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Transition Between University Students to Teachers: Practice in the Middle

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Abstract: This article presents a study done in an elementary mathematics methods course that focused on the transition of novice teachers' epistemological stances: former elementary student, university student, and teacher stances. In order to help them develop the teacher stance, we designed a three-phase activity, where two phases took place inside class and the last one occurred outside of class. Novice teachers were given an assignment where they had to rehearse a count in class and enact it in front of a small group of students. They had to write reflections on their rehearsal and enactment. Interviews were done 4 months after the end of the course. The results show that the reflections about mathematics in relation to the use of new teaching practices on eliciting students' thinking allowed the novice teachers to develop the teacher stance.

Résumé: Cet article présente une étude réalisée auprès de futurs maitres du primaire et porte sur la transition des postures épistémologiques des futurs maitres, soit: l'ancien élève du primaire, l'étudiant universitaire et l'enseignant. Dans le but de favoriser le développement de la posture de l'enseignant, nous avons développé une situation en trois phases. Deux phases ont été vécues en classe alors que la dernière a été vécue hors de la classe. Ainsi, les futurs maitres ont eu à réaliser un travail dans lequel ils devaient répéter un compte et l'enseigner à un petit groupe d'étudiants. Ils ont eu par la suite à consigner leurs réflexions sur la répétition et la réalisation par écrit. Des entrevues ont été réalisées quatre mois après la fin du cours. Les résultats montrent que la réflexion développée envers les mathématiques et l'utilisation de nouvelles pratiques enseignantes sur la sollicitation du raisonnement des élèves a favorisé le développement de la posture de l'enseignant.

BACKGROUND

A large number of novice elementary teachers have a negative perspective of mathematics (Guillaune & Kirtman, 2010), which might have a serious impact on their teaching practices (Hannula, Kaasila, Laine, & Pehkonen, 2005). New teaching practices tend to help students develop conceptual understanding, which is challenging for those novice teachers who did

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not develop it in their past experiences as math learners. Thus, the development of teaching practices for mathematics is influenced by conceptions, beliefs, and attitudes toward mathematics (Philippou & Christou, 1998). Usually, novice teachers develop their pedagogical content knowledge (Ball, Thames, & Phelps, 2008) mainly in methods courses. According to Kansanen (2009), pedagogical content knowledge might be defined as the teacher's professional knowledge on preparing the content for students in an effective way for them to learn. On the other hand, didactical knowledge is about the relationships between mathematics as conceptual learning, learners' thinking processes, and teaching practices (Jonnaert & Vander Borght, 1999). It means that didactics is also knowing how to transform the disciplinary knowledge—for example, mathematics—into subject matter for students. In this sense, didactics goes beyond the pedagogical content knowledge (Kansanen, 2009). In the teaching and learning process, a didactic contract on the implicit expectations between the learners and the instructor (Brousseau, 1998) takes place. The didactic contract has two poles, devolution and institutionalization. Devolution is a process that places the student in an adidactic situation, where the student focuses on the interactions of the milieu and on the knowledge rather than on the teacher's expectations. Students accept responsibility of the learning. Institutionalization is a process by which the teacher links the knowledge constructed in class to the standardized knowledge. Devolution implies that the learners are doing things because the situation requires it, not because the teacher expects it. However, breaches in the didactic contract might occur. For example, students will do addition when solving a subtraction problem because they did addition recently in class. They thought that it was what they had to do instead of making sense of the problem.

The focus of didactic knowledge is to help students learn mathematics; however, pedagogical knowledge is more general and includes classroom management and relational skills (Jonnaert & Vander Borght, 1999). Many teacher training programs propose field experiences as a way to develop practice and make links with the theories learned in methods courses. They put theory into practice but not practice in theory (Lampert, Beasley, Ghousseini, Kazemi, & Franke, 2012).

CONNECTING THEORY, PRACTICE, AND MATHEMATICS

There is a large body of research on teacher education in the literature. It goes into two strands: initial teacher preparation or preservice teacher education and professional development for in-service teachers. Both strands were studied using reflective practice lenses using different settings, such as a professional community of learning or a community of practice. Because of lack of space, this article focuses only on teacher preparation. Research focusing on in-service teacher preparation also investigates course settings, field experiences, and online communities. In a format that mixes course settings and field experience, a team of researchers from the University of Michigan designed and investigated a teaching program focusing on the specialized work of teaching. Their program shifts from theoretical knowledge about what teachers know and believe to the practical knowledge on what teachers do (Ball & Forzani, 2009; Lampert, 2010). The program developed, *Pedagogies of Practice*, includes routines on using instructional dialogue (Lampert et al., 2012). Through this dialogue, the teacher needs to listen and respond to students (Vézina & Suurtaam, 2008). This dialogue is a coconstruction between the teacher and the students in class, focusing on eliciting students' answers and responding to them appropriately in order to construct mathematical knowledge:

> In the back-and-forth routine dialogue among students and teacher that occurs in these routine kinds of interaction, the work of the teacher is to deliberately maintain focus and coherence as key mathematical concepts get "explained" in a way that is co-constructed rather than produced by the teacher alone. (Lampert et al., 2012, p. 131)

The focus is also on revoicing students' answers by the teacher or by other students in order to link ideas between them. Orienting the student's thinking in order to construct new mathematical ideas is one of the key elements of the routine. How to conduct this dialogue is addressed explicitly in the class, not only from the learning part of mathematics but also on how to open a discussion, how to stand in front of the blackboard, etc. (Ball & Forzani, 2009).

Some specific activities were designed to help novice teachers develop these routine skills: counting, strategy of sharing, posing a sequence of related computational problem, and solving word problems (Kazemi, Franke, & Lampert, 2009; Lampert et al., 2012). All of them were presented in class in a cycle: preparation or rehearsal, enactment with students, analysis, and reenactment. The rehearsal was done in class and the novice teachers received feedback from the teacher educator. Other novice teachers benefited from the rehearsals by both participating as learners and observing as novice teachers. During the rehearsals, novice teachers may have played different roles, which might be related to their different epistemological stances. Those stances are based on their mathematical experiences as pupils or college or university students. Each mathematical experience also reflected their affective and perceptual beliefs in relation to teaching or learning mathematics (Brown, McNamara, Hanley, & Jones, 1999).

Epistemological Stances

DeBlois and Squalli (2002) studied the epistemological stances of novice teachers in a mathematics methods course. They provided 160 novice teachers with some children's works to analyze. In a written assignment, the novice teachers interpreted the children's thinking and proposed interventions and next steps for the child's learning. The researchers discovered that the novice teachers presented three distinct epistemological stances: the former elementary school student, the university student, and the teacher. The former elementary school student stance reflects the novice teachers' experiences in elementary school, mainly a traditional approach of teaching where the teacher lectures and the students do many exercises. It does reflect the chase of one good model of teaching. This is a technician's point of view of teaching. The university student stance reflects the duality between their constructions of knowledge. Their previous knowledge about teaching mathematics is based on their experiences and now there are facing other ways to teach; that is, focusing on learning instead of teaching. They try to respect the didactic contract, share good answers, and earn good grades. In opposition, the teacher stance focuses on learning and making mistakes as a way of making sense; in other words, part of the learning. The epistemological stances, which included conceptions, beliefs, and attitudes, have an influence on how teachers teach because the stances reflect different conceptions of teaching and learning.

The transition between these stances is challenging because novice teachers resist training based on conceptual understanding (DeBlois & Squalli, 2002). Modifying their beliefs seems to be very difficult (Meirink, Meijer, Verloop, & Bergen, 2009). Thus, training where novice teachers take the former elementary school student stance and keep it along the way leads them to develop learning intentions and interventions according to their conceptions toward mathematics. In this

way, teaching and learning occur from a technician's point of view. In other words, they learn how to teach in a traditional manner, in opposition to what the course aims to do. It seems that the transition between stances is facilitated by the study of the material to be taught, by questioning a student as a way to make interventions, by a distinction between teaching and learning, and by the study of different adaptations made during the field experience (DeBlois, 2006; DeBlois & Maheux, 2005). Those elements help novice teachers make a transition between the stances, with a focus on the former elementary school student to the university student. The teacher stance seems more difficult to develop in the university context. Specifically, novice teachers are paying attention to the contexts of the learning of their program; that is, attending university courses and doing field experiences in school settings (Lamb, 2009). In the context of a university methods course, how can novice teachers adopt the teacher epistemological stance?

METHODOLOGY

The Cycle of Enactment and Investigation: The Counting Assignment

With colleagues, the author implemented the principles of Ambitious Teaching in an undergraduate course in a teaching program for elementary school teachers. These university students, or novice teachers, were enrolled in a 4-year Bachelor of Education program. The course took place during the fall semester in the second year of the program, and there were six sections offered. It occurred before their field experience scheduled in April of the following year. All of the novice teachers had spent 10 days in classrooms the previous year, and some of them had more school experience through tutoring or substitute teaching.

Based on their experience developed through a teacher educator training at the University of Michigan, the course instructors designed a cycle of enactment and investigation around a counting assignment. In this assignment, the teacher asked the students to count together, starting at a particular number and counting on by another number. For example, the count might start at 19 and count up by 11. The teacher wrote the answers and mental strategies used by students on the board. The way the count is written on the board, in an array of columns and rows, makes different patterns visible. Explaining why the patterns work using one or two operations is one of the goals of the activity. The teacher also elicited students' thinking and engaged the whole group in a mathematical discussion on their mental strategies and on the patterns. We first did the counting with the novice teachers as university students and we acted as teacher educators. For many of the novice teachers, it was difficult to share their mental strategies used to count and see patterns. In teams of two or three, the novice teachers then had to design their own counting activity, using different numbers and patterns, to rehearse in class in front of their peers in order to get feedback on their teaching. They were also required to write a short reflection on their performance. After that, they had to enact it in front of a small group of students chosen by them. Those students could be elementary school or secondary school students or adults. The enactment was video-recorded and a written reflection was handed in. This material was also used in the interviews in order to make sense of the answers given.

All of the rehearsals in class were done in five consecutive weeks. The enactments were done outside the regular hours of the course. All novice teachers received their graded assignments at the end of the fall semester. In the middle of April, the researcher, who was also a teacher

educator to some of the novice teachers, contacted the novice teachers (69) by e-mail and 19 of them were interviewed. The researcher did 16 individual interviews, and a focus group interview with three novice teachers upon their request. In this ethnography study (Litchtman, 2011), all participants responded to the four questions asked.

The Inquiry

In order to study how novice teachers might have adopted the teacher epistemological stance, four questions were asked:

1. What ideas did you have about teaching mathematics before you took the course?
2. What did you retain from your counting assignment?
3. What did this assignment change, if it changed something, in the way you see mathematics and the way you see teaching mathematics?
4. What did this assignment change in your teaching?

All interviews, including the focus group, were audio-recorded and transcribed. Pseudonyms were used for novice teachers' names. For each question, the novice teachers' representations about learning process and teaching mathematics, more specifically on mathematics pedagogy and didactics, were identified. Some new categories emerged from the corpus of data (L'Écuyer, 1990). An interpretative framework (Savoie-Zajc, 2000) was created, based on the meaning given by novice teachers on the cycle of enactment; that is, the rehearsal, the enactment, and the principles and practices. Questions were analyzed and then the novice teachers' representations were associated with epistemological stances. The points of transition between the stances were then identified. The results were presented and discussed with the other instructor and graduate students in order to validate them.

A hypothesis was made at the beginning of the research project that through this assignment, the novice teachers would have an opportunity to make transitions between the three stances. The counting activity first done with them would be an opportunity to reflect as an elementary school student, the rehearsal done in class would be an opportunity to reflect as a university student, and the enactment done with students would be an opportunity to act as a teacher. Even though the opportunity to reflect accordingly to each of the three stances was given to them, how they transitioned between the stances was still unclear. In the context of the course, the elements that helped novice teachers make a transition between the stances were not identified. The questions were thus designed to shed light on those elements.

EVIDENCES FROM THE STUDY

A Former Elementary School Stance

Analysis of the data revealed that the vast majority of the novice teachers still had a strong epistemological stance of the former elementary school student at the beginning of the course (17 participants). In fact, the ideas they had about teaching mathematics before they took the course were clearly aligned toward a traditional teaching style, such as following a textbook and proposing exercises, a lot of memorization, and very few links made between the mathematical

concepts. Mathematics was seen as an application of rules and formulas. In addition, some novice teachers clearly demonstrated strong anxiety toward mathematics and teaching mathematics:

> More drill, that is the way I learn, stencils activities, very linear: you have to understand an element in order to move on. (Andy)

> Concerned for my sake because I never liked math, so teaching the concept was scary. (Tania)

Important Points From the Counting Assignment

In response to the second question, some novice teachers retained thoughts from the counting assignment that we categorized: rehearsal in class, teacher practices, the learning process, and mathematics. Being prepared for rehearsal and seeing their classmates rehearse were two different things that allowed the novice teachers to learn about mathematics.

What some novice teachers retained about rehearsals in general was how the cycle of enactment and investigation helped them learn how to teach math and supported their self-confidence. Through observing other rehearsals, they saw their classmates teaching different counts using the same practices and receiving feedback from the professor and from their peers:

> Beneficial to teach in front of the classroom and to received feedbacks from the instructors and the classmates. Working in a group was beneficial. I know I can be in front of a class and know that I was able to do it because I have prior experience. (Cathy)

Some novice teachers also said that they learned about mathematics as a discipline and not just as content to teach. Thus, the new pedagogical knowledge gained contributed to developing new didactical knowledge:

> Strategies, I never learn or knew about them. I use them now. It changed the way you see life, it simplify: such as in grocery store. I tried to help my son to do I try to encourage to see it this way. See like a mathematician. Patterns are interesting. Fascinating, I did not have this fascination before the course. I was good in math because I could follow what was taught and I can practice. (Nadia)

The new teaching practices led many of them to think differently about how to teach toward students' thinking. Thus, they retained pedagogical knowledge from the assignment:

> It allowed me to learn different teaching strategies and how to introduce a topic, how if a student raised his hand and explain his answer, you can ask another student to explain what he thinks, or to explain what he said in his words. (Sandy)

> Having to pause, waiting for students. Make sure I wrote down some suggestions or methods that students used, so different ways to get the answer. (Gina)

Other novice teachers retained important points from the learning process. They were able to reflect on how the use of new pedagogical practices lead into didactical knowledge by understanding how those teaching strategies helped support students' learning:

> How student can learn for counting and learn for each others, explain what they did in their head. I tried it in classroom, found it helps, students are able to understand how the other students got their answers, maybe have a different way to do it, learn from each other. (Mia)

> Everyone learn to different pace, it so important to know your student, who is understanding before you move on, talk slowly. (Sally)

New Representations of Mathematics and Teaching Mathematics

Novice teachers' responses to the third question regarding the changes that occurred in their representations of mathematics and teaching mathematics through the assignment showed that they see mathematics more positively and view the teaching of mathematics as different from what they experienced as a learner. This assignment made many of them learn and think about mathematical concepts, such as mental operations and reasoning about patterns. They started seeing what was behind the operations, such as place value and different reasoning. They also realized that these concepts are linked:

> It changed the way I thought about numbers, I didn't think about numbers being breaking down, how they are compose, I didn't spend time on that, the relation between operations, all these things linked together. The count helped students and me. To see patterns changed the way I thought about it because I never take the time to think about those kinds of patterns. Decomposing the count, using place value and the strategies changed the way I looked at it. Numbers are not static. (Cindy)

Some of the novice teachers realized that there were more ways to do mathematics than only with pencil and paper. For instance, they said that mathematics used more logic than just applying formulas, and they recognized different ways to get an answer and, in many cases, that there was more than one answer. Their representations about mathematics evolved from static to dynamic, accessible, and interactive. They saw math concepts as a whole and not as compartmented topics. Furthermore, they learned that the practice of doing mathematics is a way to grow as a teacher:

> It made mathematics, teaching it, a bit more approachable because you realized that not matter what you do, there is always a potential to makes mistakes. With this activity, you realized that is it ok to makes mistakes. As a teacher or a future teacher, this is what we are concerned about, doing mistakes in front of our students; we are concerned that our insecurity about mathematics might be exposed. That activity really touched on that. It just makes more accessible or less intimidating, it has to do with the ways it is presented. (Ethan)

In addition, a new representation of teaching mathematics emerged. Teaching mathematics became oriented on a learning perspective that is student centered. Discussion and working in groups was seen not only as pedagogy but also in a didactical way. Many of the novice teachers realized that in order to guide their students and have them make sense of mathematics, they need to keep their learning goals in mind. Not only do they need to understand the concepts and strategies but they also need to know why it works that way.

> I am not going to stick on any rote learning, in some way, it might be beneficial, but they do not talking [sic] about what is really important. If you ever forget what the formula is, then you won't never be able to figure it out if know why to use the formula in the first please. I will use a method how talks about concepts before jumping into mathematics and actual formulas, because if they give an explanation before the formula, they will get information on the why they are doing and being able to figure it out by themselves. (Jada)

> I realized that you have to leave them a waiting time, don't always press for an answer, don't give the answer, guide them, helped them to come with the answer but don't give them so quickly. I see a

> teacher more like a facilitator and guiding instead of I know the knowledge and I just tell you what is the count. Making them realized that their answer is incorrect by asking them 2 or 3 questions, using what they said to get what we want them to be. (Ella)

Pedagogical Development

This assignment presented a new pedagogical approach for novice teachers. In response to the fourth question regarding changes that occurred in their teaching practices, the novice teachers mentioned that they developed communication and classroom management skills that improved their teaching, along with increased confidence in their teaching abilities. These three categories might be seen as pedagogical knowledge and attitudes about self-competency as a teacher, which is related to teaching in general:

- Communication skills

> Standing up in front of class, simultaneously writing up on the blackboard, don't turn your back to the students. Developing basic skills. Write on a line, looking at the students. (Andy)

- Classroom management

> It makes very well aware of time management, I am also more aware that students need some time to be engaged in the topic. (Jada)

- Confidence

> Demonstrating that there is a level of confidence when you are teaching math, someone like myself are not 100% very comfortable with math, there is a level of practice and devotion you have to put it to make sure you are confident when you are teaching and competent when you are doing. (Ethan)

In addition, they said that they developed awareness of planning. It is interesting to say that their explanations about planning might be seen as pedagogical knowledge, as well as didactical knowledge, due to the fact that they focused on learning mathematics. They recognized that teaching toward an instructional goal can guide their practice.

- Planning

> How to plan a lesson and teach in team teaching, have the same goal in mind for your students, have a clear objective what you want student to accomplish by the end of the lesson and you have to stick to that through the lesson and you have to touch those components you want them to accomplish, you have to remember if this have to do with my goal. (Sally)

> The teacher needs to understand in deep what you teach, you can't know in surface what you teach if you really want students to understand, to a lot of research to understand yourself for preparing your lesson, you really have to know what kind of questions a students can come up. This is the why in the rehearsal who helped to understand that. (Cindy)

DISCUSSION

In analyzing the data on novice teachers adopting the teacher epistemological stance, I realized that three points were present: gaining new perceptions of mathematical knowledge, having some didactical and pedagogical knowledge about teaching mathematics, and acting like a teacher. First of all, I observed that almost all of the novice teachers had a traditional view of teaching mathematics, mainly based on their previous experiences as math learners. The former elementary school student stance was then present. The counting assignment presented mathematics in a way that made sense and not as an application of rules to find the correct answer. It helped them see mathematics from a different perspective. The novice teachers pointed out that there were many ways to get the answer, and they were able to explain why the patterns were working. They learned that making mistakes was not a negative experience and that the teacher might think about concepts with his or her students together as a group. The process of problem solving was recognized, and the chase for one unique answer was ignored. Mathematics is now seen as accessible for all students and the teacher. In contrast with DeBlois's (2006) work, which suggests that it is the study of materials and children's work that makes novice teachers change their mind about mathematics, it can also occur when novice teachers live the tasks as learners in class and link it to their teacher stance. Secondly, novice teachers acquired new pedagogical and didactical knowledge about teaching mathematics through the entire assignment. Using and experiencing new teaching practices for eliciting students' thinking made them realize that mathematics is now taught differently. It gave them another vision of teaching mathematics in elementary school, so their stance of a former elementary school student might evolve toward something different than the university student stance because they saw that students learned successfully. In contrast with DeBlois's (2006) work, the questioning for eliciting students' thinking was really used by the novice teachers in the rehearsal and the enactment. They received feedback during the rehearsal and other novice teachers also participated. In addition, during the enactment, they experienced students who were motivated and engaged in learning. They learned how to connect students' thinking and their answers to the mathematical goal they had in mind. It is how their epistemological stance made a transition toward the teacher stance.

Thirdly, the reflections on their actions in the rehearsal and in the enactment made them see themselves as teachers. They had to play that role in front of learners; they had to put the theory into practice. They constructed the teacher epistemological stance in the action. However, in opposition with our initial hypothesis, it is not only in the enactment that novice teachers constructed the teacher epistemological stance. It is also through the reflections between mathematics and teaching practices for eliciting students' thinking in each step of the assignment—that is, counting in class, the rehearsal, and the enactment—that the transition occurred. In contrast with DeBlois's (2006) work, the findings show that the back-and-forth thinking process between mathematics and teaching practices on eliciting students' thinking helped novice teachers develop the teacher stance. Figure 1 shows the transitions between epistemological stances throughout the counting assignment.

The transition between stances is not linear, from counting in class to the enactment in front of students. It takes place through the reflections about mathematics and teaching practices about eliciting students' thinking that were constantly made by the novice teachers throughout the assignment. It is important to make a distinction here. Even if there were evidence about the construction of the teacher epistemological stance, some novice teachers showed clearly that the

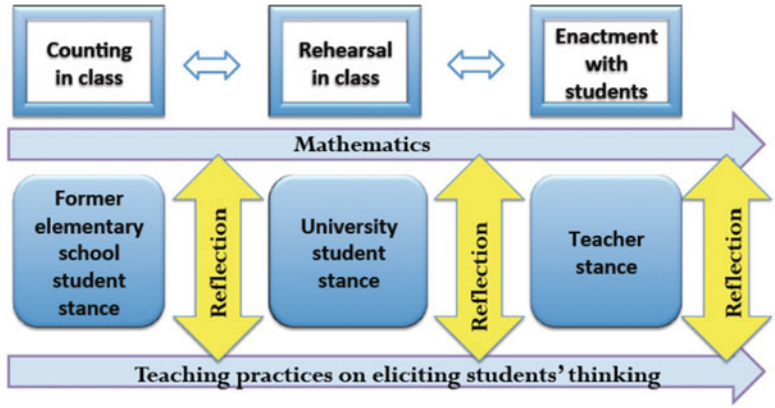

FIGURE 1 Transitions Between Epistemological Stances.

university student stance was still present. One novice teacher said that he wanted to have good grades, so he was less formal when he did his enactment because he was not in a formal setting like he was in the rehearsal: "In class, you are in university, you behave differently" (Andy). On the other hand, another novice teacher presented the university student stance through the didactic contract. She wanted to follow the protocol exactly as written:

> It didn't feel natural to count, that process was not natural: you count a little bit, then you stop and you ask if the kids understood if they understand . . . it was not natural, the enactment it feel it was forced. We were following what we had to say in our protocol and that the part I felt a little bit bizarre because we are not going with it, we have to follow a certain protocol. I almost felt like I read a script rather then. . . . I wanted to use each word in the protocol. I felt that it was constraint this is what you have to say and I couldn't deviate and have my personal approach to go about that way. (Tania)

The protocol made her nervous because she wanted to do exactly what was written instead of having her attention on students' responses. She was caught in the didactic contract: she thought she had to follow the protocol because it was an important part of the assignment. She was not familiar with the teaching practices and she experienced mathematics anxiety. In this case, she felt that she was not teaching but performing in front of an audience. Thus, the didactic contract might act as an obstacle for moving toward the teacher stance. The didactic contract might also have been an obstacle while collecting data because the researcher was also a teacher educator and some students might have been afraid of sounding negative. Further research is needed to shed light on how the didactic contract might work with the other stances.

As Ball and Forzani (2009) pointed out, this study also highlights the necessity to reconsider the place of practice in teacher programs. Using this knowledge about practices creates greater conditions for novice teachers to develop teaching practices by connecting mathematics as a subject to teach and reflections on learning. It makes them aware of the importance of developing mathematical reasoning and seeing the work of teaching as the work of guiding and learning. It is their experience as a teacher that makes them leave the former elementary school student and the university stances and develop the teacher stance. Having teacher educators aware of the transition and the development of novice teachers' epistemological stances is now seen as

necessary. Even if practice is at the core of the program, it does not mean that novice teachers will leave the former elementary school student and the university stances and keep the teacher stance. The adoption of a stance depends on the context, among others, which includes not only the setting proposed in class but also the opportunity for novice teachers to create real teaching experiences based on what they do in class and why they do it. The last point might be the most important thing for helping them change their epistemological stance because it shifts the focus from teaching to learning. More research is needed for studying in depth epistemologies about teaching and learning of novice teachers in the context of a teacher program at the university level.

CONCLUSION

This study highlights the development of novice teacher stances in a mathematics methods course, specifically through a counting assignment. The focus made on novice teacher stances allowed me to study what they gained from this assignment; that is, their new representations about mathematics and teaching mathematics and their development of pedagogical skills. The results showed how mathematics, didactics, and pedagogy presented through this assignment helped them leave the former elementary school student and university student stances to develop the teacher stance. Having them doing what teachers do helped them put theory into action and made them realize how it works and why it works.

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