influence your attention to (grades/ interest)? If so, how?
9. Focusing specifically on the mathematics content courses, how do you think these courses influenced your learning of mathematics?
10. Is there anything you'd like to add about your experiences in mathematics?

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