EFFECT OF POSITIVE REFLECTIONS ON MATHEMATICS-RELATED IDENTITY – A MIXED METHODS APPROACH

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This study examined the effect of positive narrative reflection on primary preservice teachers' (PSTs) mathematics-related identity. Using data from 51 PSTs and a mixed-methods approach, reflection essays were qualitatively coded and integrated into linear mixed models. Results showed significant increases in mathematics-related self-efficacy, identification, and attainment value, while professional teaching identity remained stable. Reflections focusing on social relations and positive emotions acted as key moderators, significantly driving these gains. High intraclass correlation coefficients revealed the enduring resilience of mathematics teacher identities despite the intervention's success. The findings suggest that the development of mathematics teacher identities relies on the type of narrative reflections which are discussed.

INTRDODUCTION

Mathematics-related identity development has long been recognised as a critical issue in primary teacher education, specifically when mathematics is an obligatory teaching subject, as in many countries worldwide. Primary preservice teachers frequently enter university with a history of negative mathematical experiences, including feelings of incompetence, anxiety, and repeated failure (e.g., Beilock et al., 2010; Lutovac & Kaasila, 2014). These experiences often culminate in what has been described as failed or fragile mathematical identities, characterised by low self-efficacy, avoidance tendencies, and unpleasant emotional orientations toward mathematics. Such biographical burdens are particularly problematic in the context of primary education, where teachers are expected not only to teach foundational mathematical content but also to foster positive dispositions toward mathematics in young learners. A growing body of research demonstrates that teachers' emotions, beliefs, and self-concepts can be transmitted – implicitly and explicitly – to their students. For instance, Maloney et al. (2013) showed that teachers' mathematics anxiety can negatively affect students' achievement and attitudes, especially in early schooling contexts. Thus, unresolved mathematical identities among primary preservice teachers may perpetuate cycles of anxiety and disengagement, undermining efforts to promote equitable and positive mathematics learning experiences.

Despite the persistence of such challenging biographies, prior research suggests that mathematical identities are not fixed and may be reshaped through targeted pedagogical interventions. Lutovac and Kaasila (2014), for example, demonstrated that some preservice teachers were able to overcome failed mathematical identities,

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depending on the pedagogical practices and reflective opportunities embedded in teacher education programs. Their work highlights the importance of narrative, reflection, and social interaction in identity reconstruction processes, while simultaneously emphasising that not all students benefit equally from such interventions.

In parallel, research from positive psychology has provided promising evidence that affective and emotional dimensions of learning can be improved through structured interventions. Jenßen (2024), among others, showed that unpleasant emotions related to mathematics can be significantly reduced through positive psychology-based interventions, such as strengths-oriented reflection. However, while these approaches have been shown to enhance emotional well-being and motivation, their potential impact on deeper, identity-related constructs remains underexplored.

To address this gap, the present study investigates the effects of a positive narrative reflection intervention on primary preservice teachers' mathematics-related identity. By combining qualitative analyses of reflective narratives with quantitative modelling of identity-related constructs, the study aims to examine which reflections drive identity development.

THEORETICAL BACKGROUND

The Concept of Mathematical Teacher Identity

In mathematics education research, identity is increasingly understood as a dynamic and narratively constructed process rather than a stable personal trait. Lutovac and Kaasila (2014) conceptualise mathematical teacher identity as a set of narratives that PSTs have about themselves as learners and future teachers of mathematics. These narratives are continuously shaped by past schooling experiences, present learning contexts, and anticipated professional futures.

For preservice teachers (PSTs), mathematical identity development is particularly demanding because it requires integrating two roles that are often experienced as conflicting: being a learner of mathematics and becoming a teacher of mathematics. Prior studies have shown that PSTs may strongly identify with the professional role of teaching while simultaneously distancing themselves from mathematics as a subject, resulting in fragmented or fragile identities (Gildehaus et al., 2024; Solomon et al., 2017). Such tensions are frequently rooted in negative biographical experiences and emotionally charged encounters with mathematics (Bekdemir, 2010).

To empirically and quantitatively examine the development of mathematical teacher identity, this study adopts a five-dimensional operationalisation of identity that captures both mathematics learner-related and professional aspects of identity

Mathematics-related self-efficacy refers to PSTs' beliefs in their ability to engage successfully with mathematical content (Ramm et al., 2006). Within our identity framework (Lutovac & Kaasila, 2014), self-efficacy can be seen as the motivational engine of identity work. High self-efficacy enables PSTs to envision themselves as

effective mathematics learners and to approach identity challenges proactively by positioning themselves as active actors with clear goals.

Math identification captures the extent to which individuals see mathematics as part of who they are (Kempen & Liebendörfer, 2021), representing the learner-related facet of identity that is often strongly shaped by prior school experiences (Lutovac & Kaasila, 2014). Identity work in this domain frequently involves narrative rehabilitation, allowing them to distance themselves from the past and reconstruct a more positive, or at least neutral, relationship with mathematics.

Teaching identification represents the professional facet of identity, reflecting the degree to which PSTs have internalised the role of being a teacher (Kempen & Liebendörfer, 2021). In contrast to math identification, which has historically foregrounded past and present dimensions, teaching identity is predominantly future-oriented and linked to professional aspirations, external demands, and ideals (Lutovac & Kaasila, 2014).

Attainment value mathematics relates to PSTs' personal importance of mathematics (Gildehaus & Liebendörfer, 2024). Within our identity framework (Lutovac & Kaasila, 2014), these values influence the emotional stakes of identity work: because many PSTs' narratives are already laden with emotions due to past school experiences, the personal importance of mathematics can lead to a sense of helplessness if failures occur. However, successful re-authoring through narrative rehabilitation allows PSTs to gain insight into their mathematical past and future, yielding stronger identity gains by helping them distance themselves from the past (Lutovac & Kaasila, 2014).

Attainment value teaching captures the personal importance of the professional aspiration to become a good math teacher (Gildehaus & Liebendörfer, 2024). This can be a very motivating force. Even when PSTs experience mathematics as a source of struggle, this future-oriented value can motivate sustained identity work by helping PSTs close the gap between the actual and the ideal state of mathematical identity (Lutovac & Kaasila, 2014).

Dimensions of narrative identity work

The development of these constructs is understood as identity work, defined as the active process of interpreting, negotiating, and re-authoring personal narratives (Lutovac & Kaasila, 2014). This active process of narrating mathematical lives enables PSTs to reinterpret past experiences and align their identity with professional aspirations. This dialogue leads to an awareness of a tension or gap between the actual and the ideal state of mathematical identity. PSTs strive to reach hoped-for or ideal professional selves while distancing themselves from feared selves often characterised by incompetence and anxiety. This narrative work is realised through three distinct but intertwined dimensions in the present study:

The dimension of *self and personal competencies* involves reflections on personal achievements. Through this agency, PSTs may position themselves as active actors

with clear goals. By re-evaluating their actual states against their ideal professional goals, they transition from presenting themselves as passive recipients to becoming active participants capable of managing the subject through hard work and preparation (Lutovac & Kaasila, 2014).

The dimension of *social relations* builds on the idea that narrative identity is inherently relational and multi-contextual, as it is influenced by different situations, social relationships, and audiences (Lutovac & Kaasila, 2014). Identity work is conceptualised as an interaction between the individual and the social-mathematical context, in which understanding is socially negotiated in response to external demands and to what is perceived as valued within the culture. In this dimension, the self is constructed in dialogue with others; for example, PSTs may utilise peers as role models to scaffold their own identification shifts, using social comparison to envision a viable path toward their professional aspirations (Lutovac & Kaasila, 2014).

The dimension of *emotions* refers to reflections of (ideally positive) emotional situations. Because many PSTs enter teacher education with negative backgrounds, their identity narratives are frequently laden with emotions (Lutovac & Kaasila, 2014). These memories act as affective anchors that can lead to a sense of helplessness or the dominance of feared selves if left unaddressed. Positive reflections may contribute to narrative rehabilitation, allowing PSTs to face affective changes, process emotion-laden memories, and gain insight into their mathematical past and future, ultimately transforming emotional energy into the professional motivation needed to distance themselves from a negative past (Lutovac & Kaasila, 2014).

Research aims and research questions

The theoretical framework of this study conceptualises mathematical teacher identity as a dynamic, narrative, and future-oriented construct that emerges through identity work across cognitive, emotional, and motivational dimensions. By operationalising identity through five interrelated variables, the framework allows for an empirical investigation of how narrative reflection interventions may support the rehabilitation of learner-related identity components while interacting with more stable professional aspirations. Building on the idea that such narrative reflections can refer to the self and personal competencies, social relations, as well as emotions, the study aims to analyse the effects of a positive narrative intervention with the following research questions:

RQ1: To what extent does a positive narrative intervention lead to significant changes in preservice teachers' mathematical teacher identity?

RQ2: How do references to the self, social relations, and emotions in this positive narrative intervention moderate the changes in the identity variables over time?

RQ3: How much of the variance in mathematics teacher identity is explained by stable individual differences versus the narrative intervention?

METHOD

Sample & research design

This study employed a mixed-methods pre-post intervention design to investigate the impact of positive narrative reflection on preservice teachers' mathematics-related identity. The sample consisted of $N = 51$ preservice teachers for primary school and special needs education. At the beginning (T1) and the end (T2) of the semester, participants completed online questionnaires assessing mathematics teacher identity-related self-efficacy, identification, and values. In between, during the semester, participants completed 7 to 9 structured narrative reflections describing three positive personal experiences with mathematics, following the prompt:

> Name three good things you like about yourself in mathematics. For example, reflect on positive experiences in mathematics that you have personally brought about in the past few days. Name as many different things as possible over time for this exercise.

Measures

At T1 and T2, mathematics-related self-efficacy (4 items, example item: "I am confident that I can perform well on homework and examinations", Cronbach's $\alpha = .90$), math identification (5 items, "I am happy when others see me as a mathematician.", Cronbach's $\alpha = .91$), teaching identification (5 items, "I am happy when others see me as a teacher", Cronbach's $\alpha = .90$), attainment value mathematics (4 items, "It is important to me to understand mathematics well", Cronbach's $\alpha = .85$), and attainment value mathematics teaching (4 items, "It is important to me to be able to explain mathematics well", Cronbach's $\alpha = .89$) were assessed by six-point Likert scales (Gildehaus & Liebendörfer, 2024; Kempen & Liebendörfer, 2021; Ramm et al., 2006). Participants' reflections were deductively coded by two coders to identify reflections about self and personal competencies (code example: "I am feeling more and more competent about the proofs of the lecture", Cohen's $\kappa = .87$), social relations (code example: "I realised that I was able to solve this exercise much faster than the others in the tutorial", Cohen's $\kappa = .94$), and positive emotions (code example: "I was very happy with my homework this week", Cohen's $\kappa = .95$).

Data Analysis Strategy

To account for the nested structure of the data (observations nested within participants), linear mixed models were conducted for each of the five dependent variables using Jamovi. The fixed effects included time (T2 vs. T1) to assess the intervention effect (RQ1), the individual number of reflections, the individual number coded reflections regarding self and personal competencies, social relations, as well as emotions, and the interaction terms (e.g., time × social) to test which reflection content moderated the change over time (RQ2). Intraclass correlation coefficients (ICCs) were calculated to determine the proportion of variance explained by stable person-level factors versus the marginal R^2, which represents the variance explained by the intervention and fixed

effects. Continuous predictors were z-standardised prior to analysis to allow for the interpretation of β as standardised coefficients.

RESULTS

Impact of Reflection on Subject-Related vs. Professional Identity (RQ1)

Table 1 presents the standardised coefficients (β) for all fixed effects, model fit indices, and stability measures of the linear mixed models. The results revealed a significant main effect of time for all three subject-related constructs: Mathematics-related self-efficacy (β= 0.49, p < .001), math identification (β = 0.40, p = .017), and attainment value mathematics (β = 0.28, p = .024). These values indicate a significant increase from pre-test to post-test following the reflection task. In contrast, no significant changes over time were observed for the professional constructs teaching identification (β = −0.03, p = .660) and attainment value teaching (β = 0.00, p = .941), suggesting that these professional roles remained stable throughout the short-term intervention.

Table 1. Results of the linear mixed models

Predictor	Math-SE	Math-ID	Teach-ID	AV-Math	AV-Teach
	β	β	β	β	β
(Intercept)	3.53***	2.88***	5.45***	3.71***	5.65***
Time	0.49***	0.40*	-0.03	0.28*	0.00
Reflexions	0.01	0.02	-0.12	-0.21	0.04
Self	0.19	0.02	0.17*	0.00	-0.01
Social	0.03	-0.04	0.11	-0.39*	0.14
Emotions	0.01	0.05	-0.14	0.29†	-0.22*
Time × Self	-0.25†	-0.19	-0.04	-0.07	-0.02
Time × Social	0.34*	0.43*	-0.12†	-0.19	0.07
Time × Emotions	0.05	-0.15	-0.09	0.26*	0.01
R^2 Marginal	.12	.07	.17	.15	.12
R^2 Conditional	.70	.69	.77	.78	.73
ICC	.65	.66	.71	.73	.69

The Moderating Role of Reflection Content (RQ2)

Regarding the question of how the frequency of thematic categories moderated the observed changes (RQ2), a significant time × social interaction was found for both

mathematics-specific self-efficacy (β = 0.34, p = .018) and identification (β = 0.43, p = .018). This indicates that participants who more frequently reflected on social relations showed a significantly higher increase in their subject-related agency and identification compared to those who focused less on social aspects.

Furthermore, a significant time × emotions interaction was observed for attainment value mathematics (β = 0.26, p = .048), suggesting that the emotional intensity of the reflection was a key driver for increasing the perceived value of the subject. Finally, a marginal trend was observed for the time × self interaction regarding mathematics-related self-efficacy (β = −0.25, p = .061), indicating that a higher frequency of personal competence-focused reflections was associated with slightly lower gains in self-efficacy.

Individual stability vs. intervention-driven change (RQ3)

Across all five models, the ICC values were high, ranging from .65 to .73. This indicates that between 65% and 73% of the total variance in mathematics teacher-related identity is attributable to stable inter-individual differences, representing the enduring influence of the participants' prior mathematical biographies.

The Marginal R^2 values, representing the variance explained by the intervention and fixed effects, ranged from .07 to .17. While the intervention successfully triggered significant shifts in learner-related constructs, the high ICCs relative to the marginal R^2 suggest that these changes occurred within a highly stable psychological framework.

DISCUSSION

Results indicate that the positive narrative intervention had an effect on preservice teachers' subject-related mathematics teacher identity, while the professional-related identity remained stable. This could be due to the specific positive narrative intervention that focused on three positive things about themselves regarding mathematics rather than being teachers (Jenßen, 2024). Results on research question 3 indicate that especially reflections about social relations and partly about positive emotions contributed to a positive development. While these findings are in line with our theoretical framework (Lutovac & Kaasila, 2014), the role of reflections regarding the self, especially on PSTs' mathematical self-efficacy, are rather astonishing. This indicates that positive reflections about personal competencies have a smaller role and that mathematics teacher identity development is to a greater extent driven by positive narratives about social relations and positive emotions. Practically, this means that future interventions should rather focus on a positive socio-emotional environment to support identity development. However, the results also show that mathematics teacher identities mostly rely on individual factors and histories and are rather stable over time (Lutovac & Kaasila, 2014).

The study has limitations due to the comparatively small number of participants from a single university. Additionally, the study relies on self-report measures, which could

be biased by preservice teachers' thoughts about social desirability. Nevertheless, the study contributes to a better understanding of the specific kinds of positive narratives that drive mathematics teacher identities, which should be analysed in more detail in future studies.

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