

Researching mathematics teachers' professional identities: complexities and ways ahead

JEPPE SKOTT, SONJA LUTOVAC AND RAYMOND BJULAND

Professional identity has become a key concern in educational research over the last quarter of a century. It reflects the recognition that there is a need to move beyond purely cognitive approaches if ambitions of research on and with teachers and teaching include understanding issues such as teachers' learning and their contributions to school and classroom practices. The more holistic perspectives in identity research acknowledge that such issues depend in fundamental ways on social and cultural contexts as well as on teachers' socio-culturally developed professional and personal biographies.

The concept of identity, however, is not easy to define and study. Vignoles et al. (2011) suggest that it is basically about "people's explicit or implicit responses to the question: 'Who are you?'" (p. 2). Although short, this is not a simple question. Immediate complexities include that "you" may be singular or plural, that is, refer to individuals or groups and – as we shall see later – it may be plural even in relation to individuals. In either case, the question may be asked of the inquirer(s) themselves or individual and collective others, including public discourses. The question may then turn into for instance "Who am I?", "Who are we?", or "Who are they?", in each case with the follow-up question of "According to whom?". It follows that identity research seeks to understand the meanings that individuals and collectives attach to themselves and others in particular contexts as well as the possible significance of doing so for current practices and discourses.

There are gaps in and quandaries for research on teacher identity. In general, the gaps include that there is limited attention paid to identities of pre- and primary school teachers; that there are relatively few studies

Jeppe Skott, *Linnaeus University*

Sonja Lutovac, *University of Oulu*

Raymond Bjuland, *University of Stavanger*

conducted with teachers in the Global south; and that identity research focuses on a limited range of school subjects (Rushton et al., 2023). Mutually related quandaries in the field concern the notion of identity itself, that is, a lack of agreement about how it may be productively defined; what theoretical frameworks to use; and the methodological difficulties involved (Graven & Heyd-Metzuyanim, 2019; Lutovac & Kaasila, 2018, 2019). Conducting empirical research, these quandaries turn into questions about how to address some more specific issues, including:

- *Identity multiplicity and variability.* For any individual or group one may consider multiple different answers to the question of "Who are you?" and multiple aspects to any one answer. The answer depends on whether it is asked in relation to one's role as a parent, a friend, a professional, etc., also if personal and professional aspects of identity are regarded as closely connected and interwoven (e.g. Clandinin et al., 2006). Besides, even if the question focuses on professional issues, for instance being a teacher of mathematics, the answer may involve being a proficient subject matter specialist, a supportive colleague, an ally of the students, and in opposition to the leadership, among many more. The multiplicity of identities is reflected in some of the most prominent theoretical references in identity research, including Gee's wording that identity is about "[b]eing recognized as a certain 'kind of person' in a given context" (Gee, 2000-2001, p. 99); Holland et al.'s comment that identities "happen in social practice" (Holland et al., 1998, p. vii); and Sfard and Prusak's definition that identities are "narratives about individuals that are *reifying*, *endorsable*, and *significant*" (Sfard & Prusak, 2005, p. 16, emphasis in original). Irrespective of which of these or other definitions of identity one opts for, each of the different identities and aspects may and may not be important in a particular situation and their relative significance may change across situations. Whether and how this is so are intricate empirical questions that may be prioritised and addressed differently in different studies.
- *Process and product aspects of identities.* The "Who are you?"-question suggests a product perspective that may be answered by the teachers themselves or others in relation to the profession, for instance in terms of being an innovative, a reformist, a committed, or a highly qualified teacher – or opposites to any of these and many other designations. There are, however, at least two different ways in which identity processes have gained attention. One of these concerns is identity change as part of long-term developmental

processes. This may be based on developmental psychology and focus on the development, maintenance, and revision of relatively stable core identities with a significant degree of continuity across time and contexts, even if "identity development [is seen] as an ongoing psychosocial task" (Luyckx et al., 2011, p. 78). While this neo-Eriksonian perspective on identity plays little role in mathematics education (Darragh, 2016; Graven & Heyd-Metzuyanim, 2019), some studies focus on fairly long-term processes and changes in teacher identity, for instance when prospective teachers undergo changes throughout the teacher education programmes (Ebbelind, 2019; Lutovac & Kaasila, 2014), when they move from pre-service education to full-time teaching (e.g. Jong, 2016; J. Skott, 2019) or when experienced teachers take part in professional development (Bjuland et al., 2012; Bobis et al., 2020; Gresalfi & Cobb, 2011). Processes may also be prominent in identity research when focusing on short-term, dynamic aspects. In this case, the emphasis is on how identities "fluctuate dramatically in salience depending on the intergroup context in which an individual finds herself" (Vignoles et al., 2011, p. 10) and whether and how they influence teachers' contributions to classroom practices. When teaching a group of students, collaborating in a team, participating in a PD, or presenting at a PTA meeting, teachers are engaged in different practices. Within and across these situations, answers to the question of who they are may change and so may the reciprocal relations between the answers and their actions. Both process and products aspects of identity, as well as the relations between them, may be foregrounded in research.

- *Location of identities.* Identities may be considered characteristics of the individual, constituted in interaction, and/or culturally developed, discursive constructs. In their review of the field, Langer-Osuna and Esmonde (2017) distinguish between *individual identities* developed in relation to different social contexts and *membership identities* for instance as "related to race, gender, and language" (p. 637); Chazan et al. (2016) argue that some scholars use identity about "a collection of self-perceptions", while others define it as "community membership, as practice, as performance, or as participation" (p. 1056). In the first group of approaches in both these descriptions of the field, identities are located primarily within the individual, even if social and cultural contexts are considered dynamically related to how they develop and function. This is so not least in the Eriksonian perspective mentioned above that

views identities as relatively stable, individual entities developed in adolescence and maintained and revised in adulthood (cf. Luyckx et al., 2011). However, some autobiographical identity research in education also seems to locate identities primarily within the individual and resembles neo-Eriksonian identity research, as the process of identity development is considered one of individual exploration and commitment: investigating possible alternatives and aligning one's identity with one or more of them. This contrasts with the second group of approaches that tends to draw on situated and sociocultural theories of human functioning and, by doing so, "draw the circle wider [than individual cognition] and seek to place thinking agents in their larger social, physical, cultural, and historical contexts" (Russ et al., 2016, p. 403). These wordings suggest that some studies in the latter group locate identities in societal structures "stemming from beyond the immediate situation and therefore subject to little agentic control, even if their meaning is negotiated locally" (J. Skott, 2022, p. 45); others emphasise the interactive constitution of identities in the locally social. The location of identities, or rather the relation between individual, social and structural perspectives on identity, is clearly important for how research is conducted.

- *Methodologies.* Identities as well as their relations to teachers' actions are not readily observable, and it is methodologically contentious how best to make inferences about identities and possible consequences of people identifying themselves or others in particular ways. However, most studies in the field are qualitative (Darragh, 2016; Graven & Heyd-Metzuyanim, 2019; Lutovac & Kaasila, 2019). This is hardly surprising, as qualitative research seeks to interpret and describe "routine and problematic moments and meanings in individuals' lives" (Denzin & Lincoln, 2018, p. 10). In the case of identity studies, the meanings in question are the ones people attach to themselves and others in particular contexts. The more specific choice of methodology and methods clearly depends on how the notion of identity is conceptualised. If narrative interpretations are taken to mean that identities are not *reflected in* verbal accounts, but *are* verbal, the methodological problem may be solved by relying on interviews or research participants' reflective writing. These are prominent methods in identity research, and approximately one third of the identity papers reviewed by Graven and Heyd-Metzuyanim (2019) were based on interviews alone. However, it may be problematic to rely exclusively

on interviews and self-reports, if identities are considered fluctuating and not only a matter of what people say, but also of what they do, think, feel, or in other ways experience about and in relation to themselves and others as they participate in social or cultural practices, for instance in school and classroom settings. As Wenger (1998), one key reference in much identity research, says: "The experience of identity is a way of being in the world. It is not, in its essence, discursive or reflective [...] words are important no doubt, but they are not the full, lived experience of engagement in practice" (p. 151). Possibly for that reason, interviews and teachers' written accounts are used in combination with other methods, often building on the trigonometrical metaphor of triangulation. That metaphor, however, may cause other concerns, if identities are considered contextually dependent, as identities *as or inferred from* verbal accounts are not necessarily the same as those that evolve in classroom situations. There are, then, methodological questions that are still in need of attention. They include how best to make inferences about the elusive, discursive construct of teacher identity and about the relationships between identities and the indefinite number of decisions and actions that teachers make daily as part of the profession.

This suggests that important, interconnected complexities of identity research include how to address questions of identity multiplicity and variability, process-product perspectives on identity, identity locations, and the methodological challenges involved. After presenting the background to the present issue of *NOMAD* and briefly outlining the different emphases in the different papers, we return to these complexity dimensions and discuss ways in which they are addressed by the authors.

Background to and papers in the present issue of *NOMAD*

In November 2022, a two-day conference was held at Linnaeus University, Sweden, to continue the discussion of theoretical issues related to research on mathematics teachers' professional identities and to provide an opportunity for presenting new empirical findings in the field. The conference attracted participants from eight different countries, young researchers as well as more experienced colleagues. The presentations and discussions showed that this is still a vibrant field of research.

The editorial board of *NOMAD* accepted our suggestion to publish the present special issue of the journal on the theme of the conference. We wrote a general call for papers, and participants in the conference were encouraged to submit proposals based on their presentations. Among

the submitted papers, we accepted six, five of which are extensions of conference contributions. The first four of these six papers are empirical pieces that build on detailed analyses of data from school, teacher education, or PD sessions to make or illustrate theoretical and methodological claims. In comparison, the last two papers shift the balance from empirical analyses to prioritising a discussion of two different, but not unrelated, theoretical approaches. These two papers have the character of theoretical essays.

We mentioned some general gaps in research on teacher identities earlier. There are also gaps in our understanding of teachers' professional identities and their relations to educational practices that are more specific to mathematics education and that the papers in the present study seek to narrow. For instance, they address the problem that there is insufficient attention to possible links between teachers' professional identities and the subject of mathematics itself (Heyd-Metzuyanim & Nachlieli, 2024; C. Skott & Psycharis, 2024); that not enough is known about aspects of teachers' identity work (Helliwell & Ebbelind, 2024; Lutovac & Havia, 2024); that more is needed on how teacher identities relate to the success or lack of success of professional development (Bjuland et al., 2024); and that more comprehensive theoretical approaches are needed to understand how teacher identities and local practices co-constitute one another (J. Skott, 2024). Addressing these problems, the papers all answer versions of the question "Who are you?", when asked of or about teachers or teacher educators of mathematics. Doing so they also more or less explicitly deal with the four quandaries for the field mentioned above.

The paper by Lutovac and Havia (2024) is based on Lutovac's keynote presentation at the conference at Linnaeus University. The authors present an empirical study of prospective teachers in Finland. They extend the notion of (individual) identity work to groups. Basing their analysis on group discussions, Lutovac and Havia are interested in how the participants collectively make sense of their autobiographical experiences of failure and success in mathematics and of their expected future challenges with teaching the subject. The authors argue that these experiences and expectations contribute to the development of the teachers' collective professional identities and change their answers to the question of "Who are we?".

Heyd-Metzuyanim's and Nachlieli's (2024) paper is based on the keynote address by Heyd-Metzuyanim at the conference. The authors combine commognition and positioning theory to understand changes in how leaders and teachers in an Israeli professional learning community implicitly identify themselves and each other when faced with a commognitive conflict. This conflict concerns the interpretation of a

mathematical task; an ensuing identity tension evolves when a teacher insists on a different interpretation than the leader. Doing so, the teacher challenges traditional claims to authority and expertise, and in the interactions that follow, answers to the questions of who is "the leader" and who is "the follower" change.

In a study of a Greek secondary teacher, C. Skott and Psycharis (2024) compare two lessons, a year apart, in which the same teacher, Victor, teaches the same unit on linear functions with the use of digital resources. Already before the classroom data were generated, Victor was recognised by himself and others as a reform-oriented teacher and a designer of digital resources. However, these identifications seem unimportant for how classroom practices evolve in the first lesson, while they play prominently in the second. The authors conclude that Victor develops from experiencing himself as struggling with inquiry-based teaching to becoming a supporter of inquiry-based learning with the use of digital resources.

Bjuland, Fauskanger, and Mosvold (2024) use an identity perspective to interpret the disappointing impact of a reform-oriented PD initiative. Drawing on Sfard's definition of identity as narrative, they analyse how two middle-school teachers engage in problem solving. The authors argue that both teachers engage exploratively with problem solving as learners of mathematics, but when teaching they are caught between an exploratory Discourse promoted by national syllabi and examination tasks and a local acquisitionist discourse that aligns with their personal preferences. Explorative teaching, then, plays different roles in their answers to who they are as learners and as teachers of mathematics.

As mentioned already, the last two papers in this issue are not empirical pieces in the usual sense. Helliwell and Ebbelind (2024) outline enactivism as an approach to identity research and discuss its potential when studying the transition from working in schools to becoming a mathematics teacher educator (MTE). They draw on their own experiences to focus on "the how" of MTE identity work, rather than on categories of identities and sub-identities. Doing so, they discuss seven methodological principles of identity work that emphasise processes and relationships. It follows that they replace the question of "Who are you?" as a teacher educator with "How are you becoming?" a teacher of teachers and how may research be conducted that sheds light on the process.

In the last paper, J. Skott (2024) presents yet another proposal for researching teacher identities as they relate to school and classroom contexts. The proposal combines a definition of teachers' identities as their professional experiences of being, becoming, and belonging with a participatory, interactionist framework called *Patterns of participation* (PoP). The argument is that this combination and its methodological

implications permit interpretations of research participants' answers to varieties of the "Who are you?" question, for instance, what teachers' professional experiences are, how these experiences develop over time, and how they relate to ongoing, interactional processes.

Revisiting four quandaries of research on teacher identity

It is apparent, even from the brief descriptions of the papers above, that they implicitly or explicitly address the four complexity dimensions mentioned earlier, but that they do so in different ways. In what follows we outline our interpretations of how this is the case.

Multiplicity and variability in the papers

Identity multiplicity and variability is apparent in all the papers. In some, this is so in discussions of how identities develop over time and in different phases of the participants' professional lives. This leads to changing answers to variants of the question of "Who are you", for instance when research participants move from teaching in school to becoming a teacher educator (Helliwell & Ebbelind, 2024), when they consider past and present educational experiences for their future career in education (Lutovac & Havia, 2024), and when they shift from aligning with fairly traditional approaches to teaching to recognising themselves as part of a reform movement promoted by national development initiatives (C. Skott & Psycharis, 2024). Other papers suggest or at least imply that multiple identities or aspects of identity may come to the fore in the short run, even within a single classroom or PD session. This is so when Heyd-Metzuyanin and Nachlieli (2024) show how teachers and leaders in a professional learning community disagree about the interpretation of a mathematical task and challenge and even reverse their positions in the process (who leads? who follows?). Bjuland et al. (2024) argue that the teachers in their study relate differently to mathematical problem solving as doers of mathematics than as teachers, indicating that different mathematically related identities co-exist. One intention of combining a definition of identity as experience with the PoP framework, as suggested by J. Skott (2024), is to understand how different answers to the "Who are you?" question come to play a role as teacher identities emerge in classroom interactions.

The papers, then, point both to multiple identities as they develop over time and emerge and play a role in classroom episodes or other local situations.

Process-product perspectives in the papers

The related question of whether identities are primarily dealt with as products and/or as long- and short-term processes is also relevant in relation to the articles in the present issue. This is apparent not least in studies that explicitly focus on identity work. As mentioned already, Helliwell and Ebbelind (2024) are less concerned with identity products in the form of categories of identities than with the process question of *how* identities evolve. Even though the sometimes-troublesome transition from being an expert schoolteacher to becoming recognised as a teacher educator may be a long-term process, the principles of Helliwell's and Ebbelind's enactivist perspective emphasise the fluctuating, situated, and relational character of professional identities, that is, short-term processes concerned with the relationships between identity narratives and enacted practices. Identity work is also a key concern in the paper by Lutovac and Havia (2024). Their study of the collective identity work of groups of prospective secondary teachers also focuses on identity processes but includes a process-product duality. The analysis is based on the premise that there is a shared collective sense of what it means to be a mathematics teacher, which is modified differently in the two focal groups of the study, leading to different identity products. One of them draws primarily on the group members' prior identities as learners of mathematics; the other includes more specific concerns about their future roles as teachers.

Other papers in this volume also include both process and product aspects of identity. Heyd-Metzuyanım and Nachlieli (2024) focus on micro-level processes of identification. They investigate interactions in a professional learning community when the participants are engaged in a task with exploratory potential. When a commognitive conflict emerges, it leads to shifts in how the research participants identify themselves and each other, which in turn impacts the character of the continued mathematical communication. The authors use of positioning theory allows them to analyse how teachers identify themselves and each other due to the reciprocal relations between fluctuating identities and communicational processes on the contents of instruction.

C. Skott and Psycharis (2024) have 20 years of data on the teacher in their case study, Victor. Previous analyses suggest that identity development is indeed a long-term process and that Victor's identity trajectory, that is, changes in identity products, may be phrased in terms of how he draws differently on six different identity markers (e.g. "reform mathematics teaching", "designer of digital resources", "embracing teacher"). At the end, he is recognised by himself and others in the Greek mathematics education community and at the school as a reform-oriented and digitally

competent teacher. The present paper focuses on changes in the significance of the identity markers as Victor engages in micro-level, classroom practices. Between them, the two studies show that developmental processes at the micro level lag those that relate to broader social contexts.

Professional identity is a recurrent theme in studies on the effects of professional development. For Bjuland et al. (2024) a PD project is the processual backdrop to their study, which is primarily on identity products in the form of the research participants' identity narratives. The authors point to changes and tensions in these narratives as the teachers relate simultaneously to explorative and acquisitionist mathematical and pedagogical discourses. A short-term process perspective on the effect of identity change is mentioned at the end when they suggest that changes in classroom practices depend not only on the teachers' narratives but also on the students' reactions.

In the last paper, the relation between process and product perspectives on identity is addressed explicitly by defining identity as experience (J. Skott, 2024). Experience is both a verb and a noun. As a verb, not least as a gerund, *experiencing*, it concerns a process and as a noun it describes a product, an *experience had*. The argument is that short-term process-product dualities are a matter of how prior *experiences had* inform and transform ongoing *experiencing*; in the long term, these dualities concern how recurrent or specific incidents of *experiencing* may reify into significant new *experiences had*.

In summary, the papers all address how developmental processes relate to identity products. However, the emphasis differs, as some focus on short-term, interactional processes and the related changes in fluctuating "identifying", while others include long-term developmental processes and seek to relate resulting identifications with teachers' participation in local practices.

The location of identities in the papers

It is not necessarily explicit where authors locate identities. It is obvious, however, that none of the six papers in the present special issue adopt an Eriksonian perspective and view identities as relatively stable entities developed in adolescence and maintained and revised in adulthood (cf. Luyckx et al., 2011). In spite of that, the approaches may use terminology that resembles the process perspectives in some Neo-Eriksonian research. To some extent, this is the case in the paper by Lutovac and Havia. Their approach to identity work may be seen as a deliberate attempt to facilitate processes of identity exploration and commitment on the part of the research participants based on their autobiographical

experiences. However, Lutovac's and Havia's extension of identity work to collectives means that identities are no longer located entirely within the individual. Indeed, they argue that the study is based on the expectation of an initial, shared sense of "we-ness" among all research participants, and one outcome of their collective identity work is that the two focal groups developed distinct, but internally coherent identities for themselves as teachers-to-be. In this study, then, identities are located not only within individuals but also at the group level and in a broader discourse on who "we", the research participants, are.

The study by Heyd-Metzuyanim and Nachlieli (2024) also locates identities at different levels. First, there is a general discourse on the responsibilities and authorities of leaders and teachers in professional learning communities. In this sense, there are professional identities located in a structural realm beyond the individual and the specific interaction (cf. the previous discussion of structure). Second, the participants draw on these structural identities as they engage with one another, but as the interaction unfolds the positions available to them are challenged and to some extent reversed. In other terms, the leaders and teachers initially attach themselves to identities of offer by the general discourse, but their positions change due to the interaction. In effect, then, the answer to the affectively laden question of who is in control and has the mathematical and professional authority is interactively constituted before or while becoming individually important.

Bjuland et al. (2024) also consider identities located at structural, locally social and individual levels. The tensions that the teachers experience are a result of conflicts between the view of quality teaching inherent in national syllabi and assessment systems and in the PD programme, on the one hand, and in school level practices on the other. In the first, teachers are valued if they succeed in engaging students in problem solving activities. In comparison the school, as interpreted by the teachers, as well as the teachers' prior experiences support a vision of teaching that aligns more closely with an acquisitionist pedagogical discourse. Manoeuvring between these narratives, which are located at different individual, social and structural levels, the teachers do not seem to develop a coherent sense of what it means to be recognised as a qualified teacher of mathematics.

The two papers that do not qualify as empirical pieces are explicit that they do not locate identities primarily within the individual. Helliwell and Ebbelind (2024) refer to Davis and Sumara to argue that from their enactivist perspective identities are "seen to arise in 'the complex mix of biological disposition, physical affect, social circumstance, and cultural context as the agent copes with the contingencies of existence' (Davis & Sumara, 2007, p.468)" (p.110). Identities are in this sense

not entities located in a mental states or traits, but they exist merely as enactments in social and cultural settings. A similarly dynamic, but still distinct perspective is suggested in the paper by J. Skott (2024). As *experiencing*, identities depend momentarily on emerging local interactions, but they also draw on *experiences had* from other social constellations beyond the present situation. Identities neither exist merely within the individual nor merely in a social or cultural realm beyond the individual. As *experiencing*, they are constituted as interactional accomplishments; as *experiences had*, they are reified answers to the "Who are you" question, answers that may to be recurrent but that are transformed in interactional processes.

The study by C. Skott and Psycharis (2024) draws on the framework presented in the paper by J. Skott (2024). The changes in Victor's identities as they relate to immediate instructional processes are seen as dependent on classroom interactions. However, they also depend on Victor's engagement in other practices and discourses, such as national development programmes, which contribute to the creation of new identity markers and shifting relationships among them. In the terminology of J. Skott (2024), Victor's *experiences had* are the constellations of identity markers that change over his career; his *experiencing* is the shifting and interactively constituted relations among them as classroom processes unfold.

All the papers, then, seek or recommend seeking coordination of identities located at social and structural levels with those adopted, enacted or used by the individual.

Methodological challenges as addressed in the papers

None of the papers in the present special issue rely – or recommend relying – merely on interviews or reflective writing. This is so also in papers that adopt a narrative stance. Heyd-Metzuyanin and Nachlieli (2024) define identities as narratives but are explicit that it is insufficient to infer identities in out-of-class settings such as interviews, if the ambition includes understanding possible relations between identities and teaching actions. Due to the pandemic, they used recordings of Zoom meetings as data material. The authors' analysis of online communication shows how positional identities changed as part of the interaction and influenced the communicational emphases in it. The interactional analysis, then, is essential to understanding the shifts in identities of leaders and teachers that develop in the episode.

Also adopting a narrative approach, Bjuland et al. (2024) analyse how experienced teachers participate in six PD sessions. They use audio and video recordings from these sessions as data material, which allows them

to investigate how the teachers react when asked to solve mathematical problems. Inferences about the teachers' identities in classrooms are based on communication between research participants in the PD session about their teaching experiences. In a somewhat similar vein, Lutovac and Havia (2024) investigate identities – in their case collective identities – of prospective teachers, when the research participants discuss their educational experiences with mathematics as part of their university course work. Based on recordings of group communication, the authors make inferences about how these experiences influence the participants' narratives of themselves as doers and future teachers of mathematics.

The approaches in the two theoretical essays also have methodological implications. This is so not least in enactivism as presented by Helliwell and Ebbelind. Equating knowing and doing, enactivism challenges a purely verbal interpretation of narrative methodology. This is reflected Helliwell and Ebbelind's (2024) seven principles for enactivist identity research, as the emphasis on processes and relationships calls for the use of a wide range of methods interpreted from a variety of different perspectives. Helliwell and Ebbelind illustrate the use of enactivism as an approach to developing and researching their own identities as mathematics teacher educators. However, the methodological recommendations are relevant also in other studies of teacher identity.

The paper by J. Skott (2024) that suggests combining the PoP framework with a definition of identity as experience also addresses questions of methodology. As in some of the other papers in this issue, it is the explicit recommendation to move beyond verbal accounts of teachers' identities, regardless of whether the accounts are made by the teachers themselves or by others. In particular, it is recommended to use observations of classrooms and collaborative settings in combination with stimulated recall interviews. The study presented in the paper by C. Skott and Psycharis (2024) uses the combination suggested by J. Skott (2024), and draws on a comprehensive set of data materials, including video recordings of lessons, pre- and post-interviews, and document analyses. This combination of methods allows the authors to make inferences about changes in the teacher's professional identities as they relate to classroom processes.

The methodological problems of identity research include making inferences about the construct of identity itself and – not least – about possible relations to between this elusive construct and teachers' contributions to school and classroom practices. The papers in the present issue have dealt with these challenges in different ways, in part depending on the theoretical stance adopted. However, they have all moved beyond relying merely on interviews or reflective writing.

Concluding remarks

We began this editorial by mentioning some general gaps and quandaries related to research on teacher identities. One of the gaps is that there are few studies on and with teachers from the Global South. It is hardly surprising that the present special issue does not remedy this situation, as the papers are primarily based on a conference held in Sweden. It is maybe more surprising that none of the papers present empirical studies of the identities of teachers of very young children, which may differ from and play different roles than in the case of teachers of older students, who generally have stronger backgrounds in mathematics. As mentioned already, however, the papers do seek to reduce a number of more specific gaps in research *mathematics* teachers' professional identities, by pointing to the significance of the subject itself, by elaborating on the notion of identity work as it relates to mathematics teachers, and by discussing the role of mathematics teachers' professional identities for the possible success of professional development programmes.

Further, the papers in different ways and more or less explicitly address the four, mutually related quandaries outlined in the introduction, the ones of identity multiplicity, of process-product duality, of identity location, and of methodology. Doing so, they all contribute with ways of addressing a key question for identity research, the question of how to adopt a holistic perspective on teachers and teaching. More specifically, this is the question of how cultural contexts, teachers' professional and personal biographies and experiences, and the professional practices and interactions in which they are involved co-constitute one another.

Finally, this issue offers valuable insights into the ways forward when researching mathematics teachers' professional identities. The papers included highlight the need for more comprehensive theoretical approaches to better investigate identity, such as the Patterns-of-Participation framework (J. Skott, 2024; C. Skott & Psycharis, 2024). Additionally, the focus on identity work in teacher education has been suggested, whether for prospective teachers or teacher educators, individuals or groups, as well as innovative theoretical and methodological approaches to this construct (Helliwell & Ebbelind, 2024; Lutovac & Havia, 2024). Finally, the papers addressing professional development for teachers advocate bridging the gap between identity and mathematics by engaging teachers in exploratory activities while considering their identities (Heyd-Metzuyanım & Nachlieli, 2024). They also advise caution when interpreting relations between structural and social discourses on the one hand and changes in how teachers engage with them on the other (Bjuland et al, 2024).

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Jeppe Skott

Jeppe Skott is a professor of mathematics education at Linnaeus University, Sweden, and a professor II at the University of Agder, Norway. His research focuses on teacher development, for instance as it relates to professional identity and other affective issues and to mathematical practices such as mathematical reasoning. There is an emphasis in his research on theorising the role of the teacher for emerging classroom processes.

jeppe.skott@uia.no

Sonja Lutovac

Sonja Lutovac is an associate professor at the Faculty of Education and Psychology, University of Oulu, Finland. Her research interests include the development of teacher identity in initial teacher education, focusing on how biographical experiences shape prospective teachers' identities, and on pedagogies in teacher education that assist and support pre-service teachers in this process.

sonja.lutovac@oulu.fi

Raymond Bjuland

Raymond Bjuland is Professor of Mathematics Education at the Faculty of Arts and Education, Department of Education and Sports Science, University of Stavanger, Norway. His research interests are related to collaborative mathematical problem solving, teacher-student dialogues, teacher identity and mathematics teacher noticing.

raymond.bjuland@uis.no