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# Developing an identity as a mathematics teacher through group work

Reidun Persdatter Ødegaard<sup>1</sup> and Marit Buset Langfeldt<sup>1</sup>

<sup>1</sup>Norwegian University of Science and Technology, Norway; [reidunp@ntnu.no](mailto:reidunp@ntnu.no),  
[marit.b.langfeldt@ntnu.no](mailto:marit.b.langfeldt@ntnu.no)

*A concern in teacher education is to tighten the connection between coursework and practice through work with core practices. In this study, we investigated student teachers' learning processes when working in groups in mathematics teacher education, where the tasks the student teachers worked with were centered around core practices. Taking a social view of learning, we describe student teachers' learning to teach mathematics through developing an identity as a mathematics teacher. Group discussions were audiotaped, transcribed, and analyzed using a grounded approach. Our findings suggest that group work centered around core practices gives student teachers good opportunity to negotiate meaning of core practices and develop an identity as mathematics teachers.*

*Keywords: Mathematics education, communities of practice, elementary school teachers, group activities, educational practices.*

## Background

The development of a mathematics teacher identity is critical for learning to teach (Goodnough, 2010). da Ponte and Chapman (2008) suggest that investigation and reflection on practice play important roles in developing a mathematics teacher identity, and several researchers have investigated opportunities for developing identity during teacher education (Lutovac & Kaasila, 2018). Essien (2014) found that during instruction in teacher education, student teachers develop an identity as mathematics learners, not as mathematics teachers. Learning mathematics and learning to teach mathematics is different in that the latter draws upon a broad range of experiences and knowledge, and teacher education programs should provide student teachers with coherent experiences to support their learning to teach mathematics. Hence, the contexts in which the student teachers develop their mathematics teacher identity through the teacher education program need to be tightly interwoven (Van Zoest & Bohl, 2005).

A concern in teacher education internationally and in Norway is that there is a gap between the teacher education coursework and school practice (Hammerness, 2013). The gap is due to a lack of coherence between activities in teacher education coursework and school practice, and teacher education programs need to build bridges between the different contexts. To bridge coursework and practice, Grossman et al. (2009) suggest that teacher education programs should be organized around the central practices of teaching, called core practices. Core practices are something a teacher often does, which enhance the students' opportunities to learn and preserve the complexity of teaching at the same time as novices can begin to master them (Grossman et al., 2009). Examples of core practices are eliciting and responding to students' ideas, leading a whole-class discussion towards a mathematical goal, or attending to students' understanding and helping them progress. Teacher education programs centered around core practices will help student teachers develop knowledge, skills, and identity, which can narrow the gap between coursework and school practice.

A typical learning activity in mathematics teacher education is group work. The goal is often that the student teachers get the opportunity to discuss and develop their mathematical thinking and their knowledge of students' mathematical thinking (Crespo, 2006). Tasks in group work can be organized around core practices, such as asking students teachers to make sense of their students' work (Crespo, 2006; Kazemi & Franke, 2004) or planning and co-teaching together (Haniak-Cockerham, 2019). More research on implementing work with core practices in teacher education coursework is needed (McDonald et al., 2013). In this study, we investigate the learning processes when student teachers participate in group work organized around core practices.

Taking a social view on learning, we consider identity to be learning as becoming (Wenger, 1998). Our research question is: *how does some student teachers' identity develop as they work with tasks centered around core practices of mathematics teaching?*

### **Theoretical framework**

Wenger (1998) stated that learning is participation in communities of practice. A community of practice is defined by mutual engagement, joint enterprise, and shared repertoire. Student teachers learn to teach in several communities of practice during their education, for example, the coursework in mathematics teacher education, the school in which they have school placement, and the classroom in which they have school placement. When student teachers participate in each of these communities, they become more central members of the communities, and their learning to teach mathematics is a nexus of their learning trajectories in all these communities. Van Zoest and Bohl (2005) argue that a theoretical framework that considers the broad range of student teachers' experiences and contexts is necessary when studying learning to teach.

In studying student teachers' learning to teach, *identity* is a useful theoretical construct (Van Zoest & Bohl, 2005). Wenger (1998) introduced identity to shift the focus to the individual, but from a social perspective. Following Wenger (1998), identity is more than the everyday use of identity as a sense of self. The construct includes knowledge, beliefs, our perceptions of others, and others' perception of us as we participate in communities of practice (Van Zoest & Bohl, 2005). As student teachers engage in practices related to mathematics teaching, their identity is developed through their modes of belonging in these practices, and we can study student teachers' learning beyond the scope of only one community.

Identity is developed through participation and non-participation in three modes of belonging: engagement, imagination, and alignment (Wenger, 1998). First, participation in engagement means to contribute to negotiation of meaning and adopt others' contributions. In engagement, members gain ownership over meaning through how they make use of, control, and adopt the meanings they negotiate (Wenger, 1998, p. 200). Non-participation is to not contribute to negotiations or to have one's ideas ignored. Second, participation in imagination is to imagine oneself across time and space, experiencing the meanings of other communities as one's own. Non-participation in imagination is to have limited access to other communities' practices, making negotiation impossible. Third, participation in alignment is to coordinate actions and efforts with the practices and meanings of another community, while non-participation is when directions are strict, leading to inflexible and vulnerable coordination. The modes of belonging strongly influence both one's identity and the

community one participates in (Goodnough, 2010). To operationalize mathematics teacher identity, we will draw on the practices of mathematics teaching.

Wenger's (1998) framework describes learning in general, so we draw on core practices of mathematics teaching (Grossman et al., 2009) to describe mathematics teacher learning as modes of belonging. We operationalize the development of mathematics teacher identity as modes of belonging in the core practices learning about students' (mathematical) understanding and orchestrating (mathematical) discussions. *Engagement* in these core practices is to mutually participate in understanding and fine-tuning how one can learn about students' understanding through attending to their work, responding to their work, asking questions, and eliciting their understanding. *Imagination* in core practices is to understand students' work and plan questions through imagining oneself as a teacher in the classroom. In coursework, the core practices student teachers participate in belong to an imagined classroom community. *Alignment* in the core practices is to align efforts with the valued enterprise. In our mathematics teacher education, reform-oriented mathematics education is communicated by the teacher educators. Student teachers participate in alignment through questioning and responding in line with the reform-oriented view of mathematics. Through modes of belonging, student teachers develop a shared understanding of the core practices, and since practice and identity influence each other (Lutovac & Kaasila, 2018), participation in core practices influences student teachers' identity development.

## **Method**

We collected data from two groups of participants: in-service teachers (ISTs) participating in a one-year teacher development program and pre-service teachers (PSTs) in their third year of teacher education. The ISTs were primary school teachers working in the 1<sup>st</sup> to 7<sup>th</sup> grades. From 2019 to 2021, group discussions in four lessons were audio-recorded and later transcribed and coded. The group discussions centered around different activities that involve working with core practices.

The tasks in the group work were centered around four core practices: attending to student work, eliciting students' ideas, responding to student work, and asking questions for whole-class discussions. First, the student teachers (ten ISTs and sixteen PSTs) practiced attending through making sense of students' written work with a multiplication task, a fraction task, and through making sense of students' utterings in a transcription of a dialogue about area measurement. Further, the student teachers practiced eliciting students' ideas and responding when they were planning questions to get insight into their thinking and support further thinking in the fraction and measurement tasks. Last, they practiced planning questions for a whole-class discussion in which connecting students' ideas was the goal in the multiplication task. The group discussions on the multiplication, fraction, and measurement tasks lasted approximately 50, 20, and 30 minutes, respectively.

We took a grounded theory approach to the analysis (Charmaz, 2006), meaning that questions arose from the codes, minimizing the risk of any pre-existing assumptions affecting our analyses. The two researchers first coded the discussions statement by statement, led by the question "what are they saying?". Comparing and grouping led to an initial set of codes, and in the next cycle, we coded the discussions based on actions, leading to a set of codes of actions student teachers do when they work with core practices in groups. We noticed that what the student teachers said and did depended on the

context they were discussing. Further, we chose to analyze our data through Wenger's (1998) notion of identity, taking the multiple contexts into account. The data was coded again through participation and non-participation in the different modes of belonging. The researchers coded one of the transcriptions together before coding the rest of the data material separately. Dialogue between the researchers was maintained throughout the coding process to secure similar coding and increase reliability.

## Results

We organize our results in two sections, participation and non-participation. We found participation to be more prominent than non-participation, and through excerpts of our data, we will show how the different modes of belonging contributed to the student teachers' identity as *mathematics* teachers.

### Participation

Throughout our data, we observed participation in a combination of engagement and imagination. The following discussion between ISTs where they discuss students' strategies for solving the multiplication task  $13 \cdot 27$  is an example of this.

- Tiril: Sort of, added them.  
Kaia: Yes, eight and four.  
Tiril: Eight and four is this one.  
Oda: But I don't understand. Why did she multiply 27 by two first?  
Lisa: In order to be able to double it.  
Tiril: Because now she has, in a way, she is supposed to have 27 thirteen times. Now she has 27 two times, which is 54, and that is, if she takes 54 twice, then she will have 108.  
Oda: Yes, four times.  
Tiril: And this is eight times.  
Oda: And then she has five left.  
Tiril: Yes, and then she has, she has taken it eight times, right? Plus four times.  
Oda: Ok, like that  
Tiril: So, she has taken not two, but one  
Oda: Thank you, now I understand.

In the first part of the excerpt, the ISTs participate in engagement, working with the core practice of attending to students' work by discussing every step of a student strategy in detail, building on each other's statements, and listening to each other. Meaning about students' multiplication strategies and their ideas is constructed. Further, in the last half of the excerpt, when they discuss the strategy, they actively refer to the student and her work and talk about her as if she was a real student. Through work with the representation of the student's work, they imagine how the student has been thinking and participate in negotiation of meaning about attending to students' work through imagination.

Further, we identified participation in a combination of alignment and imagination. In the following excerpt, PSTs discuss how they can continue to help students develop their ideas about equivalent fractions based on some students' written work.

- Anna: (...) "How can you continue the discussion if a student answers the following?"  
Maybe to get them to explain what they have been thinking. How did you get this?  
What did you do?  
Nina: Yes, I would follow up with "how have you been thinking to reach this answer?"  
Anna: Yes, and put into words what they have done.

Nina: Yes.  
 Anna: (...) “What can you, as a teacher, ask the students in order to build understanding for equivalence and common denominator?” That’s what we have to help Martin with, who does not have [common denominator in] his numerical expression.  
 Nina: We can ask Jenna, what is, or in another way, but something about her answer, which is 1 and  $\frac{8}{16}$ . She must have understood that  $\frac{8}{16}$  is equal to  $\frac{1}{2}$ . (...) We could, for example, use a number line, mark  $\frac{1}{2}$ , and then divide it into 16 pieces, and check that  $\frac{8}{16}$  is at the same place as  $\frac{1}{2}$ . Then they can maybe realize that  $\frac{1}{2}$  is the same as  $\frac{8}{16}$ . That they are equivalent, isn’t that what it means to be equivalent?

In the first four statements, Anna and Nina are planning questions they can ask the student to emphasize their thinking process, aligning with the view of reform-oriented mathematics teaching that has been communicated in the teacher education program. However, the questions they are planning are quite general and could be asked in almost any kind of mathematics teaching. In contrast, in the last two statements, Anna brings in one of the students and her interpretation of his understanding, which Nina builds upon by bringing in the other student and using her answer as a starting point for showing equivalence using a number line. When imagining the students and how they can elicit and respond to students’ thinking, the PSTs are also negotiating meaning through imagination, and their questions are directly connected to the teaching situation in question.

Further, several discussions were guided by the use of a framework or instructions in the task. Below, the ISTs are discussing a dialogue between students measuring the area of a blackboard using sheets of paper.

Hedda: (...) Are we using all these points? Or... the eight, those from Lehrer?  
 Oda: Yes, that’s what we’ll do.  
 Hedda: The first, they found out with some help from the teacher that they couldn’t write letters. Isn’t that the first point? To realize that unit of measure has the same property as the object.  
 Oda: No, isn’t this two? Where are you?  
 Hedda: He got some help from the teacher to figure out that it would be difficult to measure using the letters.  
 Else: Yes, but that is the same as number four?  
 Oda: Tiling... No identical units.

Here, the ISTs are engaging in the core practice of attending to students’ understanding, trying to label student actions in the dialogue using Lehrer’s (2003) framework. In the third utterance, Hedda points to what the students do and tries to understand what aspect of measurement they are working with by connecting the student actions to the framework. Their attempt to apply the framework to the dialogue leads them into a discussion about the meaning of the different aspects and the students’ understanding, and together they figure out which of Lehrer’s (2003) aspects is the relevant one. When they are engaging in attending to students’ understanding, the framework is supporting their work.

### **Non-participation**

As mentioned, participation was most prominent in our data, but there were also occurrences of non-participation in different modes of belonging. In the excerpt below, the ISTs work with students’ written solutions to 13·27 and plan questions for the following classroom discussion, where connecting students’ ideas is the goal.

- Else: Why is it 90 plus 50 here? (...) 140. Nothing about why she picked those numbers. Maybe it is to figure out 295 plus 54? Then it is just 90 plus 50, and then maybe she added 200.
- Anne: And then 9.
- Else: And the ones. I don't have the slightest clue what I would say, I would call in sick that day.
- Bettina: I find this really hard.
- Else: I don't understand what...
- Anne: I think it looks like her strategy is quite good. Per Christian, on the other hand, can't continue to add forever. He can't start in the seventh grade and add, for example, 13 times 69.
- Bettina: That is a very non-effective strategy. (...) What we want is for him to learn a more effective strategy.
- Anne: Yes, maybe through the use of the area model, and later learn this strategy. (...) How can we facilitate for the students to share their thoughts? That is easy, they can just come in front of the class and explain. Which talk moves will we use? Well, confirm their strategies, and maybe let someone else repeat.
- Bettina: Yes, that is what we have talked about today regarding conversations.
- Anne: Yes. I think these questions are easy. But this planning sheet, I don't think I will use it. It is not useful for me.

They are building on their engagement in making sense of the student strategies they have chosen to emphasize in the discussion when they try to formulate questions for the whole-class discussion, but they do not conclude on any questions they can ask. When Else says that she would call in sick that day and the others respond that they find it difficult as well, non-participation in engagement is shaping their identity. Further, they try to formulate some questions through the use of talk moves as a framework, but the questions they are formulating are not helping them connect students' ideas. The ISTs apply the talk moves inflexibly, not taking the teaching situation at hand into consideration, and their identity is shaped through non-participation in alignment. In the last statement, Anne creates a distance between herself and the learning material in the group work, and since she is unwilling to negotiate meaning, her identity is shaped through non-participation in engagement.

Further non-participation in imagination shaped student teachers' identity when they felt that they did not have enough information about a situation, as illustrated below.

- Anna: Yes, we might ask those questions, but as I've said, I find it hard when I haven't seen what they have drawn or how they came up with these fractions.

Anna's statement indicate that she would have been able to negotiate meaning if she had been the teacher and had access to the students' work, but here she lacks information and is therefore not able to imagine the students' work and her responses to it.

## Discussion

Our analysis of the group discussions provided insight into how participation and non-participation shaped the student teachers' identity as mathematics teachers. Student teachers' identity was developed through engagement in the core practices the tasks were centered around, through imagination of the teaching situation, and alignment with the practices for mathematics teaching communicated in the teacher education programs. The student teachers' participation in engagement could be supported by frameworks for understanding students' ideas, as in the discussion about the measurement task. However, as we can see in the discussion between Anne, Else, and Bettina, teacher

educators need to ensure that the student teachers are not adopting frameworks strictly and inflexibly. Further, student teachers' participation in imagination was supported by a representation of the classroom situation, either written work or transcriptions of dialogues. Our results are in contrast to those of Essien (2014), who found that student teachers developed a mathematical, not mathematics teacher, identity in coursework. One explanation for differing results can be that the coursework in Essien's (2014) study was not centered around core practices. From our analysis, it is evident that a combination of tasks centered around core practices, representations of the teaching situation, and frameworks for understanding student ideas support student teachers in developing a mathematics teacher identity.

Wenger (1998, p. 183) stated that most of what we do involves a combination of different modes of belonging, which is also evident from our analyses, where the student teachers negotiate meaning through more than one mode of belonging. The different modes of belonging working together promote student teachers' identity development, because they counterbalance each other (Goodnough, 2010). For example, imagination is helping the student teachers in attending to students' ideas when engagement becomes too narrow in the discussion about the multiplication strategy. Van Zoest and Bohl (2005) suggested that the different communities in which student teachers learn to teach should be strongly intertwined to help the student teacher develop a mathematics teacher identity. Work centered around core practices is a way of intertwining the school community and the teacher education community (Grossman et al., 2009), and the student teachers had opportunities to develop their mathematics teacher identity in several modes of belonging.

When we were planning this study, we chose to collect data from both PSTs' and ISTs' coursework, because we were expecting a difference in how they would work with core practices. Despite our expectations, our analyses did not reveal any differences in the two groups of teacher students' participation in core practices. Since identity captures beliefs, experiences, and knowledge (Van Zoest & Bohl, 2005), one could expect that PSTs' and ISTs' identity development would be different. However, the ISTs in our study are participating in a teacher development program for teachers who do not have any prior education from mathematics teacher education. The ISTs' mathematics teacher identity might therefore not include much prior experience or knowledge, making their identity more similar to the PSTs' identity. Further, in our study we are not giving a description of the student teachers' identity before and after group work, because we would need longitudinal data, and possibly interview data, to do so. Rather, we describe the processes in which the student teachers develop their identity, finding that group work around core practices gives both PSTs and ISTs opportunities to participate in different modes of belonging.

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