



HAL
open science

We are digital natives – preservice teachers’ professional mathematical identities

Marianne Maugesten, Odd Tore Kaufmann, Tamsin Meaney

► **To cite this version:**

Marianne Maugesten, Odd Tore Kaufmann, Tamsin Meaney. We are digital natives – preservice teachers’ professional mathematical identities. Thirteenth Congress of the European Society for Research in Mathematics Education (CERME13), Alfréd Rényi Institute of Mathematics; Eötvös Loránd University of Budapest, Jul 2023, Budapest, Hungary. hal-04421627

HAL Id: hal-04421627

<https://hal.science/hal-04421627v1>

Submitted on 27 Jan 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

We are digital natives – preservice teachers’ professional mathematical identities

Marianne Maugesten¹, Odd Tore Kaufmann¹ and Tamsin Meaney²

¹ Østfold University College, Norway; marianne.maugesten@hiof.no

² Western Norwegian University of Applied Science, Norway

The aim of this study is to investigate the impact of programming on preservice teachers’ professional identity during the last two years of their studies. In two focus group interviews in year 3 and year 5 of their teacher education, four preservice teachers reflected on the introduction of programming in mathematics and how they would integrate it into their future mathematics teaching. Their stories were connected to past, present and future concerns with teaching and learning mathematics through programming. In both interviews, they told stories about how they were motivated to teach programming, while identifying themselves with the students as digital natives, connected to their past and present experiences. In the first interview they considered they would teach older teachers about programming when they were employed in a school, but in the last interview they felt they lacked both experience and knowledge about programming in mathematics.

Keywords: Preservice teachers, programming, professional mathematics identity.

Introduction

Around the world, and especially in Europe, computational thinking (CT) has received increased attention in school curriculums, with many countries implementing programming and CT either as a new subject or integrated into existing subjects. In the 2020 Norwegian curriculum, CT became part of mathematics and the core element of Inquiry and problem solving which is to be implemented across all subjects (Ministry of Education and Research, 2020). Wing (2006) defined CT as the thought processes involved in formulating problems and solutions that can be effectively carried out by an information-processing agent. Programming is an activity that analyses a problem, so that a solution can be designed and implemented. Hence programming concretises CT. Although Moreno-Léon et al. (2019) distinguished between CT as a cognitive ability and programming as just one way of developing that ability, in this paper, we have chosen not to make such a distinction and use programming to also refer to CT.

The choice to use programming to learn CT-specific concepts or as an entrance to understand mathematics better largely depends on the teachers who teach it (Kaufmann & Stenseth, 2021). In a Finnish study, Pörn et al. (2021) used a web-based survey to explore teachers’ answers to an open question about “what is programming in primary school?” Although they were teaching programming in primary schools, these mathematics teachers’ education included no or very limited programming. Most teachers connected programming to writing, giving or following instructions. Only a few teachers connected programming to central computer science concepts, such as algorithms and abstractions, and explicit connections to mathematical content were scarce. Similarly, in analysing interviews with 20 Swedish teachers who taught programming in their mathematics lesson, Kilhamn et al. (2021) found that the teachers were positive to programming, but, like the teachers in the study

reported by Pörn et al. (2021), did not always see clear connections to mathematics. The teachers gave four types of arguments for teaching programming in mathematics. Two of the types, “programming is a potentially powerful tool” and “programming increases engagement”, were not connected explicitly to mathematics. The other two categories, “programming develops computational thinking” and “programming is a way of learning mathematics” were less frequently chosen, indicating that few teachers viewed programming as helping students learn mathematics. Misfeldt et al. (2019) also conducted a survey exploring Swedish teachers’ views on relationship between mathematics and programming. The results suggest that the mathematics teachers were interested in working with programming, but did not feel well prepared for teaching programming in mathematics. Rather, they expressed that their students could use their mathematical competence while programming. The teachers viewed their students as “digital natives” (Prensky, 2001), because they were raised using various digital tools. Prensky (2001) contrasted digital natives to digital immigrants, who must learn about digital tools as adults. These findings suggest that mathematics teachers mainly considered programming as motivating and engaging for students, with little awareness about how programming could be used to develop students’ understanding of mathematics.

In Norway and elsewhere, there has been much less attention on preservice teachers, than on teachers or students, and their views on the implementation of programming in the new mathematics curriculum (Pörn et al., 2021). Kaufmann and Maugesten (2022) reported the results of an electronic survey of 400 Norwegian preservice teachers about their views in using digital tools in mathematics education in general and the use of programming in particular. They found that even though the preservice teachers did not have much experience with programming, they were positive about the implementation of programming in mathematics education. They also viewed the importance of programming related to multilingual classrooms and differentiated teaching higher than for mathematical topics, such as geometry. In this paper, we add to what is known about preservice teachers by describing how they present programming in relationship to their professional mathematical identities.

Mathematical professional identities

Identity is a crucial factor in becoming teachers and so identifying characteristics of preservice teachers’ identities at different stages of teacher education is important (Lamote & Engels, 2010). We consider professional mathematics teachers’ identities “as a set of self-understandings related to the ways of being, living, and projecting into the teacher profession, facing the voices, demands, and social and political conditions of the teaching practice” (Losano et al., 2018, p. 291). We use the term professional identity to refer to the formation of a mathematics-related teacher identity, within a community of preservice teachers.

Research indicates that mathematics teachers’ identities influence how they interact with their students and position themselves as teachers of mathematics (Bobis et al., 2020). According to Sfard and Prusac (2005), students’ identities as successful learners are critical because of their tendency to act as self-fulfilling prophecies. Hence, how preservice teachers’ identities as mathematics teachers of programming shift or develop is important to explore, as they are also likely to act as self-fulfilling prophecies in how they consider programming should be integrated into teaching mathematics.

Identities are always developing, as experiences are interpreted and reinterpreted (Beijaard et al., 2004; Lutovac & Kaasila, 2012) and are, therefore, formed within specific social and cultural contexts. Preservice teachers' professional mathematical identities include not only perceptions on who they are as preservice teachers, but also the kind of teacher they want to be. We see professional mathematical identities as the set of stories preservice teachers tell others about themselves as mathematics teachers of programming, using their past and present experiences as well as expectations for their futures to make sense of their roles and identities.

To understand their identities, it is important to interpret the preservice teachers' stories (Lutovac & Kaasila, 2012). These stories could include reflections on different experiences that they have had. For example, according to Lutovac and Kaasila (2012), preservice teachers' experiences of their own years at school have a central meaning for their views of mathematics and their professional mathematical identity, as well as their experiences in their teacher education courses. However, they argue that preservice teachers' stories about their future identities, about the kind of teacher they want to be, have generally been overlooked (Lutovac & Kaasila, 2012). In considering if and how the professional identities of mathematics preservice teachers change, there is a need to consider their stories about their past, present and future selves.

Therefore, we aim to describe the aspects of professional identity that mathematics preservice teachers highlight at different times, in relationship to teaching programming, at the middle and at the end of their teacher education. This provides us with insights into what if anything changes about their professional mathematical identities. Our research question is:

How do preservice teachers' professional identities as mathematics teachers of programming change during their teacher education?

Methods

Convenience sampling (Lewis-Beck et al., 2003) was used to ask for volunteers for the focus group interviews. We invited to participate a group of 19 preservice teachers in their third year in teacher education for teaching Grades 1–7, who had participated in the survey described by Kaufmann and Maugesten (2022). In 2019, the first and second author conducted a focus group interview with four preservice teachers from this group. A focus group interview was chosen because Bjuland et al. (2012) considered that teachers' professional identity is expressed in their interactions and collaborations with others, as they reflect on their own activity and on their roles as teachers.

The respondents were women aged between 21–23 years. They can be considered representative of preservice teachers for Grades 1–7 in Norway, since the majority are women aged between 20 and 25 years. In 2022, we conducted a follow-up focus group interview with the same four preservice teachers. The questions were similar, but with more focus on programming. For both interviews, the questions were distributed to the preservice teachers in advance. The first interview took an hour and was conducted one week before the Norwegian Government announced that programming should be integrated into mathematics education. The last interview occurred at the end of the preservice students' education, after they had finished their master thesis. The second interview was conducted on Zoom and took one hour. Between the two interviews, the preservice teachers continued their

teacher education which included completing a compulsory task on problem solving and programming as well as participating in practicums in schools, which could include programming.

We analysed the stories the preservice teachers told in the two interviews to answer our research question about how their professional mathematical identities changed during their teacher education. The interviews were transcribed and the first two authors read through them individually. We identified stories about digital tools and programming in the preservice teachers' past, present and future in both interviews. By comparing these stories in the two interviews, we were able to investigate changes in the preservice teachers' professional mathematics identities.

Results

The results are presented according to the three categories of stories: the past, the present and the future. In each category, we began by giving a short summary of the results in the first interview and then presenting the results from the second interview. In the next section, we discuss the results in regard to what they show about if and how preservice teachers' professional identities changed. Rather than see the preservice teachers as individuals, we focus on the changes across the group. We do this because there were few differences in opinion noted in the interviews and the preservice teachers often used "we" to indicate agreement among themselves.

The past

The stories that the preservice teachers told about their past experiences were based in the first interview about what they had experienced as students at school. In the second interview, their past experiences were based on what they had learnt when completing their teacher education.

In the first interview, the preservice teachers' stories about their past included describing themselves as digital natives (Prensky, 2001) because they have grown up with digital tools.

PT3: I remember myself as a student that we used the Smartboard from 5th grade, I think. It was at that time Smartboard became popular. We also used GeoGebra in the classroom. I have learned Excel too. It has been such a big part of my life, the whole life, that it is easier for me to learn programming and use it in teaching, since I have a relationship with digital tools.

Although they knew little about programming, they were convinced that they would be able to learn it easily.

In the second interview, the preservice teachers still considered themselves as digital natives because they had grown up with digital tools, allowing them to master it, as indicated by PT4:

PT4: But I think we're still as technically minded as ever, in terms of our generation and what we grew up with. That hasn't changed. But experience and competence development, it has.

There was no change in how preservice teachers saw themselves as digital natives. However, in the second interview, they considered that they had not developed their competence in programming and they had no experience in teaching it. Rather because it was valuable, they would be able to easily learn it because they were digital natives. Their reflections led them to focus on a lack of competence and experience, including with teaching mathematics through programming, from their school and

teacher education experiences. They considered that their professional identity would not meet the expectations of experienced teachers about new teachers who had master degrees.

The present

The stories about the present focused on how they viewed themselves in regard to what they knew about programming. In the first interview, although the preservice teachers identified challenges in teaching programming in mathematics, they saw themselves as digital natives who had a positive attitude towards programming which meant they would be able to do it. They considered themselves as future mathematics teachers with positive attitudes toward programming, who could motivate their students. They aligned themselves with their students as being digital natives who would share an interest in and enjoy programming in the mathematics classroom.

In the second interview the preservice teachers still had a positive attitude towards programming, but they now mentioned having insufficient knowledge about programming in mathematics. As a result, their professional identity, to a certain extent, was one of teachers who had insufficient competence and experience. They could not see opportunities to increase their competence through different professional development activities at school.

PT3: For my part, I feel that there is a big gap in my competence in programming.

PT1: I wish we could have been a little precautionary so that we were also involved in the development and learned programming.

The preservice teachers' self-understanding seemed to have changed because they had reinterpreted their lack of experience in programming, against expectations of experienced teachers in the schools where they expected to work. Even though one of them have written a master thesis about programming, and they had worked with programming in their fourth year, and they have had practicum in schools where the theme was programming, they still considered themselves to be insufficiently qualified. They remained positive and wanted to learn more, but their lack of knowledge affected their own expectations of what their professional identities should be.

The future

The stories the preservice teachers told about their futures focused on their professional identities as beginning teachers in schools. During the first interview, they believed that their role as future teachers was to train the other teachers about the use of programming in mathematics teaching.

PT1: I imagine that we are the ones beginning our jobs in the schools who are going to get questions from those who are educated about – yes, you have had about programming at school. Can you show me? And then it has to be the case that we have learned it so well that we can also teach other teachers how to use it.

In the second interview, the preservice teachers acknowledged that teachers already had two years of including programming in their mathematics lessons and that they did not have similar experiences. At the end of their education, the preservice teachers realised that this lack of experiences affected the professional identities that they wanted for themselves.

PT2: I also feel that student engagement and how they get it done and master programming has also made me realize... Whereas when I have seen the students, how they master and like it, I think that I can do that too. It's also been a good experience, in terms of attitude towards it.

They still believed they could learn and that students being motivated, interested and positive was important in teaching programming. In the first interview, there was little about how mathematics could be connected to programming. In the second interview, they considered the connection to be important but they needed more knowledge about how to achieve it. Their professional identity as teachers who would teach mathematics through programming had changed. They no longer considered that they were better than teachers who were digital immigrants. Instead, they felt that there would be an expectation among their future colleagues that they could not fulfill.

PT4: That I'm able to see the problem-solving with it, that I'm able to see the algebra and that I'm able to pass it on to the students. That it won't just be games and fun. I need help with that.

There is a change in that for their future the preservice teachers considered that they needed to know how programming could be linked to different mathematical topics. They needed to learn how to make these connections if they were to be the kind of teacher that they wanted to be.

Discussion

The two focus group interviews with the same preservice teachers, with a two-year time difference, gave us the opportunity to investigate how they interpreted and re-interpreted their experiences as becoming mathematics teachers teaching programming. Their past, present and future experiences were important in understanding what they considered to be an appropriate professional identity as mathematics teachers teaching programming and whether they had met this expectation (Lutovac & Kaasila, 2012).

The preservice teachers told similar stories from their past, in both interviews. They still considered themselves to be digital natives (Prensky, 2001) and identified themselves with school students as digital natives, who had grown up in a digital world. When the preservice teachers discussed their present experience as preservice teachers, there were differences in how they interpreted their experiences. In the first interview, they were convinced that it was enough to have a positive attitude and to be motivated to successfully learn programming in the same ways that they had experienced learning to use other digital tools. In the second interview they still stated that it was important to have knowledge and experience about programming, but their interpretation of their experiences of teacher education indicated that they did not consider that they had learnt enough about programming and how it could be related to mathematics. This meant that they now identified themselves as novel learners of programming that needed more knowledge. There was also a shift in how the preservice teachers identified as future or beginning teachers. In the first interview, they claimed that there was no need for more knowledge in programming to teach in school. After two years of experience with programming, their professional identity, for the kind of mathematics teacher they wanted to be, had changed. They were still positive about implementing programming in school and wanted to be good mathematics teachers who included programming in their teaching. However, their recognition of the lack of knowledge of programming made them reconsider their professional identities. They still considered themselves different to the experienced teachers in school, but this time they considered that these teachers' professional identities were the ones that they wanted. They no longer imagined themselves as being a resource person for other teachers. As new teachers, they needed more

knowledge so they could be seen as having the appropriate and necessary experience of teaching programming in mathematics which the “other” teachers in the school might not have.

Our results were in alignment with studies in the other Nordic countries. For example, Kilhamn et al. (2021) found that teachers highlighted that programming was motivating in mathematics classrooms. In our study, the preservice teachers also mentioned motivation as a reason for teaching programming, rather than developing the students’ mathematical competence. Misfeldt et al. (2019) also found that the mathematics teachers in Sweden did not feel prepared for teaching programming, but rather expressed that they and their students used mathematical competencies while programming and considered it was useful to do so. The preservice teachers, in our study, labelled themselves and the students as digital natives because they were grown up with digital tools. Therefore, learning to program would not be an obstacle but connected it to mathematics might be.

The preservice teachers’ professional identities, as teachers of programming in mathematics has implications for teacher education. Identities are considered critical to mathematics learning because of their “tendency to act as self-fulfilling prophecies” (Sfard & Prusak, 2005, p. 19). However, a positive attitude towards programming clearly became insufficient as the preservice teachers learnt more about what programming in mathematics involved them needing to know as a teacher. At the end of their education, the preservice teachers could identify the professional identity they wanted as mathematics teachers of programming. These were the teachers already working in schools who had experiences with programming. Teacher educators can utilise these designated identities, in Sfard and Prusak’s (2005) terms, to support preservice teachers in their final years of their education to expand school students’ experiences about how programming could be related to mathematics learning in a meaningful and understandable way.

References

- Beijaard, D., Meijer, P. C., & Verloop, N. (2004). Reconsidering research on teachers’ professional identity. *Teaching and Teacher Education*, 20(2), 107–128. <https://doi.org/10.1016/j.tate.2003.07.001>
- Bjuland, R., Cestari, M. L., & Borgersen, H. E. (2012). Professional mathematics teacher identity: Analysis of reflective narratives from discourses and activities. *Journal of Mathematics Teacher Education*, 15(5), 405–424. <https://doi.org/10.1007/s10857-012-9216-1>
- Bobis, J., Khosronejad, M., Way, J., & Anderson, J. (2020). “Sage on the stage” or “meddler in the middle”: shifting mathematics teachers’ identities to support student engagement. *Journal of Mathematics Teacher Education*, 23(6), 615–632. <https://doi.org/10.1007/s10857-019-09444-1>
- Kaufmann, O. T., & Maugesten, M. (2022). “I do not know much about programming, but I think that it is good for mathematics”: Views of student teachers in Norway on integrating programming into mathematics education. In G. A. Nortvedt, N. Buchholtz, J. Fauskanger, M. Hähkiöniemi, B. E. Jessen, H. K. Nilsen, M. Naalsund, G. Pálsdóttir, P. Portaankorva-Koivisto, J. Radišić, J. Ö. Sigurjónsson, O. L. Viirman, & A. Wernberg (Eds.), *Bringing Nordic mathematics education into the future. Proceedings of Norma 20, The ninth Nordic Conference on Mathematics Education* (pp. 113–120). Svensk förening för MatematikDidaktisk Forskning - SMDF.

- Kaufmann, O. T., & Stenseth, B. (2021). Programming in mathematics education. *International Journal of Mathematics Education in Science and Technology*, 52(7), 1029–1048. <https://doi.org/10.1080/0020739X.2020.1736349>
- Kilhamn, C., Rolandsson, L., & Bråting, K. (2021). Programmering i svensk skolmatematik [Programming in Swedish school mathematics]. *LUMAT: International Journal on Math, Science, and Technology Education*, 9(1), 283–312. <https://doi.org/10.31129/LUMAT.9.2.1457>
- Lamote, C., & Engels, N. (2010). The development of student teachers' professional identity. *European Journal of Teacher Education*, 33(1), 3–18. <https://doi.org/10.1080/02619760903457735>
- Lewis-Beck, M., Bryman, A. E., & Liao, T. F. (2003). *The Sage encyclopedia of social science research methods*. Sage Publications.
- Losano, L., Fiorentini, D., & Villarreal, M. (2018). The development of a mathematics teacher's professional identity during her first year teaching. *Journal of Mathematics Teacher Education*, 21(3), 287–315. <https://doi.org/10.1007/s10857-017-9364-4>
- Lutovac, S., & Kaasila, R. (2012). Dialogue between past and future mathematical identities. *Nordic Studies in Mathematics Education*, 17(3-4), 125–13.
- Ministry of Education and Research (2020). *Mathematics subject curriculum*. <https://www.udir.no/lk20/mat01-05>
- Misfeldt, M., Szabo, A., & Helenius, O. (2019). Surveying teachers' conception of programming as a mathematical topic following the implementation of a new mathematics curriculum. In U. Jankvist, M. Van den Heuvel-Panhuizen & M. Veldhuis (Eds.), *Proceedings of the Eleventh Congress of the European Society for Research in Mathematics Education, CERME11* (pp. 2713–2720). Freudenthal Institute, Utrecht University and ERME.
- Moreno-Leon, J., Robles, G., Roman-Gonzalez, M., & Garcia, J. D. R. (2019). Not the same: A text network analysis on computational thinking definitions to study its relationship with computer programming. *Revista Interuniversitaria de Investigación en Tecnología Educativa*, 7, 26–35. <http://dx.doi.org/10.6018/riite.397151>
- Prensky, M. (2001). Digital natives, digital immigrants part 2: Do they really think differently? *On the Horizon*, 9(6), 1–6.
- Pörn, R., Hemmi, K., & Kallio-Kujala, P. (2021). Inspiring or confusing - a study of Finnish 1-6 teachers' relation to teaching programming. *LUMAT General Issue*, 9(1), 366–394. <https://orcid.org/0000-0001-5665-6031>
- Sfard, A., & Prusak, A. (2005). Telling identities: In search of an analytic tool for investigating learning as a culturally shaped activity *Educational Researcher*, 34(4), 14–22.
- Wing, J. M. (2006). Computational thinking. *Communications of the ACM*, 49(3), 33–35. <https://doi.org/10.1145/1118178.1118215>