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Mathematical Identity and Professional Development of Future Teachers

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KLJUČNE BESEDE: anksioznost, matematična identiteta, samoučinkovitost, učiteljski študij, profesionalni razvoj

POVZETEK – Vloga matematične identitete v poklicnem razvoju bodočih učiteljev je izjemno pomemben dejavnik čustvene in refleksivne razsežnosti izobraževanja bodočih učiteljev. V raziskavi je sodelovalo 272 študentov pedagoških smeri na Hrvaškem, in sicer iz univerz v Zagrebu, Slavonskem Brodu, Pulju in Zadru. Namen raziskave je bil ugotoviti stopnjo matematične samoučinkovitosti učencev in preučiti dejavnike, ki prispevajo k razvoju kompetenc za poučevanje matematike. Pri delu je bila uporabljena kvantitativna in kvalitativna metodologija, raziskovalne metode in tehnike teoretične analize in anketnega raziskovanja, instrument pa je bil strukturirani anketni vprašalnik. Kvantitativne podatke smo obdelali z deskriptivno, primerjalno in regresijsko analizo, kvalitativni del pa s tematsko analizo. Dobljeni rezultati so pokazali, da imajo učenci nizko stopnjo matematične samoučinkovitosti, a pozitiven odnos do matematike in visoko samoučinkovitost pri poučevanju. Raziskava prispeva k razumevanju povezave med matematično identiteto in profesionalnim razvojem bodočih učiteljev ter poudarja potrebo po sistematični podpori pri razvoju njihovih kompetenc pri poučevanju matematike.

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ABSTRACT – The role of mathematical identity in the professional development of future teachers is a crucial factor within the emotional and reflective dimensions of teacher education. The conducted study included 272 students from Croatian teacher education programs at the Universities of Zagreb, Slavonski Brod, Pula and Zadar. The aim of the research was to determine the level of students' mathematical self-efficacy and to examine the factors contributing to the development of competencies for teaching mathematics. A mixed -methods approach was applied, combining theoretical analysis and survey research methods and techniques, with a structured questionnaire as the main instrument. Quantitative data were processed using descriptive, comparative and regression analyses, while qualitative data were analyzed through thematic analysis. The results showed that students demonstrate a low level of mathematical self-efficacy, but hold positive attitudes toward mathematics and report high self-efficacy in teaching. The study contributes to the understanding of the relationship between mathematical identity and the professional development of future teachers, highlighting the need for systematic support in developing their teaching competencies in mathematics.

1 Introduction

The concept of identity presents a challenge due to the variety of theoretical approaches and conceptual meanings across numerous disciplines (Canrinus et al., 2011; Leitch & Harrison, 2016). In philosophy, Taylor (1989) emphasizes the narrative dimension of identity; sociology links it to roles and social interactions (Jenkins, 2008), while psychology highlights its cognitive and emotional aspects (Erikson, 1968). Due to its interdisciplinary nature, identity is considered a multidimensional concept whose meaning shifts depending on the theoretical framework and research focus.

In education, teacher identity goes beyond the traditional transmission of knowledge, encompassing the shaping of students' attitudes toward the subject and the fostering of critical thinking (Kadum et al., 2023). Teacher identity is seen as a dynamic combination of personal beliefs, professional experiences and societal expectations (Beauchamp & Thomas, 2009; Domović, 2011). In their identity model, Kaplan and Garner (2018) emphasize the interplay of ontological beliefs, goals and behaviours, while Wenger (1998) highlights the importance of communities of practice in shaping identity.

The professional identity of mathematics teachers, which includes both general professional and specific disciplinary aspects, is further complicated by the interaction between pedagogical beliefs and attitudes toward mathematics. Mathematics teachers therefore possess a dual identity structure, which creates particular challenges but also opportunities for their professional development (Lutovac & Kaasila, 2017).

Identity is not only a reflection of knowledge and skills, but also of emotions, beliefs and experiences related to learning and teaching mathematics (Darragh et al., 2021), as well as the way an individual sees themselves in relation to mathematics and how they integrate mathematical content into their professional and personal life (Bognar, 2019; Graven & Lerman, 2014).

Darragh et al. (2021) highlight four dimensions of identity, which according to the DSMRI model also consist of interconnected dimensions: mathematical knowledge for teaching, self-efficacy in teaching mathematics (Bandura, 1997), a vision of high-quality mathematics instruction and one's personal relationship with mathematics. Research shows that the way individuals perceive themselves as learners of mathematics influences their identity as future teachers, as these early experiences shape their confidence, beliefs, and approach to teaching mathematics. Therefore, both their relationship with mathematics as learners and their relationship with teaching mathematics as future teachers are crucial for the development of teacher identity (Arslan et al., 2022). Vizek Vidović (2011) likewise analyzes three approaches to teacher professional development, including the formation of identity through internal and external factors at different stages of a teaching career.

The professional development of mathematics teachers is a continuous process of enhancing competencies and skills with the aim of improving the quality of instruction (Desimone, 2009; Domović, 2011). It is a long-term process that involves collaborative learning, the implementation of new strategies and reflection on one's own practice (Garet et al., 2001; Lutovac & Kaasila, 2017). The professional identity of teachers is shaped by personal beliefs, experiences and social contexts (Canrinus et al., 2011), and indicators of identity include job satisfaction, self-efficacy, professional commitment and motivation (Canrinus et al., 2011). Effective professional development includes a subject-matter focus, active participation, alignment with the curriculum, sustained duration and collegial learning (Desimone, 2009). The most successful programs last longer, connect theory and practice, and encourage reflection and mentoring (Desimone, 2009; Garet et al., 2001).

Mathematical identity and professional development are connected in a bidirectional interaction: strengthening mathematical identity fosters motivation for professional development, while high-quality development can transform the teacher's identity (Gra-

ven & Lerman, 2014). Teachers who perceive themselves as competent mathematicians are more likely to introduce innovations in teaching and experiment with new methods (Lutovac & Kaasila, 2017). This synergy contributes to the development of students' mathematical literacy, critical thinking, and motivation to learn, which positively impacts the quality of education and student success in STEM fields in the long term.

2 Methodological Framework of the Research

Research Aim, Hypotheses, and Research Questions

The aim of this study is to examine the level of mathematical self-efficacy among teacher education students and to identify the key factors that contribute to the development of their competencies for teaching mathematics.

H1: The students who took the higher-level (A) of the state graduation exam in mathematics have significantly higher mathematical self-efficacy and self-efficacy in teaching mathematics compared to the students who took the basic level (B).

H2: Mathematical self-efficacy, attitudes toward mathematics, and pedagogical beliefs significantly contribute to explaining the variance in self-efficacy in teaching mathematics, with psychological factors having a stronger predictive influence than mathematical achievement alone.

RQ1: How do competencies for teaching mathematics develop during the teacher education program and are there significant differences between students of different years of study regarding mathematical self-efficacy and self-efficacy in teaching?

RQ2: What are the main challenges in teaching mathematics according to the perceptions of future teachers?

Sample

The study was conducted on a convenience sample of 272 student teachers from four Croatian universities. Most participants were in their fourth (27.9%) and fifth year of study (27.2%), while first-year students were least represented (7.0%). The majority of the respondents had completed a vocational school (59.9%), followed by a general gymnasium (26.8%). It is concerning that 89.3% of the students took the basic level, and only 10.7% the higher level of the State mathematics graduation exam, which indicates a weaker mathematical preparedness among future teachers. The study included the students with an active enrolment status who participated voluntarily and completed the questionnaire in full.

Research Instrument

For the purposes of the study, a structured questionnaire consisting of three parts was used. It included demographic data (year of study, type of secondary school, level and grades in mathematics), standardized scales of mathematical self-efficacy, anxiety,

attitudes, and professional development (α = 0,78-0,91), as well as two open-ended questions on the challenges and desired changes in mathematics teaching. All scales were in a 5-point Likert format and demonstrated reliability above 0.78.

Data Collection Procedure

Data were collected during the 2024/2025 academic year in collaboration with the teacher education faculty members. The students participated voluntarily after the purpose of the study was explained and informed consent was obtained. The questionnaire was administered in groups at the beginning or end of class and completion took 25-30 minutes. The procedure included collecting and coding the data with full anonymity and confidentiality of the participants.

Data Analysis

Quantitative data were processed using descriptive statistics (measures of central tendency, variability, and distribution) and correlation analysis (Pearson coefficients). Comparative analysis included ANOVA tests for the differences between years of study and t-tests for the differences based on the level of the State mathematics graduation exam. Hierarchical regression analysis was used to identify predictors of self-efficacy in teaching mathematics. Qualitative data were analyzed using the thematic analysis according to Braun and Clarke (2006), resulting in three main themes: the affective-motivational, epistemological-cognitive and pedagogical-didactic dimensions of challenges in teaching mathematics. Quantitative data were processed in SPSS, and qualitative data in NVivo.

3 Research Results and Discussion

Quantitative Results

Table 1 presents the demographic characteristics of the sample, which consisted of 272 participants. The sample of 272 participants shows a relatively even distribution of students in the higher years of study. The largest proportion consisted of fourth-year (27.9%) and fifth-year students (27.2%), while the smallest proportion consisted of first-year students (7.0%). This distribution is expected, given that the teacher education students focus more on the issues related to teaching mathematics in the later years of their studies.

According to the type of secondary school completed, students from vocational schools dominate the sample (59.9%), while students from general gymnasiums make up 26.8%. Other types of schools (language gymnasium 5.1%, classical gymnasium 1.5%) are represented in smaller percentages. The analysis of the State mathematics graduation exam level showed a dominance of the basic level (B 89.3%), while only 10.7% of students took the higher level (A), indicating a relatively low level of mathematical preparation among future teachers.

Table 1

Demographic characteristics of the sample (N = 272)

Year of study	*f*	*%*
1st year	19	7.0
2nd year	39	14.3
3rd year	64	23.5
4th year	76	27.9
5th year	74	27.2

Descriptive statistics of average math grades showed moderate values: the grade in mathematics on the State graduation exam (M = 3.38) was slightly higher than the average grade in secondary school (M = 3.17) and the average grade in mathematics courses during university studies (M = 3.28). Standard deviations were around 0.90, indicating moderate variability, while the grade range (1-5) allows for a detailed analysis of relationships between variables. Descriptive statistics for composite variables, such as mathematical self-efficacy and anxiety, are presented in Table 2.

Table 2

Descriptive statistics of composite variables

Composite variable	*N*	*M*	*SD*	*Min*	*Max*	*α*
Mathematical self-efficacy	272	2.79	0.83	1.00	4.75	0.89
Mathematical anxiety (reverse-scored)	272	2.68	0.82	1.00	4.67	0.85
Attitudes toward mathematics	272	3.97	0.83	1.50	5.00	0.82
Self-efficacy in teaching	272	4.22	0.68	1.50	5.00	0.91
Pedagogical beliefs	272	4.39	0.50	2.67	5.00	0.78
Perception of study quality	272	3.16	0.71	1.86	4.57	0.86
Self-perception of development	272	2.93	0.97	1.00	5.00	0.84
Professional development	272	413	0.50	3.00	5.00	0.79

Remark: α = Cronbach's alpha reliability coefficient

Table 2 shows that students have relatively low levels of mathematical self-efficacy (M = 2.79), which is concerning for future mathematics teachers. The level of mathematical anxiety is also moderate (M = 2.68), suggesting the presence of some anxiety related to mathematics. On the other hand, students hold positive attitudes toward mathematics (M = 3.97) and report a high general teaching self-efficacy (M = 4.22). Pedagogical beliefs are also high (M = 4.39), indicating positive beliefs about teaching. The perceived quality of the study program is moderate (M = 3.16), while self-perceived development is relatively low (M = 2.93). Professional development scores are high (M = 4.13). All Cronbach's alpha coefficients are satisfactory ($\alpha > 0.78$), confirming the reliability of the instruments.

Correlation analysis (Table 3) revealed a strong correlation between mathematical self-efficacy and mathematical anxiety (r = 0.721), which is expected because anxiety was reverse-coded, with higher scores indicating lower anxiety.

Table 3

The correlation matrix

Variable	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1. Mathematical self-efficacy	1.000								
2. Mathematical anxiety	0.721*	1.000							
3. Attitudes toward mathematics	0.653*	0.482*	1.000						
4. Self-efficacy in teaching	0.684*	0.521*	0.714*	1.000					
5. Pedagogical beliefs	0.312*	0.214*	0.453*	0.521*	1.000				
6. Perception of study quality	0.342*	0.284*	0.412*	0.493*	0.384*	1.000			
7. Mathematics grade (State Graduation Exam)	0.581*	0.452*	0.423*	0.414*	0.183*	0.234*	1.000		
8. Mathematics grade (secondary school)	0.614*	0.483*	0.463*	0.442*	0.212*	0.264*	0.784*	1.000	
9. Mathematics grade (university)	0.523*	0.412*	0.381*	0.453*	0.243*	0.314*	0.652*	0.693*	1.000

Remark: * $p < 0.01$

The analysis of Table 4 shows medium to high correlations between mathematical self-efficacy and teaching self-efficacy ($r = 0.684$), suggesting that students with higher mathematical self-efficacy also have higher teaching self-efficacy. Attitudes toward mathematics show significant correlations with all variables, especially with teaching self-efficacy ($r = 0.714$), indicating the importance of positive attitudes for the development of teaching competencies. Mathematics grades (State Graduation Exam, secondary school, university) are highly correlated with each other ($r > 0.65$), confirming the consistency of mathematical achievement across educational levels.

The analysis of variance shows no statistically significant differences in mathematical self-efficacy across years of study ($p = 0.055$), whereas teaching self-efficacy increases significantly during the course of study ($F(4.267) = 8.42$, $p < 0.001$, $\eta^2 = 0.112$). Post-hoc tests reveal that the fifth-year students ($M = 4.41$) have a significantly higher teaching self-efficacy than the first-year students ($M = 3.95$). The results of the t-tests show significant differences between the students who took the basic (B) and higher (A) levels of the State Mathematics Graduation Exam across all measured variables (Table 4).

Table 4

The differences according to the level of the State Graduation Exam (t-test)

Variable	*B level (n = 234)*		*A level (n = 29)*		*t*	*p*	*Cohen's d*
	M	SD	M	SD			
Mathematical self-efficacy	2.71	0.79	3.42	0.91	-4.56	< 0.001	0.84
Mathematical anxiety	2.61	0.78	3.18	1.02	-3.42	< 0.001	0.65
Attitudes toward mathematics	3.93	0.82	4.31	0.76	-2.45	0.015	0.48
Self-efficacy in teaching	4.18	0.68	4.52	0.59	-2.63	0.009	0.52

The students who took the higher level of the State Mathematics Graduation Exam show a significantly higher mathematical self-efficacy (Cohen's d = 0.84), lower mathematical anxiety (Cohen's d = 0.65), more positive attitudes toward mathematics (Cohen's d = 0.48) and a higher teaching self-efficacy (Cohen's d = 0.52).

The results confirm hypothesis H1, indicating the importance of a strong mathematical preparation for the development of teaching competencies. Hierarchical regression analysis shows a gradual increase in the explained variance in teaching self-efficacy across the three models.

Model 1 includes only mathematics grades and explains 20.1% of the variance. All three grades (State Graduation Exam, secondary school, university) significantly contribute to the prediction. Model 2 adds mathematical self-efficacy and anxiety, which significantly increases the explained variance to 51.2%.

Mathematical self-efficacy shows the strongest predictive effect (β = 0.287). Model 3 includes attitudes toward mathematics and pedagogical beliefs, further increasing the explained variance to 67.2%. Attitudes toward mathematics have the strongest predictive effect (β = 0.342), while grades lose significance, confirming the mediating effect of psychological variables.

Qualitative Results

The analysis of the interviews resulted in three thematic categories, each comprising two corresponding codes. A qualitative thematic analysis was conducted on the responses to two open-ended questions from the survey questionnaire, using Braun and Clarke's (2006) approach to the thematic analysis. The analysis involved six phases: familiarization with the data, initial coding, searching for themes, reviewing themes, defining and naming themes, and final reporting.

Table 5

Hierarchical regression analysis

Dependent variable: Self-efficacy in teaching

Model	*Predictors*	*β*	*t*	*p*	R^2	ΔR^2	*F*
Model 1					0.201	0.201	22.65**
	Mathematics grade (State Graduation Exam)	0.142	2.18	0.030			
	Mathematics grade (secondary school)	0.201	2.91	0.004			
	Mathematics grade (university)	0.198	3.02	0.003			
Model 2					0.512	0.311	69.42**
	Mathematics grade (State Graduation Exam)	0.058	1.12	0.264			
	Mathematics grade (secondary school)	0.089	1.68	0.094			
	Mathematics grade (university)	0.124	2.45	0.015			
	Mathematical self-efficacy	0.287	4.89	< 0.001			
	Mathematical anxiety	0.112	2.01	0.045			
Model 3					0.672	0.160	82.15**
	Mathematics grade (State Graduation Exam)	0.021	0.48	0.634			
	Mathematics grade (secondary school)	0.048	1.02	0.308			
	Mathematics grade (university)	0.098	2.15	0.032			
	Mathematical self-efficacy	0.201	3.78	< 0.001			
	Mathematical anxiety	0.067	1.35	0.178			
	Attitudes toward mathematics	0.342	6.89	< 0.001			
	Pedagogical beliefs	0.185	4.12	< 0.001			

Remark: ** $p < 0.001$

Theme 1: Affective–Motivational Dimension

Theme 1 highlights the emotional and motivational barriers in mathematics education, which often outweigh cognitive difficulties. The students recognize mathematical anxiety as a multi-layered phenomenon, associated with sociocultural factors, personal predispositions and collective stereotypes about mathematics as a "difficult" subject.

Mathematical anxiety manifests through cognitive symptoms (blocked thoughts), emotional symptoms (fear, shame, anger) and somatic symptoms (rapid heartbeat, sweating, tension), and it can significantly affect the working memory and the executive functions required for mathematical thinking.

Lack of motivation refers to the absence of intrinsic drivers, such as natural curiosity or enjoyment in problem-solving. The students express a concern about external motivation through grades, rather than deriving internal satisfaction from learning.

Theme 2: Epistemological–Cognitive Dimension

Theme 2 emphasizes the epistemological and cognitive challenges associated with the nature of mathematical knowledge and the processing of abstract information.

The abstractness of the concepts refers to the gap between the students' concrete experiences and abstract mathematical objects, such as numbers, functions, geometric shapes and algebraic structures. The students note that the learners often struggle with visualizing mathematical concepts, understanding symbolic notation and transferring knowledge between different representations of the same concept.

The complexity of the content refers to the cognitive overload caused by the mismatch between the students' developmental capabilities and the complexity of the material, with too much new information presented in a short time. What is intuitive for the teacher may be incomprehensible to the student.

Theme 3: Pedagogical–Didactic Dimension

Theme 3 relates to the practical challenges of lesson organization and represents one of the most complex issues in contemporary education. The students recognize that learners are unique not only in their level of knowledge but also in their cognitive profiles, learning styles, information processing speed and cultural backgrounds.

Student Heterogeneity – The students express a concern about learner heterogeneity, which includes differences in mathematical abilities, processing speed, working memory, learning styles, cultural backgrounds and prior knowledge. Heterogeneity is further increased by the inclusion of students with special educational needs, diverse socioeconomic backgrounds and speakers of other languages.

Individualization in Mass Education – Providing individualized support to students is hindered by time constraints (45-minute lessons), spatial limitations (fixed seating arrangements) and teachers' administrative demands. The students are aware that teachers often feel frustrated because they know what should be done (differentiation, individual support), but lack the practical conditions for implementation.

4 Conclusion

The results of the study on mathematical identity and professional development of future teachers confirmed both of the proposed hypotheses and provided a deeper understanding of the relationship between mathematical self-efficacy, attitudes toward mathematics and professional competencies in teaching. Mathematical identity proved

to be a particularly important factor shaping the emotional, cognitive, and pedagogical dimensions of the future teaching profession.

First Hypothesis (H1): The students who took the higher level (A) of the State Mathematics Graduation Exam have a significantly higher mathematical self-efficacy and teaching self-efficacy compared to the students who took the basic level (B) – this hypothesis was fully confirmed. It is evident that the students achieve significantly higher results across all relevant variables: mathematical self-efficacy, attitudes toward mathematics, teaching self-efficacy and lower levels of mathematical anxiety.

This result indicates that the level of prior mathematical preparation is directly related to later feelings of competence and confidence in teaching mathematics, confirming the need to strengthen the mathematical component in both secondary and university education for future teachers.

Second Hypothesis (H2): Mathematical self-efficacy, attitudes toward mathematics, and pedagogical beliefs significantly contribute to explaining the variance in teaching self-efficacy, with psychological factors having a greater predictive effect than mathematical achievement alone – this hypothesis was also confirmed.

The results from the hierarchical regression analysis showed that academic achievement alone explained only 20.1% of the variance in teaching self-efficacy, while the inclusion of psychological variables increased the explained variance to 67.2%. The strongest predictors were attitudes toward mathematics ($\beta = 0.342$), pedagogical beliefs ($\beta = 0.185$), and mathematical self-efficacy ($\beta = 0.201$), while mathematics grades lost statistical significance. This confirms that the development of teacher competence is not solely the result of cognitive abilities, but also of positive emotional and reflective relationships with the subject.

Qualitative findings further confirmed the importance of affective-motivational and pedagogical factors in forming professional identity. The students highlighted challenges such as fear of mathematics, lack of student motivation, the abstractness of concepts and class heterogeneity. At the same time, they emphasized the need for individualized approaches, development of methodological flexibility and the creation of a supportive environment where mathematics is connected to experiential learning.

The confirmed hypotheses together indicate that the professional development of future mathematics teachers arises from a dynamic interaction between knowledge, emotions and beliefs. Teachers who develop positive attitudes and a sense of self-efficacy become more confident, open to innovation and more successful in creating a stimulating classroom climate.

Therefore, the results of this study point to the need for systematically strengthening the psychological and reflective components in teacher education. Teacher education programs should integrate content that fosters the development of mathematical identity, reduces anxiety and increases the feeling of competence in teaching, which would contribute not only to the personal and professional growth of future teachers but also to the long-term quality of students' mathematics education.

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Matematična identiteta in profesionalni razvoj bodočih učiteljev

Koncept identitete v mnogih znanstvenih disciplinah ostaja izziv zaradi številnih teoretičnih pristopov in konceptualnih pomenov (Canrinus et al., 2011; Leitch in Harrison, 2016). Vloga učitelja matematike presega tradicionalno posredovanje znanja, saj vključuje oblikovanje odnosa učencev do matematike in spodbujanje kritičnega mišljenja. Na področju izobraževanja se identiteta učitelja razume kot dinamična kombinacija osebnih prepričanj, vrednot, poklicnih izkušenj in družbenih pričakovanj (Beauchamp in Thomas, 2009). Profesionalni razvoj učiteljev matematike se nanaša na sistematičen in stalen proces izboljševanja kompetenc, spretnosti in poklicnih vrednot, da bi izboljšali kakovost poučevanja (Desimone, 2009; Domović, 2011), pri čemer ne gre za enkraten dogodek, temveč za dolgoročen proces, ki vključuje sodelovalno učenje, uporabo novih strategij v praksi in refleksijo o lastnem delu (Garet idr., 2001). Če zgoraj navedeno analiziramo v sodobnem izobraževalnem kontekstu, pridobiva vprašanje učiteljeve identitete vse večji pomen, saj se profesionalni razvoj ne obravnava več le kot kopičenje znanja in spretnosti, temveč tudi kot proces oblikovanja profesionalne identitete.

Matematična identiteta kot sestavni del učiteljeve profesionalne identitete zajema osebna stališča, prepričanja, občutke in izkušnje, povezane z matematiko, ter vpliva na način, kako bodoči učitelji pristopajo k poučevanju tega predmeta. Raziskave potrjujejo, da sta samozavest in čustvena povezanost z matematiko eden od najpomembnejših dejavnikov za uspešno poučevanje (Graven in Lerman, 2014; Bognar, 2019). V tem kontekstu ima matematična identiteta pomembno vlogo pri razumevanju, kako študenti, bodoči učitelji, razvijajo kompetence za kakovostno in refleksivno poučevanje (Darragh idr., 2021).

Na podlagi Bandurinih (1997) teoretičnih postulatov o samoučinkovitosti in modela DSMRI (Kaplan in Garner, 2018) je cilj te študije preučiti raven matematične samoučinkovitosti študentov, bodočih učiteljev, in opredeliti najpomembnejše dejavnike, ki prispevajo k razvoju njihovih kompetenc za poučevanje matematike. Članek tako raziskuje povezavo med matematično samoučinkovitostjo, odnosom do matematike, matematično anksioznostjo in samoučinkovitostjo študentov pri poučevanju s poudarkom na tem, kako osebne izkušnje, predhodna priprava in pedagoška prepričanja oblikujejo njihovo pripravljenost za pedagoško delo (Graven in Lerman, 2014; Lutovac in Kaasila, 2017).

Raziskava je bila izvedena na vzorcu 272 študentov pedagoških smeri študija iz štirih hrvaških univerz: Oddelka za družbene in humanistične vede Univerze v Slavonskem Brodu, Fakultete za pedagoško izobraževanje Univerze v Zagrebu, Fakultete za pedagogiko v Pulju in Oddelka za pedagoško izobraževanje Univerze v Zadru. V vzorec so bili zajeti študenti različnih letnikov študija, pri čemer je bil največji delež študentov četrtega (27,9 %) in petega (27,2 %), najmanjši pa delež študentov prvega

letnika (7,0 %). Največji delež študentov v vzorcu je končal eno od poklicnih srednjih šol (59,9 %), sledile so jim splošne gimnazije (26,8 %), druge vrste šol pa so bile zastopane v manjšem deležu.

Uporabljen je bil kvantitativno-kvalitativni pristop. Kvantitativni del raziskave je vključeval vprašalnik s standardiziranimi lestvicami, ki so merile matematično samoučinkovitost, matematično anksioznost, odnos do matematike in samoučinkovitost pri poučevanju matematike (α = 0,78–0,91). Prvi del je obsegal demografske spremenljivke, vključno z letnikom študija, vrsto končane srednje šole, stopnjo državne mature iz matematike ter ocenami iz matematike na državni maturi, v srednji šoli in med študijem. Kvalitativni del pa je obsegal odprta vprašanja o osebnih izkušnjah in dojemanju poučevanja matematike.

Uporabljene so bile metode deskriptivne, primerjalne in regresijske analize ter tematska analiza odprtih odgovorov. Kvantitativni podatki so bili obdelani z deskriptivno statistiko, ki je vključevala izračun mer centralne tendence, variabilnosti in porazdelitve za vse numerične spremenljivke. Korelacijska analiza je bila izvedena z uporabo Pearsonovih korelacijskih koeficientov med spremenljivkami za ugotavljanje povezav med različnimi konstrukti. Primerjalna analiza je vključevala ANOVA teste za preučevanje razlik med leti študija in t-teste za preučevanje razlik med študenti, ki so opravljali različne stopnje državne mature. Nazadnje je bila izvedena tristopenjska hierarhična regresijska analiza za identifikacijo napovednih dejavnikov samoučinkovitosti pri poučevanju matematike. Kvalitativni podatki so bili analizirani s tematsko analizo po pristopu Brauna in Clarka (2006). Postopek je vključeval šest faz: seznanitev s podatki, začetno kodiranje, iskanje teme, pregled teme, definiranje in poimenovanje tem ter končno poročanje. To je omogočilo globlje razumevanje odnosa med kognitivno, čustveno in refleksivno dimenzijo matematične identitete. Podatki so bili zbrani v študijskem letu 2024/2025 v sodelovanju z učitelji na omenjenih programih za usposabljanje učiteljev, med anketiranci pa so bili študenti različnih letnikov študija in stopenj predhodne matematične priprave, s čimer je bila zagotovljena reprezentativnost vzorca. Vsi kvantitativni podatki so bili obdelani s statističnim paketom SPSS, za kvalitativno analizo pa je bila uporabljena programska oprema NVivo.

Rezultati kvantitativnega dela so pokazali, da imajo študenti pedagoških smeri zmerno raven matematične samoučinkovitosti, vendar močno pozitiven odnos do matematike in visoko samoučinkovitost pri poučevanju. Vendar pa ima večina povečano stopnjo matematične anksioznosti, zlasti med tistimi, ki so na državni maturi opravljali osnovno raven matematike.

Prvo hipotezo H1: Dijaki, ki so opravljali višjo raven (A) državne mature iz matematike, imajo statistično značilno višjo matematično samoučinkovitost in samoučinkovitost pri poučevanju matematike v primerjavi z dijaki, ki so opravljali osnovno raven (B), je potrdila analiza s t-testi, ki je pokazala statistično značilne razlike v korist te skupine. Drugo hipotezo H2: Matematična samoučinkovitost, odnos do matematike in pedagoška prepričanja pomembno prispevajo k razlagi variance samoučinkovitosti pri poučevanju matematike, pri čemer imajo psihološki dejavniki večji napovedni vpliv kot sami matematični dosežki, je potrdila tudi regresijska analiza (R^2 = 0,672).

Najpomembnejši napovedovalci so bili odnos do matematike (β = 0,34), pedagoška prepričanja (β = 0,19) in samoučinkovitost pri matematiki (β = 0,20), medtem ko akademski dosežki niso imeli pomembnega vpliva.

Kvalitativna analiza odgovorov študentov je opredelila tri tematske enote:

- *afektivno-motivacijska dimenzija, ki vključuje strah, negotovost in tesnobo, ki so povezane z matematičnimi nalogami,*
- *epistemološko-kognitivna dimenzija, ki se nanaša na razumevanje matematike kot abstraktne, a logične discipline in*
- *pedagoško-didaktična dimenzija, ki poudarja pomen razumljivega, izkustvenega in individualiziranega pristopa k poučevanju.*

Študente najbolj skrbi pomanjkanje zaupanja v lastno matematično znanje in strah pred prenosom negativnega odnosa na učence. Vendar pa večina izraža optimizem in motivacijo za nadaljnji profesionalni razvoj.

Pridobljeni rezultati potrjujejo, da matematična identiteta bodočih učiteljev ni izključno posledica kognitivnih sposobnosti, temveč kombinacija čustvenih izkušenj, refleksivnosti in pedagoških prepričanj. Podobno kot ugotovitve Gravena in Lermana (2014) se identiteta oblikuje z nenehno interakcijo med osebnimi prepričanji in izobraževalnim okoljem. Učitelji, ki razvijejo pozitiven odnos do matematike in visoko samozavest, pri pouku pogosteje uporabljajo ustvarjalne pristope in spodbujajo globlje razumevanje med učenci.

Visoka stopnja tesnobe pri nekaterih anketirancih kaže na potrebo po boljši podpori pri matematičnem in metodološkem izobraževanju. Sistematična refleksija, mentorstvo in izkustveno učenje lahko pomembno prispevajo k zmanjšanju negotovosti in razvoju pozitivne profesionalne identitete. Rezultati kažejo tudi na pomen razvoja čustvene kompetence bodočih učiteljev, sposobnosti prepoznavanja in obvladovanja lastnih čustev v kontekstu poučevanja.

Zgornji rezultati prispevajo k razumevanju kompleksnosti profesionalnega razvoja bodočih učiteljev matematike in kažejo na potrebo po vključevanju afektivnih dimenzij v učni načrt za izobraževanje učiteljev. Kombinacija teoretičnega razumevanja, refleksivne prakse in čustvene podpore se izkaže ključnega pomena za uspešno oblikovanje identitete kompetentnega in samozavestnega učitelja.

Raziskava je nazadnje potrdila, da ima matematična identiteta ključno vlogo pri razvoju profesionalne samozavesti in kompetenc bodočih učiteljev. Študenti, ki imajo pozitiven odnos do matematike in visoko samozavest pri poučevanju, kažejo višjo stopnjo refleksivnosti in odpornosti na stres. Zato bi moral biti profesionalni razvoj bodočih učiteljev uravnotežen med kognitivno, čustveno in refleksivno komponento.

Rezultati kažejo na nujnost, da se v študijske programe pedagoških fakultet uvajajo vsebine, ki spodbujajo samorefleksijo, čustveno pismenost in pedagoško samozavest. S krepitvijo matematične identitete bodoči učitelji postanejo sposobnejši ustvarjati pozitivno vzdušje v razredu, razvijati zanimanje učencev za matematiko in dolgoročno prispevati h kakovosti izobraževanja.

Data Availabilty Statement

This article is based on research data deposited in the authors' personal archives and are not publicly available; however, they may be obtained from the author upon reasonable request.

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