



Mathematics Teachers' Beliefs, Self-assessments and Their Teaching Practices in Republic Croatia

Zoran Horvat^{a*}, Ante Kolak^b

^{a,b}*Faculty of Humanities and Social Sciences, Ivana Lučića 3, 10000 Zagreb, Croatia*

^a*Email: zohorvat@ffzg.hr*

^b*Email: akolak@ffzg.hr*

Abstract

The aim of this research was to analyse the beliefs, self-assessments, teaching practices and some extracurricular activities of mathematics teachers in the Republic of Croatia. In order to conduct the research on the competence profile of math teachers and present the findings, an instrument was devised based on relevant research in the field of math education as well as relevant theory and research in pedagogy and psychology. Primary objective of the research was set on determining predictive value of individual teacher characteristics, deriving from their attitudes, beliefs, self-assessment and teaching practice and the amount in which they contribute to the quality of their teaching methods and practices. Main assumption of this study is that the perception of academic self-efficiency, teacher system of values and beliefs reflect teacher competence profile, determine their teaching and upbringing role and are the foundation for acquiring values and achieving educational outcomes of students. Participants in the research were 348 elementary and high school mathematics teachers from all Croatian counties.

Keywords: mathematics education; teacher competencies; teachers' beliefs and self-assessments.

1. Introduction

Contemporary educational systems are based on educational outcomes, competencies and standardized student achievements. Standardization of student achievements refers to attaining learning goals, which in mathematics reflects in acquired skills and competencies related to logical thinking, concluding and providing different arguments in solving various tasks.

* Corresponding author.

The focal point of educational standards are measurable competencies which represent a set of knowledge, skills, abilities and values which enable student to certain level of expertise and ability in some field of work. Success in mathematics is strong predictor of achievements in related fields, including future profession selection, which is among other things manifested by avoiding faculties in fields such as mathematics, science and technology [1]. Therefore, it is important for mathematics education to have clear objectives, goal setting methods and systematic evaluation of student progress based on contemporary approach to each student.

Since it is obvious how educational goals are set high on advanced level of attained knowledge, there is a constant pressure on mathematics education which is faced with low student achievements and lack of the basic mathematics skills. According to Croatian *National Curriculum Framework* [2] main curriculum goals in mathematics are given within expected student achievements who should: acquire principal mathematical knowledge, skills and processes, develop capability for abstract and spatial thinking etc. Among many other mathematics curriculum goals there is also emphasis on solving mathematical problems and applying mathematics in various contexts, including professional life. Regarding mathematical competence and its applicability as primary goal of acquired knowledge it is evident from national *State Matura Examination* results how most of croatian students do not acquire higher levels of knowledge and skills necessary to be able to apply it in different contexts of everyday life. In other words, croatian students are not able to achieve level of critical thinking and develop sufficient problem solving methods and it remains among biggest concerns and challenges of teaching mathematics.

Despite the focus on understanding and determining what teachers need to know about mathematics, the field of mathematics education still knows too little about the mathematical knowledge required for teaching [3]. Based on the analysis of research in mathematics education Ball and his colleagues [4] conceived a framework that describes the knowledge needed to teach mathematics:

- knowledge of mathematics within the school curriculum;
- knowledge of mathematics used in teaching that is outside the school curriculum;
- knowledge of students and their specifics relevant to mathematics education;
- combination of knowledge of teaching and knowledge of mathematics

From the first days of their work, teachers enter classrooms with certain beliefs about teaching, learning, evaluating student achievement, curriculum, and student abilities [5]. There is a consensus among researchers that these beliefs are moderators of the success of their educational activities [6]. Given that behavior is partly determined by beliefs, as a indicator of teacher competence, some researchers state that the behavior of individuals in private life is the greatest reflection of their professional competence [7]. Namely, professional beliefs significantly determine how teachers will behave and how they will teach [8] and teachers acquire them very early, most often through their own experiences and various beliefs. The beliefs of teachers are very enduring and deeply rooted, and during their education they can resist rational arguments and scientific evidence that are of the opposite view regarding their teaching practices [9]. Many authors point to the complexity of teachers' beliefs about teaching and learning [10], while in the context of mathematics teaching it is often pointed out that the relationship between teachers' beliefs and their educational practice can be

explained by cultural and curricular specifics [11]. In research on teacher competencies, they are mainly considered in terms of beliefs [12, 13], teaching practices [11], and a sense of teacher self-efficacy [14, 15, 16].

2. Methods

The objective of this research is to analyse the beliefs, self-assessments, teaching practices and some extracurricular activities of teachers that are related to their teaching performance. In order to conduct the research on the math teachers' beliefs, teaching practices, pedagogical and didactic knowledge and present the findings, an instrument was devised based on relevant research in the field of math education as well as pedagogy and psychology.

As the main objective of the research is determining predictive value of individual teacher characteristics, deriving from their attitudes, beliefs, self-assessment and teaching practice and the amount in which they contribute to the quality of teaching, starting with the assumption that the perception of academic self-efficiency, teacher system of values and beliefs significantly reflect teacher competence profile and determine their teaching and upbringing role in the foundation for acquiring values and achieving educational outcomes by their students.

A research tool was devised on that premises comprising four parts:

- Scale of teacher beliefs about teaching and education in general, including specific and problematic areas of math education;
- Scale of teacher self-efficiency;
- Their teaching practices, including participation in professional training and enhancement.

Therefore, as a framework in methodological approach of this study beliefs, self-assessment and teaching practice of the participants in the research were firstly analysed as separate, and subsequently in their inter-relationship with series of regression analyses. In regression analysis models are therefore included among the primary independent variables (gender, work experience, initial education, professional status) and also by beliefs and participant self-assessment, which are separated by factor analyses of specific scales, and are as such included into predictive variables in the process of the results synthesis obtained.

2.1 Research sample

The research participants were mathematics teachers who work in secondary schools and mathematics teachers who work in the fifth to the eighth grade of primary schools. Out of 348 teachers, 287 female teachers (82.5%) and 61 male teachers (17.5%) participated in the research. The structure of respondents by work experience was as follows: 21% of teachers up to 5 years of work experience, 22% of teachers with experience between 6 and 15 years, 35% of teachers with experience between 16 and 29 years, and 20% of teachers over 30 years of work experience.

As for the workplace of the respondents there was 136 teachers (39%) in the primary school, 105 teachers (30%)

in the secondary vocational schools and 106 teachers (30%) in gymnasium schools.

Through their working experience and professional development of 348 teachers who participated in the research there are 70 (20%) who achieved the status of mentors, 49 (14%) in the status of teacher advisors and only 3 (0.9%) of those who completed doctorate degree. Since among the respondents there were 74 teachers (21%) who have up to five years of work experience and are not yet able to acquire the status of mentor or advisor, then there are 70 (26%) teacher-mentors and 49 (18%) teacher-advisors which is a total of 44% of teachers who have progressed in their professional status.

3. Results

Relationship between a teacher's competence and student achievement is arguably one of the most significant challenges in considerations on teachers' competencies and therefore studying teachers' competencies has to encompass a wide spectrum of their beliefs and attitudes in order to gain a perspective on their approach to students and teaching. This claim is supported with research showing that the role and actions of teachers, perception of the importance of mathematics, perception of math as a social activity and as the field of success shape the beliefs and students' attitudes towards mathematics [17] which is guided by the notion that teachers have an influence on educational aspirations and academic success of their students [18, 19], emphasizing the complexity of each class dynamics, which, using the average student achievement variable determines the relationship between students in the context of the perception of their academic self-efficiency [18]. Mathematics competence is not all about acquiring knowledge and developing various skills, but is strongly determined by social and affective factors of teaching mathematics and numerous didactical and curricular challenges. Students often have positive or neutral attitudes and emotions towards mathematics at the beginning of their education, while it often results in animosity towards mathematics and lack of motivation and underestimating their own potentials [20]. Pedagogical and psychological dimensions of teaching process and emotional and affective components of learning mathematics are fast growing research area and there are also many questions that still need to be explored. Stimulating and cooperative environment, as well as competent teacher who employs pedagogical strategies have proved to be one of the key factors to enable students to develop a positive attitude towards mathematics and sense of personal responsibility for success and progress as well as self-awareness in relation to students' mathematical achievements.

3.1 Regression analysis results

In correlation analysis various regression analysis were conducted where the main assumptions of regression analysis like normality and homoscedasticity were considered and afterwards, *F-value* and significance level ($p < .05$), *R-Square* with *Adjusted R-Square* and *Beta Coefficients* were evaluated in regression models.

Regarding the insight into the specific needs of students in learning mathematics, the only significant predictor was proven to be the gender of the teacher ($\beta = .25^{***}$), where female teachers showed a much higher level of self-assessment and teaching practices than their male colleagues. When considering professional competence, significant predictors were work experience ($\beta = .18^{**}$) and further education and training ($\beta = .17^{**}$), where

the more experienced teachers assessed their expertise on a much higher level compared to their colleagues with 5 years of work experience or less. In self-assessing social competence, two significant predictors were present, out of which a more relevant variable is workplace ($\beta = .25^{***}$), whereas gender plays a less relevant role ($\beta = .12^*$). In working with students with certain disabilities teacher's workplace ($\beta = .25^{***}$), has proven to be the single and fairly significant predictor, which was confirmed in previous analyses, indicating the higher level of competence self-assessment among elementary school teachers, compared to the high school ones. The same has been established for adjusting to and helping students with learning disabilities ($\beta = .25^{***}$) that have negative attitude towards learning math, to whom elementary school teachers dedicated a substantially more amount of time. Regarding recognizing students with dyscalculia, elementary school teachers also assess their competence to detect children having this disability much higher than those working in high schools, however more thorough analyses have proven self-assessment in recognizing dyscalculia not to be consistent in any of the groups according to workplace along with contemporary definition of dyscalculia. Teaching directed towards the student has three substantial predictors: workplace, gender and the acquired additional education.

Teacher workplace ($\beta = .36^{***}$) has proven to be the best predictor for student-oriented teaching, demonstrating high level of adjustment to students among elementary school teachers, compared to high school teachers. Regarding the metacognitive aspect, it has been determined that gender and further education equally contribute to the metacognitive aspect of teacher performance. Female teachers have demonstrated a higher level of student support and the accompanying regressive model has established gender as the single statistically relevant factor in this dependant variable ($F(10, 348) > 13, p < .001$).

Professional development ($F(10, 348) > 10.5^{***}$) is also influenced by gender ($\beta = .14^{**}$), showing female teachers as more prone to professional training. However, further acquired education based ($\beta = .23^{***}$) on this aspect of teaching has turned out to be a better predictor. Female teachers ($p < .01$) also more frequently evaluate their work performance by taking into account student feedback on their teaching and are more prone to expert training through mobility projects, peer evaluation and action research ($\beta = .17^{**}$). In the regression analysis of the teacher self-assessment scale ($F(10, 348) > 12.3, p < .001$) it has been determined that the differences in the self-assessment of the professional competence are most prominent considering teacher work experience ($\beta = .15^{**}$), where the more experienced ones consider themselves significantly more competent than the younger ones with up to five years work experience. Beliefs on student mathematical capabilities are a negative predictor, meaning that the teachers displaying a more optimistic attitude towards students and their capabilities have a slightly lower assessment of their professional competence, in connection to the group of elementary school teachers who graduated from the Faculty of Teacher Education. As the most prominent predictor of teachers' professional competence have proven to be beliefs about curriculum ($\beta = .22^{***}$), showing higher level of math competence assessment among teachers who consider curriculum aspects of modern education relevant. Workplace ($\beta = .21^{***}$), is the best predictor for self-assessment of social competence, demonstrating the connection between elementary school workplace and teacher self-assessment in

working with children with specific disabilities in learning math and the notion of student-oriented teaching in general. These analyses have shown that elementary school teachers tend to offer help to students with learning difficulties more often than high school teachers, link tasks with everyday situations, help students that have negative attitude towards learning mathematics. In the frequency of certain actions and practice in the metacognitive aspect of teacher performance, the greatest connection is with beliefs about teacher social skills and self-assessment of awareness of student individuality in math teaching, which are strongly connected with elements of teaching oriented towards supporting students. Work experience ($\beta = -.23^{***}$), is negatively connected with teaching methods related to student support, meaning that younger teachers are more inclined to emphasize the importance of persistence and work habits in learning mathematics and more frequently encourage attitudes towards learning among less successful students and believe and advocate in their teaching that every student can be successful at mathematics. Teachers with 30 years of work experience and more feel most competent in working with gifted students. Significant differences have been established among the most experienced teachers and both groups with up to 15 years work experience ($p < .01$), showing teachers to be gradually more prone to working with gifted students with increasing work experience. Predictors of professional development and teacher training through professional meetings are attitudes and beliefs on curriculum and, to a lesser extent self-assessment of professional competence. Reflexive aspect of teacher performance is mostly determined by awareness on student individuality in math teaching ($p < .01$), showing female teachers as more successful ($p < .01$). Teachers that consider themselves more competent in the field of expertise more often participate in professional training through mobility projects, peer evaluation and action research ($p < .001$). Male teachers consider themselves more competent in the field of mathematics expertise ($p < .01$), whereas in the assessment of the methodical aspect of teaching, they consider themselves less successful than female teachers ($p < .01$). The results show that female teachers follow guidelines from documents encompassed by *National Frame Curriculum* (2010) in preparation, performance and teaching evaluation significantly more frequently than male teachers. In the final combined regression analyses ($F(10, 348) > 14.4$, $p < 0.001$) there was significant relationship between socio-demographic factors and professional profile of teachers and their attitudes, beliefs and self-assessment, including which of the factors or characteristics can serve as the best predictors of their teaching and out of classroom practice relevant to the quality of the teaching process. It has been determined that teacher beliefs correspond with their self-evaluation in the sense of efficiency in teaching practice ($p < .05$), which affects their approach to teaching and students, highlighting workplace, gender and teaching experience as variables that shape students' performance the most.

4. Final considerations

Related to socio-demographic and professional characteristics of the participants in the research, the most significant are gender and workplace differences. Indicative results related to working with gifted students and recognizing students with difficulties in learning mathematics point to potential directions for development of mathematics teacher training, as well as the need for a more detailed research. The results synthesis demonstrates the way in which performance and work experience self-assessment, taking into consideration the specifications of workplace (elementary, high school, student age etc.) affect the beliefs and teaching patterns of the participants more significantly than Teaching Faculties programs, whose differences are primarily

determined by self-assessment of the professional competence, also influenced by workplace variable as well as distinctiveness of working with younger schoolchildren. Teacher workplace has proven to be the best predictor for student-oriented teaching, demonstrating high level of adjustment to students among elementary school teachers, compared to high school teachers. Regarding the metacognitive aspect, it has been determined that gender and further education progression equally contribute to the metacognitive aspect of teacher performance. Workplace is the best predictor for self-assessment of social competence, demonstrating the connection between elementary school workplace and teacher self-assessment in working with children with specific disabilities where primary school teachers tend to offer help to students with learning difficulties more often than high school teachers. It is indicative that initial education of teachers would be more efficient in terms of teaching practice if more oriented towards learning and teaching process, academic achievements and students' educational prospects in order to improve quality of teaching competence. It could only be achieved by considering the structure and amount of pedagogical and didactic and methodical contents in teacher training, which implies a necessary correlation and assessment of challenges from the teaching practice and the domain of research in field of didactics of mathematics.

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