

Becoming a Mathematics Teacher: Tracing Teacher Identity Development Throughout an Initial Teacher Education Degree

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In this qualitative case study, we trace the journey of one preservice secondary mathematics teacher through each of their placement experiences during their initial teacher education degree. The purpose of tracing this journey was to examine the way in which teacher identity develops throughout an entire preservice education degree. The findings of this case study reveal how formative and transformative school-based placement experiences are and begin to shed light on the key placement experiences that shape a positive mathematics teacher identity. Practical implications in relation to quality supervision of mathematics preservice teachers are also revealed in the data.

Teacher identity significantly influences teachers' motivation, commitment to the profession, and their resilience in navigating the challenges of the profession (Day, 2018). It is a construct shaped by personal beliefs, professional experiences, and the contexts in which teachers work (Cross Francis et al., 2018). Consequently, understanding how teacher professional identity is formed and sustained is fundamental to addressing key educational issues such as the high attrition of early career teachers (Wyatt & O'Neill, 2021) and the current shortage of Australian mathematics teachers (Australian Teacher Workforce Data [ATWD], 2021). Therefore, it is important to identify initial teacher education experiences that lead to the development of positive teacher professional identity for secondary mathematics educators to ensure graduates are well situated to remain in the profession. This study takes a unique longitudinal view of PST identity development using the theoretical and analytical frames of Self-Determination Theory and 3-Dimensional Space Narrative Structure respectively.

Preparing Preservice Mathematics Teachers for Career Success

Teacher Identity

It is essential that initial teacher education (ITE) ensures preservice teachers are well situated to flourish and remain in the profession. We deliberately use the verb flourish to evoke the literal meaning of the word – “to grow or develop in a healthy or vigorous way, especially as the result of a particularly congenial environment” (Oxford English Dictionary, 2023). With this definition in mind, we are concerned about understanding the impact of ITE experiences on beginning teachers' capacity to flourish in the profession, and thus consider that a flourishing early career teacher is one who has developed a positive mathematics teacher identity.

Teachers' professional identity is dynamic, multidimensional, and contextual (Beijaard et.al., 2004), reflecting “the degree to which a person categorises her/himself personally and occupationally as someone who enacts the roles required of a teacher, engages with the social ties of the profession, and is committed to the career in the future” (Richardson & Watt, 2018, p. 39). The development of teacher professional identity is constantly shaped by interactions between teachers and their environments (Yang et al., 2021). The interplay between multiple teacher identity elements has seen some research distinguish between personal and social identity (Tice & Baumesiter, 2001). Personal identities refer to individual expressions of attributes, goals, values, competencies, and self-concepts (Richardson & Watt, 2018). Social

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identities refer to interpersonal relations and group memberships, and are associated with the group norms. Personal and social identities are related in that group identification is dependent on how well personal identity aligns with group membership requirements. Lasky (2005) describes teacher identity as “how teachers define themselves to themselves and to others” (p. 901), capturing the relationship between personal and social identity. Identity is formed by the network of interpersonal relationships in an individual’s environment; therefore, teachers’ professional identity is something personally held but socially constructed.

A flourishing, positive mathematics teacher identity is shaped by personal and social motivators. Tice and Baumeister (2001) posit that identity begins with motivation and suggests social motivators (the need to belong) are central. The importance of belonging has been emphasized in key motivation theories such as self-determination theory (SDT) which describes how teacher professional identity is influenced by their sense of autonomy, belonging (relatedness), and competence (self-efficacy) (Ryan & Deci, 2017).

In relation to identity development, it is necessary to differentiate between teachers and preservice teachers (PSTs). This paper focus on the identities of PSTs who bring with them values, beliefs, and experiences as students, which may differ with what they experience in the classroom as a teacher. PSTs have a dual role and identity as a student and a teacher, and part of developing a positive teacher identity is the rectification of experiences as a student with becoming a teacher. This makes placement experiences a critical time for identity development, and thus we focus on these experiences in this study.

Self-determination Theory (SDT) and Teacher Identity

Whilst not initially designed to explore teacher identity development, SDT has since been applied in educational research to understand identity formation (e.g., Wong & Liu, 2024). SDT is applicable to understanding teacher identity given it pertains to social and personal influences on individual’s motivations. An individual’s pursuit to personally fulfil the three basic psychological needs of autonomy, belonging, and competence (Ryan & Deci, 2017) can be supported or hindered by their social environments (contexts) in which they work. Autonomy describes control over one’s actions and having ownership over their work and decisions (Ryan & Deci, 2017). Belonging, which some consider the primacy of the interpersonal self (Tice & Baumesiter, 2001), encompasses being connected to those around us and is related to feeling a sense of group membership and group identification. The alignment between personal interests and values and those of the group can also support a sense of belonging. The need for competence describes the need to feel capable, effective, and knowledgeable (Ryan & Deci, 2017). As well as internal influences, Ryan and Deci (2020) propose that environments that encourage embracing challenge, give constructive feedback, and allow for growth opportunities support a sense of competence. The three psychological needs proposed in SDT will be used as the theoretical frame to analyse identity development in this study. Analysis will focus on understanding how specific experiences influence PSTs sense of autonomy, belonging, and competence and therefore their overall identity development.

School-based Placements, Teacher Professional Identity, and SDT

In this study, placements are situated as fundamental ITE experiences as they are opportunities for PSTs to apply their knowledge and develop their professional identify in a way that cannot be replicated at university. The interactions with mentors and students, and the critical self-reflection from authentic teaching experiences that occur during placement help PSTs align their initial beliefs with the realities of the profession (Torres-Cladera et al., 2021). The perception of being recognised as a “teacher” in a school also plays a symbolic role in solidifying teacher identity. Drawing on the theoretical framing of the study, placements should allow for the development of autonomy as PSTs engage in making instructional decisions,

competence by refining their teaching skills, and belonging as they form professional relationships. Diverse placement experiences are also important as they enable PSTs to confront and adapt their pedagogical beliefs and values, thereby fostering a stronger professional identity (Turner & Jumatova, 2020), which explains why ITE programs typically offer multiple placement experiences. During a placement, experiencing and overcoming challenges can be formative for identity. Emotional challenges such as insecurity and perceived failure are common but can act as catalysts for reflection and professional growth (Prabjandee, 2019). The ability of the PST to navigate these challenges with psychological and logistical support can facilitate the internalisation of a positive teacher identity. Thus, placement experiences involve important social interactions and opportunities for personal development that can critically shape a future teacher's identity. The research question that will be answered in this study is: *What experiences during school-based placements influenced a preservice mathematics teachers' sense of autonomy, competence, and relatedness?* Answering this question will add to our understanding of critical experiences that foster a positive mathematics teacher identity.

Research Design

The stories we tell about who we are shape how we interpret the past, understand the present, and who we will become in the future. Our stories (narratives) are how we come to understand and give meaning to our lives. Narratives are not just reflections of experiences but are active constructions that shape how individuals perceive and respond to their world (Clandinin & Connelly, 2000). Given this, the dynamic development of teachers' professional identity is explored in this case study through a narrative research design. Narrative inquiry as a qualitative research design typically involves following the story of an individual (Cresswell, 2012) allowing for a deep understanding of how individual PSTs negotiate their professional identities by making sense of their placement experiences through the stories they tell.

To examine individual experiences told through stories in a narrative inquiry, Clandinin and Connelly (2000) describe a Three-Dimensional Space Narrative Structure (3D-SNS). In this structure, the three dimensions include interaction, continuity, and situation. This framework enables researchers to examine the complex interplay between personal experiences, social contexts, and the temporal aspects of identity construction (Clandinin & Connelly, 2000). Interaction describes the personal (looking inwards) and social (looking outwards) interactions situated in stories, aligning with the view that identity is both an individual and a social phenomenon. Continuity refers to time and how the past, present, and future can be referenced in a story. For PSTs, their narratives can reveal how they rectify their beliefs as a past student, as a present student-teacher, and as future teachers. Situation refers to place and context in which the stories are taking place. The situational dimension underscores the significance of the placement school environment and the available relational and material resources in shaping PSTs' professional identities.

As an analytic frame, 3D-SNS connects to the study's theoretical framing (SDT) by recognising how teacher identity dynamically develops through over time (continuity), through interactions, within specific contexts (situations) to shape an individual's sense of autonomy, belonging, and competence. For example, the 3D-SNS dimensions allowed us to identify how 'interactions' that supported or hindered the fulfilment of a PSTs SDT needs—such as when positive supervisory feedback enhanced a sense of competence. Similarly, 'continuity' helped trace how shifts in autonomy unfolded over time, revealing how confidence and identity are co-constructed. By focusing on the story's PSTs tell about their placement experiences, this study aims to provide a nuanced understanding of how particular 'interactions' and specific 'situations' that occur over time ('continuity') during placements can enhance autonomy, competence, and relatedness, thus fostering a positive professional identity. In analysing the data, deductive codes based on interactions between SDT and 3D-SNS included the following:

autonomy-continuity (past/present/future), autonomy-situation (context), belonging-interaction (school community, students, supervising teacher), competence-continuity (past/present/future), competence-interaction (other teachers, personal, students), competence-situation (context). Coding was carried out in NVivo and findings reported using a narrative structure. One participant was chosen for the case as the goal was to deeply understand the complexity of PSTs experiences during placements throughout an ITE program (given each placement has unique characteristics as expectations of teaching expertise increase). The participant, Mei (pseudonym), was an international student undertaking a 2-year postgraduate degree in secondary mathematics education in Australia. Mei was interviewed each week of her first placement (4 week placement, 4 interviews total), at the midway point and end point of her second placement (4 week placement, 2 interviews total), and at the conclusion of her final placement (4 week placement, 1 interview total).

Findings

Mei's first placement was a time of nervousness and excitement. During the first week of the placement, Mei experienced small threats to her competence when experiencing an Australian high school for the first time. For Mei, the unfamiliar Australian school context and teaching in her non-native language were key challenges. Mei felt these difficulties were exacerbated by being placed in an all-boys school, where she felt that female teachers had their authority challenged ("it's tough for female teachers"). Mei tackled these challenges through positive interactions with other teachers, who reassured her that managing behaviour in classrooms was a constant challenge even for expert teachers. During this week, Mei's positive interactions with her supervising teacher and students reinforced her sense of belonging and she felt cared for by her supervisor ("my supervisor will ask me every day are you feeling comfortable"). Mei also reported feeling competent when she had positive student interactions despite feeling challenged by their behaviour – "when I help them to finish one question, they then smile at me and say, 'thank you Miss'. I feel a sense of achievement".

Similar themes continued into week two as Mei continued to wrestle with her autonomy in finding her own teaching style whilst developing her competence in managing classroom behaviour. When struggling to gain student attention ("they just don't obey my instructions"), Mei was self-aware of her emotional response when her competence was challenged and noted "it is hard, it is a real skill to try not to take it personally...it's a real funny thing of learning how to act angry but not feeling angry or frustrated or disappointed". To overcome this, Mei was supported with positive encouragement from her supervisor. At this midway point through placement, Mei liked the high levels of structure her supervisor was providing through the provision of a specific daily timetable as they helped ease anxiety. This indicates that Mei did not yet seek autonomy but rather appreciated specific direction. This week included a turning point where Mei started to consider making her own pedagogical choices, such as including group work and ICT, rather than following the explicit instruction model shown by her supervisor. However, she lacked confidence in these decisions and felt it would threaten her ability to manage the class: "They might not do the tasks, they might keep always chatting". Her supervisor reinforced these fears and Mei expressed frustration at this: "my supervisor just suggests for us to write on the whiteboard...but I think when we receive the teaching from uni, we are encouraged to use technology". This highlights a tension between her training and growing desire to make pedagogical decisions, and the direction from her supervising teacher.

In week three, Mei grappled with her perceptions of how a classroom should be run and her current teaching context. For example, Mei expressed frustration that colleagues did not check homework, showing she was developing her autonomy and competence in her ability to confidently express her own teacher beliefs. Mei had strong opinions about this based on observations: "they didn't have the solid foundation...most of them are struggling with how to

calculate a negative number". This shows Mei beginning to consider her own autonomy and realising that mathematics classrooms have diverse learners. Overall, Mei's identity was still developing as she was changing her teaching style depending on who was observing her.

By the conclusion of her first placement, Mei transitioned from feeling overwhelmed to a growing feeling of confidence and fulfillment. Her competence improved as she reflected "I have gradually found out how to deal with students, how to communicate with students". Mei reflected on how proud she felt when the students said they would miss her. She also felt a great sense of competence when seeing a struggling student perform well on a test – "I was so excited when I saw his quiz. It's just like, wow". The stories Mei chose to tell upon concluding her placement demonstrated how social interactions with students supported both her sense of self-efficacy and belonging. This was a shift from week one where Mei sought substantial reassurance from her supervisor. Given classroom management remained her primary concern, this was a stated goal for placement two. Mei's other goal was being "confident when I introduce the topic" due to language challenges. Whilst Mei was shifting her concentration from internal to external matters, her primary focus remained internal. Regardless of challenges, she affirmed the experience was enjoyable and that she had transformed from "nervous, also even panic...but after the placement, I think the worries, the nerves are just gone".

For her second placement experience (~6 months after the first placement), Mei attended a coeducational public school. Mei reported midway through that she was enjoying the experience and felt well supported by her supervising teacher. Her sense of competence was growing in relation to managing diverse student groups ("I know I have to use different strategies for different students") with the support of her supervisor ("She's very good. Taught me a lot about how to manage students in different classes...it's very useful"). Mei's growing self-efficacy was expressed through her reflections that "I think it's a bit better than my first prac...I know how to deal with students and how to organise my lesson plans". During this placement, Mei was developing her own teaching style and began experimenting with teaching strategies but recalled challenges integrating tools like ICT: "Some of the students are actually playing, but...I feel like it's not so helpful for those students who are not", showing critical reflection. At the conclusion of the placement, Mei reflected "I did enjoy the placement, I learned a lot...I think I progressed a lot.", and highlighted a memorable experience: "They were very sweet...I said this is going to be our last lesson, and some girls they just said "no, Miss, I'm going to miss you". I said, "I'm going to miss you too"." This shows Mei becoming an appreciated part of the school community. Her goals going into her final placement remained centred on managing classroom behaviour, as she was still negotiating the tension between authority in the classroom and creating positive student relationships ("I don't want them to hate me, but sometimes I have to do it").

For her final placement (~4 months after placement two), chose to remain at the same school as she enjoyed her second placement and felt familiar with the systems. During this placement Mei was given greater independence to teach classes without her supervisor in the room. Her supervisor expressed to her "my standards will be stricter" as it was Mei's final placement, and Mei stated "I feel a bit stressed" due to this. Mei noted this stress before some lessons as said, "every lesson I will take a deep breath before I went into the classroom". Mei told a story about one challenging lesson: "one boy just said 'you are not even my teacher, why should I listen to you'...heartbreaking". Incidents like these highlight the difficulties PSTs face in establishing credibility, particularly in mathematics where content authority can be contested. During these experiences, Mei felt supported by her supervising teacher and noted that her needs as a teacher with English as an additional language were supported by her supervisor providing her with specific wordings to say in response to particular situations "so if I am in the same situation, I can just remember the sentence". This shows a shift in Mei from prioritising student approval, to understanding professional responses to situations and the value of consistency in responses

to students. By the conclusion of all placements, though some classes specifically challenged Mei, she did feel that she continued to progress in her ability to independently manage classes, with the advice of her supervisor. However, her perceived competence still made her feel that “for my future career, I might start with just casual or part-time, as full time is quite hard for me”. As well concerns over managing classes independently, Mei’s worries were also driven by workload observations – “I noticed my colleagues from [the] maths staff room, they were always busy with writing reports, marking their papers, preparing the lessons, and some of them might have full periods on the same day...I don’t think I can handle it”. Despite these challenges, Mei’s highlight of placement was described as follows: “every lesson I feel a sense of achievement...after every lesson they would say thank you Miss, see you next time...I feel so good every time when they said it to me”, showing how the interpersonal interactions continued to be key for Mei.

Discussion

Mei’s placement experiences throughout her ITE program show growth from a nervous beginning teacher to an increasingly confident mathematics teacher, demonstrating how dynamically formative and transformative placement experiences are for teacher identity development (Torres-Cladera et al., 2021). In this section, the key themes related to autonomy, belonging, and competence will be discussed. In unpacking Mei’s experiences, 3D-SNS elements of interaction, situation, and continuity can also be seen.

As Mei’s confidence increased and she gained greater control over her teaching choices, her journey reflected an identity shift from hesitation to autonomy. Autonomy was closely tied to her sense of competence, emphasising the relationships between SDT elements (Ryan & Deci, 2017). Across placements, Mei’s confidence in making pedagogical decisions increased as she gained experience in seeing a range of schools and classes. However, Mei’s experiences also showed tensions for PSTs in negotiating classroom authority. Rather than being solely negative experiences, these challenges proved to be formative catalysts (Prabjandee, 2019).

Through her placements, Mei’s autonomy was supported by gaining greater independence from her supervisor. By the final placement, Mei felt she could begin to make her own decisions about pedagogy and classroom management, and was more focused on her own teaching decisions rather than seeking student approval. However, as expectations of independence increased, it brought raised levels of stress as supervisor oversight lessened. This finding is consistent with literature on the psychological demands of early-career teaching, which emphasises the need for structured yet gradual release of responsibility to avoid burnout (Wyatt & O’Neill, 2021; Yang et al., 2021). Mei’s growing autonomy came in conjunction with the realisation of critical professional challenges, such as recognition of workload demands, which caused a rethinking of future career plans. This emphasises what is already understood in research about teacher identity influencing commitment to the profession (Day, 2018).

In relation to Mei’s sense of belonging, her placement experiences illustrated a journey from seeking approval to professionalism. Belonging was critical to Mei’s teacher identity development, showing the importance of the social aspect of identity (Tice & Baumesiter, 2001) and how identity is shaped by the context in which teachers work (Cross Francis et al., 2018). Mei’s experiences demonstrate the importance of a collegial environment for PSTs on placement. Mei’s story is one of growing professional confidence that was substantially supported by strong, positive supervisor relationships and strong collegial support. Social interactions with teachers and students were key sustaining experiences for Mei, highlighting the importance of embedding PSTs meaningfully in the school community. Navigating classroom authority with students was not a simple task for Mei, and it was an aspect of teaching she constantly reflected. What Mei came to learn, through supervisor guidance, was the importance of balancing consistency and discipline with developing student relationships. For

PSTs, the lack of natural authority they have during placements is a tangible challenge (Vetter et al., 2013) particularly if a supervisor is no longer present in the classroom, and supervisors need to be aware of this issue when mentoring PSTs. As a result, they may need to give practical strategies that differ from how an established teacher might gain authority in a classroom.

Mei's sense of competence similarly grew through each placement and was shaped by internal factors as well as external interactions with her supervisor, other teachers, and students (Ryan & Deci, 2020). Whilst Mei's self-efficacy grew substantially, questions about teaching mathematics remained at the conclusion of placements, highlighting that early career mathematics teachers are not yet the "complete package" when entering the profession (i.e., still have developing competence and confidence to teach mathematics). There were additional challenges to Mei's competence as she had to quickly understand the Australian educational system and each unique school context. This draws attention to the potential need for universities, schools, and supervisors to provide additional support to international students. Mei's competence centred around two differing themes: managing student behaviour and teaching mathematics. Classroom management was Mei's top concern and focus during the early weeks of her first placement, highlighting that it is difficult for some PSTs to concentrate on the intricacies of teaching mathematical content during the first placement. By the conclusion of Mei's placements, she did feel substantially more confident in managing behaviour, but understood that her skills were still developing. Despite this, Mei slowly shifted from frustration to strategic thinking about behaviour management. In relation to teaching mathematics, Mei developed from reluctant compliance with her supervisor's pedagogical directives to experimenting with pedagogy. This shift was fostered by her growth in autonomy, which fed a sense of competence in making her own teaching decisions.

Whilst Mei's journey demonstrated a PST who was gaining confidence in their ability to teach mathematics, this in turn caused new concerns over the sustainability of a full-time role. This was driven by a change in Mei's focus on the immediate present situation to reflection on the future, showing how past experiences shape future aspirations and actions. Understanding the demands of the job combined with judgements on her perceived competence influenced Mei's future professional decisions before graduating from ITE. Previous research has identified the influence of self-efficacy on teachers' career commitment (Richardson & Watt, 2018). This emphasises how critical placements are for establishing a robust workforce in secondary mathematics education, and how carefully we must treat placement experiences. In Mei's case, three positive placement experiences in collegial supportive environments still resulted in an outcome of questioning how feasible her teaching career was. If preservice secondary mathematics teachers are already rethinking their capacity to remain in the profession *before* entering the profession, this is a key matter for ITE programs and further research to consider and address proactively. In Mei's case, being highly self-aware of not being the "complete package" prior to graduation was shaping her future career plans. A limitation of findings presented in this paper is the exploration of one teacher's unique experiences, thus further research could attend to diversity of PSTs narratives using 3D-SNS.

Conclusion

If we are to address critical global concerns regarding recruitment and retention of secondary mathematics teachers, it is important that we pay attention to how we are situating PSTs to flourish as they enter the profession. School-based placements are a crucial element of ITE, offering PSTs opportunities to integrate content knowledge with practical experiences in real classroom settings (Turner & Jumatova, 2020). Positive placement experiences, characterised by supportive mentorship, play a significant role in shaping a robust professional identity (Cross Francis et al., 2018). As teacher identity dynamically shaped by contextual and

experiential variables, the extent to which ITE fosters identity growth will impact early-career teachers' resilience and long-term commitment to teaching (Beijaard et al., 2004).

This narrative study of one preservice teacher's placement experiences demonstrated a growth journey in terms of autonomy, competence and belonging which was supported by effective supervision and collegial school environments. Mei exhibited a transformational trajectory from apprehension about her ability to teach mathematics and gain classroom authority, to increased confidence in making pedagogical decisions and managing classes. However, it should be again stressed that PSTs like Mei are still developing a robust teacher identity upon exiting ITE. As previous research has highlighted, early career teachers require continued support to solidify their professional identity and sustain motivation in teaching (Wong & Liu, 2024). Without structured induction and professional learning opportunities, the positive gains made during ITE may be at risk of erosion due to the pressures of the profession (Wyatt & O'Neill, 2021). Overall, this study reinforces the argument that well-supported placements are crucial for sustaining a resilient mathematics teaching workforce (Day, 2018).

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