Croatian Journal of Education
Vol. 23; Sp.Ed.No.1/2021, pages: 125-141
Original research paper
Paper submitted: 2nd July 2020
Paper accepted: 1st November 2020
https://doi.org/10.15516/cje.v23i0.4103

Pre-service Primary Education Teachers' Achievement Goals in Mathematics and Their Approach to Learning and Teaching Mathematics

Daria Rovan, Dubravka Glasnović Gracin and Goran Trupčević
Faculty of Teacher Education, University of Zagreb

Abstract

In Croatia, as in many other countries, primary education teachers are trained as generalists and mathematics is only one of several different subjects that they teach, so when choosing their profession they are not necessarily drawn by their interest in becoming a mathematics teacher. Still, it is very important that they have a positive attitude towards mathematics and are motivated to teach it to their students. The aim of this study was to explore whether pre-service teachers with different achievement goal profiles have different beliefs about mathematics and teaching and learning mathematics. The participants were 325 pre-service primary education students. The research was conducted in three waves, during the students' first, third and fifth year of study. In their first year of studies, we collected data on the achievement goals in mathematics that they had in high school, and self-efficacy in mathematics. Epistemic beliefs, subjective value of mathematics and mathematics anxiety were assessed at all measurement points. In their third and fifth year of study, we also collected data on the participants' mathematics teaching efficacy beliefs and, in their fifth year, beliefs on teaching and learning mathematics. The results of the cluster analysis showed that we could group pre-service primary education teachers into three groups according to the profiles of their achievement goals in high school: (1) all goals high, (2) all goals low, (3) mastery orientation. The results showed differences between the groups in terms of motivation for learning mathematics at the beginning of their studies. However, these differences tend to

be less prominent over time. At the end of their studies, they do not differ in their mathematics teaching efficacy beliefs or their beliefs about teaching and learning mathematics.

Key words: *achievement goals; mathematics education; motivation; teacher education; teachers' beliefs.*

Introduction

In Croatia, as in many other countries, primary education teachers are trained as generalists and mathematics is only one of several different subjects that they teach. This means that when choosing their future profession, they are not necessarily drawn by their interest in becoming a mathematics teacher. However, it is very important that they have good mathematics teaching skills, have a positive attitude towards mathematics and are motivated to teach it to their students (Cross Francis et al., 2015). According to Kagan (1992), the teachers' pedagogical approach process depends on three factors: the particular class of students a teacher faces, curricular content, and teachers' beliefs related to their previous experiences. On the basis of the research review, Levin (2015) points out that teachers' beliefs and teacher knowledge are closely related, especially the practical knowledge that guides their behaviours.

When pre-service teachers begin their studies at university, they come with beliefs deeply rooted in their former primary and secondary education experiences (Pajares, 1992), and those beliefs serve as a filter for interpreting new knowledge and new experiences (Levin, 2015). As Levin and He (2008) found out in their study of teacher candidates' belief systems, there are three main sources of the pedagogical beliefs of pre-service teachers: their family background and personal experiences as K-12 students (35%); their teacher education coursework including exposure to various readings, theories, and professors' ideas (31%); and their experiences of observing and practicing in classrooms during their teacher education programs (35%). Therefore, everyone involved in teacher education should know what beliefs pre-service teachers bring to their professional education process and how those conceptions can be addressed and developed to help teachers acquire the knowledge and skills necessary for effective teaching.

The most appropriate research design to address a research question on the development of pre-service teachers' beliefs would be longitudinal design. However, at this point, there are only a small number of longitudinal studies on pre-service teachers' beliefs, with a few notable exceptions (e.g. Buldur, 2017; Domović & Vizek Vidović, 2019; Löfström & Poom-Valickis, 2013), of which only two (Blömeke et al., 2014; Swars et al., 2009) are related to teaching mathematics. The results of these studies are somewhat inconclusive but mainly show that during their studies pre-service teachers develop adaptive teachers' beliefs. However, none of these studies attempts to classify pre-service teachers into groups who start their education with more or less adaptive beliefs on learning and then follows the development of these teachers' beliefs until the end of their studies.

Recently, there has been a rise in the interest in researching the motivational profiles of different groups of students in the light of the achievement goal framework (Hornstra et al., 2017; Pastor et al., 2007; Rogat & Linnenbrink-Garcia, 2019; Schwinger & Wild, 2012; Shim & Finch, 2014; Tuominen-Soini et al., 2008, 2011, 2012). The achievement goal approach (Elliot, 2005; Elliot & Hulleman, 2017) is the theoretical framework explaining how students interpret and experience achievement situations and direct their achievement-related behaviours. According to the 2 x 2 achievement goal model (Elliot & McGregor, 2001), achievement goals are composed of distinct combinations of two fundamental dimensions: definition of standards (mastery vs. performance) and valence (approach vs. avoidance). Standards that serve as the referent point in performance evaluation can be absolute or intrapersonal and lead to the pursuit of mastery goals or can be normative and lead to the pursuit of performance goals. Individuals with mastery goals are focused on the development of competence through task mastery, while individuals with performance goals are focused on demonstration of competence relative to others. Furthermore, competence can have approaching valence when individuals are directed toward positive or desirable events and have positive expectations (e.g. success), or avoiding valence when individuals try to avoid negative or undesirable events and are preoccupied by negative expectations (e.g. failure).

Therefore, we can differentiate four different types of achievement goals. Mastery-approach goals have a focus on task mastery, learning and understanding (e.g. *"I want to learn as much as possible in mathematics."*); mastery-avoidance goals are concerned with avoiding misunderstanding and not learning what is required or possible (e.g. *"I worry that I won't learn everything that I could in mathematics."*). Performance-approach goals represent wanting to demonstrate superior performance, doing better than others, being the smartest or the best at a task (e.g. *"My goal is to have better grades in mathematics than the other students."*), while performance-avoidance refers to wanting to avoid an inferior performance or displaying a lack of competence in comparison to others (e.g. *"My goal is to avoid performing worse than other students in mathematics."*).

Over the past few decades, many research studies, correlational and experimental, have explored the outcomes of the pursuit of different achievement goals (see Elliot & Hulleman, 2017; Huang, 2012; Kaplan & Maehr, 2007; Utman, 1997). The research shows that mastery-approach goals are consistently related to adaptive motivational beliefs (intrinsic motivation, interest, subjective value, self-efficacy), adaptive learning strategies (deep approach to learning, self-regulated learning activities) and positive emotions. Mastery-avoidance goals are motivated by avoidance tendencies and therefore positively correlated with negative emotions such as test anxiety, and negatively correlated to academic achievement. Performance-approach goals are consistently related to academic achievement and grit, but also to some less desirable outcomes like surface approaches to learning. Performance-avoidance goals have a particularly detrimental effect on motivation as well as on achievement. They are related to negative emotions (e.g. shame) and a surface approach to learning.

Studies based on variable-centred analyses are not informative in terms of which combination of achievement goals are adaptive or maladaptive. Therefore, in order to answer these kinds of research questions, researchers use a person-centred approach (e.g. cluster analysis) (Hulleman & Senko, 2010). This methodological approach has resulted in the identification of different achievement goals profiles that are relatively stable (Tuominen-Soini, Salmela-Aro & Niemivirta, 2011) and related to distinctive patterns of outcomes. For example, students that are mastery oriented (with dominant mastery goals) and success oriented (with both high mastery and high performance goals) value school and are equally engaged in learning, but with a higher emotional cost for the group of success-oriented students (Tuominen-Soini, Salmela-Aro & Niemivirta, 2008, 2012). In addition, success-oriented students, as well as indifferent students (with all goals low), have high fear of failure (Tuominen-Soini et al., 2011).

Therefore, we expect that pre-service teachers' achievement goal profiles based on their approaches to learning mathematics in high school will act as a filter in forming and developing their beliefs about teaching and learning mathematics during their teacher education. So, the aim of this study was to explore whether pre-service teachers with different achievement goal profiles have different beliefs about mathematics (beliefs about knowledge and knowing, i.e. epistemic beliefs in mathematics, self-efficacy in mathematics, subjective value of mathematics and mathematics anxiety), and different beliefs about teaching mathematics (mathematics teaching self-efficacy and beliefs about different approaches to teaching, such as student-centred vs. teacher-centred). These beliefs are very important because if teachers want to encourage students' mathematical thinking, they should hold beliefs that support the development of problem-centred, learner-oriented classroom environments (Cross, 2009). Also, the relationship between teachers' beliefs about mathematics and their teaching practices is documented by numerous researchers (Cross et al., 2015).

More precisely, we sought to answer the following questions:

1. Is there an "at-risk group" of future primary education teachers that begins their studies with low motivation for learning mathematics?

   Hypothesis 1: The pre-service teachers can be categorized into groups with different achievement goal profiles ("mastery oriented", "all goals high" and "all goals low").

   Hypothesis 2: The group with all goals low will have the lowest subjective value and self-efficacy for learning mathematics and the least sophisticated epistemic beliefs (i.e. will hold beliefs that knowledge is fixed, not needing evidence to be justified, and that knowledge is simple rather than complex) in the first year of their studies, in comparison to the other groups of pre-service teachers.

   Hypothesis 3: The group with all goals high will have the highest mathematics anxiety in the first year of their studies in comparison to the other groups of pre-service teachers.

2. Will the groups of future primary education teachers with different achievement goal profiles have different attitudes towards learning and teaching mathematics during and at the end of their studies?

   Hypothesis 4: The differences between groups with different achievement goal profiles in their epistemic beliefs, subjective value and mathematics anxiety will be stable during their studies.

   Hypothesis 5: The group with all goals low will have the lowest self-efficacy for teaching mathematics and beliefs about teaching mathematics in comparison with the other two groups.

Method

Participants

The research involved two cohorts of pre-service teachers, i.e. primary teacher education students of the Faculty of Teacher Education, University of Zagreb, who began their studies in the academic years 2013/2014 and 2014/2015. This study involves a five-year integrated teacher education university graduate programme, which provides the competencies for teaching six different subjects in primary grades (grades 1 – 4): Croatian Language, Mathematics, Science, Music Art, Visual Art, and Physical Education. The study programme includes basic subjects (e.g. Mathematics) and pedagogical and psychological education in the first years of the study, while teaching specific subjects (e.g. Mathematics Education) and school practice come in later years of the study. The data collection was conducted in three waves, during the students' first, third and fifth year of study. In their first year of study, students take two courses on the basics of mathematics, and in their fourth and fifth years of study, they take four courses on teaching mathematics. At the first measurement point, 325 students in their first year of study participated (183 students during the academic year 2013/2014 and 142 students during 2014/2015); at the second measurement point, there were 192 students (99 students during 2015/2016 and 93 during 2016/2017), and at the third measurement point, 212 students took part (122 during 2017/2018 and 90 during 2018/2019). The study participants were predominantly female (95% at the first measurement point, 95.4% at the second and 96.2% at the third). The average age of the students at the beginning of the study was 19.5 years.

Procedure

Data collection was carried out in groups, immediately before or after classes, with the instruction that it is being carried out for the purpose of scientific research, that it is anonymous and that participation in the research is voluntary. All participants signed a consent form to participate in the study. At the first measurement point, a questionnaire was applied which consisted of five scales: Achievement Goals, Epistemic Beliefs, Self-Efficacy, Subjective Value of Learning Mathematics and Mathematics Anxiety. At the second and third measurement point, three scales - Epistemic Beliefs,

Subjective Value of Learning Mathematics and Mathematics Anxiety - were applied again, and the scale of Mathematics Teaching Efficacy Beliefs was added. At the third measurement point, the scale of Teachers' Beliefs about the Teaching and Learning Mathematics was also applied.

The questionnaires took about 20 minutes to complete. In the questionnaires, participants were required to indicate to what extent they agreed with each statement; the degree of agreement ranged from 1 (strongly disagree) to 5 (strongly agree), except for the Self-Efficacy Scale where the agreement ranged from 1 (strongly disagree) to 7 (strongly agree). Results on individual scales were formed as arithmetic means of responses on the corresponding items. Basic demographic data on the participants was also collected in the questionnaire.

Instruments

The Achievement Goals Scale (Rovan, 2011) includes four subscales measuring different achievement goals operationalized in line with the 2x2 model of achievement goals (Elliot & McGregor, 2001): Mastery-Approach Goal (three items, e.g. "*I want to learn as much as possible.*"; α =.85), Mastery-Avoidance Goal (three items, e.g. "*I am worried that I won't learn all that I could.*"; α = .76), Performance-Approach Goal (three items, e.g. *"I try to be successful compared to other students."*; α = .76) and Performance-Avoidance Goal (three items, e.g. *"I am worried that I will have worse results than other students."*; α = .89). In the accompanying instructions, it was clearly indicated to give ratings based on the achievement goals that they had during high school education.

Epistemic Beliefs Scale (Rovan, 2011) is intended to measure beliefs about the nature of knowledge and knowing in the field of mathematics. The scale consists of two subscales: Justified Knowledge (five items, e.g. "*We can be sure that something we learned is correct if we can apply it to a real-life situation.*") and Simple Knowledge (six items, e.g. "*If professors were more committed to practicing exercises and less concerned with theory, students would benefit more from it.*"). Beliefs about the need for evaluation of knowledge are considered more sophisticated, while beliefs about the simplicity of knowledge are considered less sophisticated. Coefficients of reliability obtained by the method of internal consistency in this study were relatively low, but sufficient (Simple Knowledge: α = 0.59 - 0.65; Justified Knowledge: α = 0.71 - 0.74).

The Mathematics Self-Efficacy Scale (Rovan, 2011) measures student self-efficacy in mathematics. The scale contains six items (e.g. *"I am sure I can ... understand all parts of mathematics content."*), and the reliability of the scale in this study was α = .93.

Subjective Value Scale. Items used in this scale were formed in accordance with the expectancy-value theory (Wigfield & Eccles, 2000, 2002) and adapted for assessing the subjective value of mathematics both while students are taking mathematics courses and afterwards. We decided on including two items on interest in mathematics (e.g. "*I generally find solving tasks in mathematics to be very boring / very interesting.*"), one item related to the attainment value of mathematics *("How important is it to you personally*

to be successful in solving problems involving mathematics or mathematical reasoning? Not at all important / Very important."), and three items on utility of mathematics (e.g. *"How useful are things you learned in mathematics in everyday life?"*). Participants expressed their agreement with individual items on a scale of 1 to 5, with clearly defined reference points (e.g. 1 = *"Not at all important"*; 5 = *"Very important to me"*). Although the theory presumes the multifactor model with separate components of value, it is not uncommon to use the total score as an indicator of global assessment of a subjective value. Reliability of a resultant thus formed and expressed as the internal consistency coefficient ranged from α = .75 to α = .82 in this study.

Mathematics Anxiety Scale. To assess mathematics anxiety, the scale developed by Hunt et al. (2011) was adapted. It consists of three subscales related to different aspects of mathematics anxiety. The first subscale (maths evaluation anxiety) refers to mathematics anxiety in test situations (four items, e.g. *"Writing an unannounced test in a maths class."*), the second subscale (everyday/social life maths anxiety) considers anxiety when applying mathematics in everyday situations (11 items, e.g. *"Calculating how many days there are to someone's birthday."*), and the third subscale (maths observation anxiety) refers to anxiety when exposed to a mathematical content (five items, e.g. *"Observing someone solving a mathematical problem."*). For each item, participants assessed how anxious they were in each situation. Ratings were given on a scale from 1 (*"I am not upset"*) to 5 (*"I am very upset"*). Reliability of individual subscales expressed as the internal consistency coefficient ranged from α = .81 to α = .89.

Self-Efficacy Scale for Teaching Mathematics. An adapted version of the Personal Mathematics Teaching Efficacy subscale, a part of the MTEBI instrument (Mathematics Teaching Efficacy Beliefs Instrument) (Enochs et al., 2000), was used to examine self-efficacy in teaching mathematics. The scale consists of 13 items (e.g. *"I will continually find better ways to teach mathematics."*). The reliability of the scale expressed as the internal consistency coefficient was α = .85 in this study.

The *Teacher Beliefs in Teaching and Learning Mathematics Scale* was developed for the purpose of this research, based on the Confidence, Commitment, Collaboration, and Student Thinking in Mathematics and Science (CCCSMS) beliefs scales (Hudson et al., 2012). The scale consisted of 18 items, and by exploratory factor analysis we determined a 3-factor structure. The subscales were: understanding students' thinking (e.g. *"In general, I will know how to ask questions that will help me understand how students think in mathematics."*); student-centred teaching (e.g. *"Students learn mathematical concepts better when using investigative activities."*); and, teacher-centred teaching (e.g. *"It is the student's role to understand the teacher's way of solving a problem."*). Each subscale consisted of six items and had reliability coefficients α ranging between .62 and .74.

Results

In order to categorize pre-service teachers into groups with different achievement goal profiles, a cluster analysis was performed. Since this research was aimed at

clustering participants into groups in order to explore differences between groups with different achievement goal profiles, we used the K-means clustering method that requires the pre-specification of the number of clusters. For the clustering, we used results of the achievement goals subscales: mastery-approach, mastery-avoidance, performance-approach and performance-avoidance. In accordance with previous research on achievement goal profiles (e.g. Hornstra et al., 2017; Rogat & Linnenbrink-Garcia, 2019; Schwinger & Wild, 2012; Shim & Finch, 2014; Tuominen-Soini et al., 2008, 2011, 2012), the presumed number of clusters was three to six. As a preliminary step to explore our data and decide on number clusters for the K-means method, we used Ward's method for hierarchical cluster analysis. Accordingly, the three-cluster solution was chosen as optimal.

For clustering, the average raw scores on the achievement goal subscales were used. Through eight iterations, the following cluster centres were obtained: Cluster 1 ($C_{MAp} = 3.45$, $C_{MAv} = 3.31$, $C_{PAp} = 3.20$, $C_{PAv} = 3.45$), Cluster 2 ($C_{MAp} = 1.95$, $C_{MAv} = 1.89$, $C_{PAp} = 1.83$, $C_{PAv} = 1.60$), Cluster 3 ($C_{MAp} = 3.96$, $C_{MAv} = 3.09$, $C_{PAp} = 2.63$, $C_{PAv} = 1.60$). The clusters were defined to maximize the differences between clusters. Cluster 1 was labelled as "*all goals high*" students ($N = 126$) due to the high values obtained on all subscales, while Cluster 2 was labelled as "*all goals low*" students ($N = 92$) due to the low value on all subscales. Given the higher cluster centre obtained for the mastery-approach goal, followed by moderate values for the mastery-avoidance and performance-approach goals and a low value for the performance-avoidance goal, Cluster 3 was labelled as "*mastery oriented*" students ($N = 107$).

Descriptive statistics for all analysed constructs is presented in Table 1. To answer the first research problem, we performed a one-way ANOVA to analyse the differences between groups with different achievement goals on epistemic beliefs, subjective value, self-efficacy and mathematics anxiety. As can be seen in Table 2, there are significant differences between different groups for all the tested constructs except one – epistemic beliefs about simple knowledge. Post-hoc analyses show that the "all goals low" group has the least adaptive approach to learning mathematics – the lowest epistemic beliefs about justified knowledge, the lowest subjective value of mathematics, the lowest self-efficacy in mathematics and the highest mathematics anxiety. On the other hand, the "all goals high" group has adaptive epistemic and motivational beliefs and relatively high mathematics anxiety, but not higher than the "all goals low" group. Therefore, we confirmed that the pre-service teachers can be categorized into groups with different achievement goal profiles (Hypothesis 1). Also, as expected, the group with all goals low had the lowest subjective value and self-efficacy for learning mathematics and the least sophisticated epistemic beliefs in the first year of their studies in comparison to the other groups of pre-service teachers (Hypothesis 2). The group with all goals high had the highest mathematics anxiety only in comparison to the mastery oriented group, so the Hypotheses 3 was partially confirmed.

Table 1.

Descriptive statistics for groups with different achievement goals

	Groups								
	all goals high (1)			all goals low (2)			mastery oriented (3)		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
First year									
Epistemic beliefs on justified knowledge	126	3.90	0.59	92	3.59	0.81	107	3.89	0.58
Epistemic beliefs on simple knowledge	126	3.01	0.51	92	3.01	0.52	107	2.88	0.57
Subjective value of mathematics	126	2.97	0.72	92	2.16	0.69	107	3.31	0.70
Self-efficacy in mathematics	126	5.07	1.11	92	4.51	1.39	107	5.58	1.05
Everyday/social life maths anxiety	126	1.91	0.75	92	1.85	0.76	107	1.53	0.53
Maths observation anxiety	126	1.79	0.81	92	2.01	0.93	107	1.45	0.51
Maths evaluation anxiety	126	3.15	0.95	92	3.30	1.07	107	2.64	0.92
Third year									
Epistemic beliefs on justified knowledge	83	4.07	0.58	46	3.88	0.55	62	3.99	0.62
Epistemic beliefs on simple knowledge	83	2.78	0.51	46	2.69	0.50	62	2.66	0.54
Subjective value of mathematics	83	2.99	0.68	46	2.63	0.76	62	3.52	0.67
Everyday/social life maths anxiety	83	1.68	0.73	46	1.64	0.68	62	1.51	0.57
Maths observation anxiety	83	1.61	0.78	46	1.69	0.72	62	1.38	0.59
Maths evaluation anxiety	83	2.92	1.04	46	3.08	0.91	62	2.43	0.87
Mathematics teaching efficacy beliefs	83	3.89	0.51	46	3.82	0.56	62	4.02	0.54
Fifth year									
Epistemic beliefs on justified knowledge	89	4.18	0.57	53	4.18	0.59	70	4.28	0.46
Epistemic beliefs on simple knowledge	89	2.44	0.55	53	2.20	0.50	70	2.32	0.43
Subjective value	89	3.58	0.60	53	3.37	0.79	70	3.88	0.61
Everyday/social life maths anxiety	88	1.68	0.66	53	1.71	0.71	70	1.63	0.61
Maths observation anxiety	88	1.52	0.66	53	1.53	0.74	70	1.32	0.57
Maths evaluation anxiety	88	2.77	1.12	53	2.86	1.01	70	2.40	0.96
Mathematics teaching efficacy beliefs	89	4.12	0.44	53	4.15	0.54	70	4.22	0.56
Understanding students' thinking	88	3.99	0.45	52	4.07	0.60	70	4.02	0.54
Student-centred teaching	88	4.33	0.43	52	4.39	0.42	70	4.33	0.40
Teacher-centred teaching	88	2.24	0.61	52	2.15	0.51	70	2.23	0.56

Table 2.

Results of a one-way ANOVA examining the differences between groups with different achievement goal profiles in the first year of their studies

	F	*df*	*p*	η_p^2	Bonferroni
Epistemic beliefs on justified knowledge	7.19	2, 322	<.01	0.04	1>2; 3>2
Epistemic beliefs on simple knowledge	2.40	2, 322	>.05	0.02	/
Subjective value	68.34	2, 322	<.001	0.30	1>2; 3>1; 3>2
Self-efficacy	20.33	2, 322	<.001	0.11	1>2; 3>1; 3>2
Everyday/social life maths anxiety	9.49	2, 322	<.001	0.06	1>3; 2>3
Maths observation anxiety	16.12	2, 322	<.001	0.09	1>3; 2>1; 2>3
Maths evaluation anxiety	13.00	2, 322	<.001	0.08	1>3; 2>3

Note: 1 = "all goals high" group, 2 = "all goals low" group, 3 = "mastery oriented" group

To address the second research problem, we performed a repeated measures ANOVA for all variables with two or three measuring points and a one-way ANOVA for the variables measured only in the third wave (Table 3.). The first thing we can notice is the significant effect of the year of study with effect sizes for all variables, ranging from 0.02 for everyday/social life maths anxiety to the 0.23 for mathematics teaching efficacy beliefs, and even 0.41 for subjective value or 0.42 for epistemic beliefs on simple knowledge. So, we can conclude that during their studies all pre-service teachers develop more adaptive beliefs compared with their initial beliefs. The achievement goal profiles effect is not significant for all variables. Achievement goal profiles have a significant effect on the subjective value (effect size is 0.26), maths observation anxiety and maths evaluation anxiety (with effect sizes around .10), and epistemic beliefs on simple knowledge (effect size is 0.06). These results clearly indicate that the "mastery oriented" group holds the most adaptive beliefs, followed by the "all goals high" group. The majority of these effects can only be fully understood if we take into account the interactions of the achievement goal effect and the effect of teacher education. These interactions were significant for the subjective value of mathematics, everyday/social life maths anxiety and maths observation anxiety. For subjective value of mathematics, there is more intensive growth in values for the "all goals low" and "all goals high" groups than for the "mastery oriented" groups. Also, the differences between the groups are greater in the first year than later. Regarding anxiety scales, "all goals low" and "all goals high" have similar trajectories with a significant drop in values, while the "mastery oriented" groups start with the lowest values and keep them until the fifth year. So, the groups of students that started their studies with less favourable beliefs improve them more by the end of their teacher education in comparison to the groups of students with more favourable beliefs.

Table 3.

Results of a repeated measures ANOVA examining the differences between groups with different achievement goal profiles at their first, third and fifth year of studies

		F	*df*	*p*	η_p^2	Bonferroni
Epistemic beliefs on justified knowledge	Year of study (1st, 3rd, 5th)	20.39	2, 306	<.001	0.12	
	Achievement goals profiles	2.41	2, 153	>.05	0.03	
	Year x Ach. goals	1.37	4, 306	>.05	0.02	
Epistemic beliefs on simple knowledge	Year of study (1st, 3rd, 5th)	111.91	2, 306	<.001	0.42	
	Achievement goals profiles	4.57	2, 153	<.05	0.06	1>3
	Year x Ach. goals	2.32	4, 306	>.05	0.03	
Subjective value	Year of study (1st, 3rd, 5th)	103.93	2, 306	<.001	0.41	
	Achievement goals profiles	27.35	2, 153	<.001	0.26	1>2; 3>1; 3>2
	Year x Ach. goals	6.98	4, 306	<.001	0.08	
Everyday/social life maths anxiety	Year of study (1st, 3rd, 5th)	3.54	2, 304	<.05	0.02	
	Achievement goals profiles	2.87	2, 152	<.05	0.04	
	Year x Ach. goals	2.93	4, 304	<.05	0.04	
Maths observation anxiety	Year of study (1st, 3rd, 5th)	14.20	2, 304	<.001	0.09	
	Achievement goals profiles	9.01	2, 152	<.001	0.10	1>3; 2>3
	Year x Ach. goals	2.52	4, 304	<.05	0.03	
Maths evaluation anxiety	Year of study (1st, 3rd, 5th)	19.78	2, 304	<.001	0.12	
	Achievement goals profiles	9.35	2, 152	<.001	0.11	1>2; 3>1; 3>2
	Year x Ach. goals	1.71	4, 304	>.05	0.02	
Mathematics teaching efficacy beliefs	Year of study (3rd, 5th)	44.85	1, 153	<.001	0.23	
	Achievement goals profiles	1.53	2, 153	>.05	0.02	
	Year x Ach. goals	0.65	2, 153	>.05	0.01	

Note: 1= "all goals high" group, 2 = "all goals low" group, 3 = "mastery oriented" group

Finally, we performed a one-way ANOVA examining the differences between groups with different achievement goal profiles in the fifth year of their studies. The results were insignificant for all subscales (Understanding students' thinking – F (2,207) = 0.46, $p > .05$; Student-centred teaching – F (2,207) = 0.51, $p > .05$; Teacher-centred teaching – F (2,207) = 0.42, $p > .05$). When we take into account the insignificant effect of achievement goal profiles for mathematics teaching efficacy beliefs, we can conclude that achievement goal profiles do not have an effect on teacher beliefs directly related to the teaching. Therefore, Hypotheses 4 and 5 were not confirmed.

Discussion and conclusions

The results of this study provide valuable information on the beliefs that pre-service teachers bring to their teacher education. They enter their studies with qualitatively different orientations to learning mathematics that are reflected primarily in their subjective view of the value of mathematics but also have an effect on their self-efficacy, mathematics anxiety and epistemic beliefs on justified knowledge. Awareness of these differences can help university teachers to provide adequate support to pre-service teachers in developing their mathematical competencies and beliefs about learning and teaching mathematics. Our results are in line with other research showing that the mastery orientation group outperforms all other groups in motivation and performance (Rogat & Linnenbrink-Garcia, 2019; Schwinger & Wild, 2012; Shim & Finch, 2014; Tuominen-Soini et al., 2008, 2011, 2012).

The results of our study also demonstrate the value of subject-centred analyses and the multiple goals perspective on achievement goals, since achievement goal profiles are found to be very useful in explaining the differences in pre-service teachers' approaches to learning mathematics. Using this approach, we can easily identify "at risk" groups of pre-service teachers with relatively low motivation for learning mathematics, maladaptive epistemic beliefs and high maths anxiety that certainly require special attention from their university mathematics teachers.

Our results on adaptive development of pre-service teachers' beliefs during their studies regardless of their achievement goals profile, as well as the results of some previous research (Blömeke et al., 2014; Buldur, 2017; Swars et al., 2009), support the conclusion about the importance of high-quality teacher education, especially emphasizing the role of mathematics pedagogical content knowledge. They also prove that teachers' beliefs are malleable, and not fixed. Therefore, in teacher education we should promote the growth mindset (Dweck & Molden, 2017) that students' and pupils' (mathematical) abilities are not fixed, but can be increased through learning. Also, we could try to identify "at risk" groups of students at the beginning of their studies, offer additional support to them and evaluate the possible effects of this intervention.

In conclusion, our research results are in line with the assumption that both previous experiences of learning mathematics and experiences during the teacher education programs are important in the process of forming beliefs about mathematics and teaching

mathematics. However, more complex research is needed to reveal the possible interplay of these factors in developing pre-service teachers' approach to teaching mathematics. Also, some limitations of our study should be noted. Firstly, the reliability coefficients were somewhat low, especially for epistemic and teachers' beliefs, so the results should be taken with caution. Furthermore, because of the problems with insufficient data common to longitudinal studies, sample size for some of the analyses was relatively small. More studies with different groups of pre-service teachers will be needed to confirm generalizability of our conclusions and to establish whether the quality of teaching during the teacher education program has an impact on the development of pre-service teachers' beliefs and motivation. Furthermore, it would be especially interesting to follow pre-service teachers longitudinally and explore possible changes in their approach to learning and teaching mathematics during their in-service years. Research focused on transition from pre-service to in-service teaching (e.g. Clark, 2020; Gresham, 2018) points to the importance of continuing the development of teachers' beliefs and approach to teaching.

References

Blömeke, S., Buchholtz, N., Suhl, U., & Kaiser, G. (2014). Resolving the chicken-or-egg causality dilemma: The longitudinal interplay of teacher knowledge and teacher beliefs. *Teaching and Teacher Education, 37,* 130–139. https://doi.org/10.1016/j.tate.2013.10.007

Buldur, S. (2017). A longitudinal investigation of the pre-service science teachers' beliefs about science teaching during a science teacher training programme. *International Journal of Science Education, 39*(1), 1-19. https://doi.org/10.1080/09500693.2016.1262084

Clark, S.K. (2020). Examining the development of teacher self-efficacy beliefs to teach reading and to attend to issues of diversity in elementary schools. *Teacher Development.* https://doi.org/10.1080/13664530.2020.1725102

Cross, D. I. (2009). Alignment, cohesion, and change: Examining mathematics teachers' belief structures and their influence on instructional practice. *Journal of Mathematics Teacher Education, 12* (5), 325–346. https://doi.org/10.1007/s10857-009-9120-5

Cross Francis, D., Rapacki, L., & Eker, A. (2015). The individual, the context, and practice: A review of the research on teachers' beliefs related to mathematics. In: H. Fives, & M.G. Gill, (Eds.) *International handbook of research on teachers' beliefs* (pp. 336–352). Routledge.

Dweck, C. S., & Molden, D. C. (2017). *Mindsets: Their impact on competence motivation and acquisition.* In A. J. Elliot, C. S. Dweck, & D. S. Yeager (Eds.), *Handbook of competence and motivation: Theory and application* (p. 135–154). The Guilford Press.

Elliot, A. J. (2005). *A Conceptual History of the Achievement Goal Construct.* In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (p. 52–72). Guilford Publications.

Elliot, A. J., & Hulleman, C. S. (2017). *Achievement goals*. In: A. J. Elliot, C. S. Dweck, & D. S. Yeager (Eds.), *Handbook of competence and motivation: Theory and application* (pp. 43–60). Guilford Press.

Elliot, A. J., & McGregor, H. A. (2001). A 2 x 2 achievement goal framework. *Journal of Personality and Social Psychology, 80*, 501–519. https://doi.org/10.1037/0022-3514.80.3.501

Enochs, L.G., Smith, P.L., & Huinker, D. (2000). Establishing factorial validity of the mathematics teaching efficacy beliefs instrument. *School Science and Mathematics, 100*, 194-202. https://doi.org/10.1111/j.1949-8594.2000.tb17256.x

Gresham, G. (2018). Preservice to inservice: Does mathematics anxiety change with teaching experience? *Journal of Teacher Education, 69,* 107 - 90. https://doi.org/10.1177/0022487117702580

Hornstra, L., Majoor, M., & Peetsma, T. (2017). Achievement goal profiles and developments in effort and achievement in upper elementary school. *British Journal of Educational Psychology, 87*(4), 606-629. https://doi.org/10.1111/bjep.12167

Huang, C. (2012). Discriminant and criterion-related validity of achievement goals in predicting academic achievement: A meta-analysis. *Journal of Educational Psychology*, 104, 48-73. https://doi.org/10.1037/a0026223

Hudson, R. A., Kloosterman, P., & Galindo, E. (2012). Assessing pre-service teachers' beliefs about the teaching and learning of mathematics and science. *School Science and Mathematics, 112,* 433-442. https://doi.org/10.1111/j.1949-8594.2012.00162.x

Hulleman, C. S., & Senko, C. (2010). Up around the bend: Forecasts for achievement goal theory and research in 2020. In: T. Urdan & S. Karabenick (Eds.), *Advances in Motivation and Achievement, Vol. 16* (pp. 71-104). Emerald. https://doi.org/10.1108/S0749-7423(2010)000016A006

Hunt, T. E., Clark-Carter, D., & Sheffield, D. (2011). The development and part validation of a U.K. scale for mathematics anxiety. *Journal of Psychoeducational Assessment, 29*(5), 455–466. https://doi.org/10.1177/0734282910392892

Kagan, D.M. (1992). Implications of research on teacher belief. *Educational psychologist, 27*(1), 65–90. https://doi.org/10.1207/s15326985ep2701_6

Kaplan, A., & Maehr, M. L. (2007). The Contributions and Prospects of Goal Orientation Theory. *Educational Psychology Review*, 19, 141-184. https://doi.org/10.1007/s10648-006-9012-5

Levin, B. B. (2015). The development of teachers' beliefs. In: H. Fives, & M. G. Gill, (Eds.), *International handbook of research on teachers' beliefs* (pp. 48–65). Routledge.

Levin, B. B., & He, Y. (2008). Investigating the content and sources of preservice teachers' personal practical theories (PPTs). *Journal of Teacher Education, 59,* 55–68. https://doi.org/10.1177/0022487107310749

Löfström, E., & Poom-Valickis, K. (2013). Beliefs about teaching: Persistent or malleable? A longitudinal study of prospective student teachers' beliefs. *Teaching and Teacher Education, 35,* 104-113. https://doi.org/10.1016/j.tate.2013.06.004

Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Journal of Educational Research, 62*(3), 307–332. https://doi.org/10.3102/00346543062003307

Pastor, D., Barron, K., Miller, B., & Davis-Becker, S. (2007). A latent profile analysis of college students' achievement goal orientation. *Contemporary Educational Psychology. 32*(1), 8-47. https://doi.org/10.1016/j.cedpsych.2006.10.003

Rogat, T.K., & Linnenbrink-Garcia, L. (2019). Demonstrating competence within one's group or in relation to other groups: A person-oriented approach to studying achievement goals

in small groups. *Contemporary Educational Psychology, 59*, 101781. https://doi.org/10.1016/j.cedpsych.2019.101781

Rovan, D. (2011). *Odrednice odabira ciljeva pri učenju matematike u visokom obrazovanju* [Achievement goals in learning mathematics in higher education] [Unpublished doctoral dissertation]. University of Zagreb.

Schwinger, M., & Wild, E. (2012). Prevalence, stability, and functionality of achievement goal profiles in mathematics from third to seventh grade. *Contemporary Educational Psychology 37*(1), 1-13. https://doi.org/10.1016/j.cedpsych.2011.08.001

Shim, S. S., & Finch, W. H. (2014). Academic and social achievement goals and early adolescents' adjustment: A latent class approach. *Learning and Individual Differences, 30,* 98–105. https://doi.org/10.1016/j.lindif.2013.10.015

Swars, S.L., Smith, S.Z., Smith, M.E., & Hart, L. C. (2009) A longitudinal study of effects of a developmental teacher preparation program on elementary prospective teachers' mathematics beliefs. *Journal of Mathematics Teacher Education, 12,* 47–66. https://doi.org/10.1007/s10857-008-9092-x

Tuominen-Soini, H., Salmela-Aro, K., & Niemivirta, M. (2008). Achievement goal orientations and subjective well-being: A person-centred analysis. *Learning and Instruction*, *18*(3), 251-266. https://doi.org/10.1016/j.learninstruc.2007.05.003

Tuominen-Soini, H., Salmela-Aro, K., & Niemivirta, M. (2011). Stability and change in achievement goal orientations: A person-centered approach. *Contemporary Educational Psychology, 36*(2), 82–100. https://doi.org/10.1016/j.cedpsych.2010.08.002

Tuominen-Soini, H., Salmela-Aro, K., & Niemivirta, M. (2012). Achievement goal orientations and academic well-being across the transition to upper secondary education. *Learning and Individual Differences*, *22*(3), 290-305. https://doi.org/10.1016/j.lindif.2012.01.002

Utman, C.H. (1997). Performance effects of motivational state: A meta-analysis. *Personality and Social Psychology Review, 1,* 170-182. https://doi.org/10.1207/s15327957pspr0102_4

Vizek Vidović, V., & Domović, V. (2019). Development of teachers' beliefs as a core component of their professional identity in initial teacher education: A longitudinal perspective. *CEPS Journal, 9*(2), 119-138. https://doi.org/10.26529/cepsj.720

Wigfield, A., & Eccles, J. S. (2000). Expectancy–value theory of achievement motivation. *Contemporary educational psychology*, *25*(1), 68–81. https://doi.org/10.1016/j.dr.2009.12.001

Wigfield, A., & Eccles, J. S. (2002). The development of competence beliefs, expectancies for success, and achievement values from childhood through adolescence. In: A. Wigfield & J. S. Eccles (Eds.), *Development of achievement motivation* (pp. 91–120). Kluwer. https://doi.org/10.1016/B978-012750053-9/50006-1

Daria Rovan
Faculty of Teacher Education
University of Zagreb
Savska cesta 77, 10000, Zagreb, Croatia
daria.rovan@ufzg.hr

Dubravka Glasnović Gracin
Faculty of Teacher Education
University of Zagreb
Savska cesta 77, 10000, Zagreb, Croatia
dubravka.glasnovic@ufzg.hr

Goran Trupčević
Faculty of Teacher Education
University of Zagreb
Savska cesta 77, 10000, Zagreb, Croatia
goran.trupcevic@ufzg.hr

Ciljevi postignuća u matematici budućih osnovnoškolskih učitelja i njihov pristup učenju i poučavanju matematike

Sažetak

U Hrvatskoj, kao i u mnogim drugim zemljama, osnovnoškolski učitelji korisnici su generaliziranoga obrazovanja i Matematika je samo jedan od nekoliko različitih predmeta koje poučavaju, tako da ih pri odabiru profesije nužno ne privlači interes da budu učitelji matematike. Ipak, njihov pozitivan stav prema matematici i motivacija za poučavanje učenika matematici vrlo su važni. Cilj je ovoga istraživanja ispitati imaju li učitelji s različitim profilima ciljeva postignuća različita uvjerenja o matematici i poučavanju i učenju matematike. U istraživanju je sudjelovalo 325 studenata, budućih učitelja primarnoga obrazovanja. Istraživanje je provedeno u tri ciklusa: tijekom prve, treće i pete godine studija ispitanika. Na prvoj godini studija prikupljali smo podatke o ciljevima postignuća u matematici koje su sudionici imali u srednjoj školi i o samoučinkovitosti u matematici. Epistemološka uvjerenja, subjektivnu vrijednost matematike i tjeskobu procjenjivali smo u svim ciklusima mjerenja. Na trećoj i petoj godini studija sudionika također smo prikupljali podatke o njihovim uvjerenjima o učinkovitosti u poučavanju matematike i, na petoj godini, uvjerenja o poučavanju i učenju matematike. Rezultati klaster analize pokazali su da se budući učitelji, studenti primarnoga obrazovanja, mogu grupirati u tri skupine prema profilima ciljeva postignuća u srednjoj školi: (1) svi visoki ciljevi, (2) svi niski ciljevi i (3) orijentacija prema vještini. Dobiveni rezultati pokazali su razlike između skupina s obzirom na motivaciju za učenje matematike na početku studija. Ipak, te su razlike manje uočljive tijekom vremena. Na kraju studija sudionici se ne razlikuju u svojim uvjerenjima o učinkovitosti u poučavanju matematike niti u svojim uvjerenjima o učenju matematike.

Ključne riječi: *ciljevi postignuća; matematičko obrazovanje; motivacija; obrazovanje učitelja; uvjerenja učitelja.*