inAmath

true face of Math

An interdisciplinary approach to mathematical education

STUDY ON TEACHER'S READINESS FOR TEACHING MATH FOR DEVELOPING STUDENTS' COMPETENCES FOR 21ST CENTURY

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InAMath - An interdisciplinary approach to mathematical education

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Study on teacher's readiness for teaching math for developing students' competences for 21st century

In the project InMath we examined teacher's readiness for teaching math for developing students' competences for 21st century. The main objective of the study was facilitating cross-curricular math teaching to support students' math learning. In the current educational landscape the digitalisation, structure a context which has to be taken into account. The digitalisation of society has the impact on math teaching in the three main dimensions, digitalisation of society requires math application integrating digital tools, digital tools and learning environments provide a productive context for teaching, the digital technology influence the development of core math discipline. In the teacher preparation and practice, the research model TPACK - Technological Pedagogical Content Knowledge has gained significant importance globally. In math teaching most important is how teachers files and whether the teaching efficacy beliefs are on a sufficient level to enable quality teaching. Therefore the main objective of this study was to explore the relationships between Technological Pedagogical Content Knowledge (and related knowledge domains) and Mathematics Teaching Efficacy Beliefs - MTEBI. We conducted the survey utilising MTEBI (Enochs et al., 2000) and adapted TPACK (Schmidt et al., 2009; Schmidt et al., 2020). The MTEBI identifies teachers' maths teaching efficacy beliefs which are essential for coping with pedagogical change utilising two scales, the teaching efficacy and outcome expectancy (Enochs et al., 2000). The TPACK examined teachers' self-assessment of (1) their technology knowledge both alone and in relation to pedagogy knowledge and (2) their pedagogy content knowledge of maths and maths in cross-curricular connections. Scales applied were: pedagogy content knowledge of maths and maths in cross-curricular connections – PCK (Schmidt et al., 2020); technology knowledge – TK (Schmidt et al., 2009); technology pedagogy knowledge – TPK (Schmidt et al., 2020); and technology, pedagogy, content knowledge – TPCK (Schmidt et al., 2020). We did not focus specifically on either content knowledge – CK or pedagogy knowledge – PK.

We examined the relationship between TPACK facet scores and total MTEBI facet scores and MTEBI. We expected that in current post-digital society the TPACK significantly correlate with MTEBI.

In the TPACK model of knowledge domains, the particular focus is on the role of technology integration at the intersection of technology knowledge, pedagogy knowledge and content knowledge. In a post-digital society, we cannot think of pedagogy without technology, and technology influences curriculum-specific content, but technology is no longer an autonomous object of investigation. Therefore, TPACK offers a good model for studying integrated knowledge domains. Furthermore, TPACK is examined in maths teaching in relation to teachers' preparation as integrative, providing a framework for teachers' initial and continuing professional development and has been recognised in maths teaching as adding technology-supported learning to many maths concept areas.

TPACK knowledge domains are examined as correlated to teachers' pedagogical beliefs, values beliefs that can predict technology integration, self-efficacy beliefs and self-efficacy beliefs about technology integration. TPACK knowledge domains affect teachers' self-efficacy beliefs about technology integration. Research findings argue for beliefs guiding teaching practice are as important as teachers' knowledge. The pedagogical practice and especially its technology application inform teachers' knowledge and pedagogical beliefs. Beliefs and knowledge as an outcome measure of teachers' technology preparation programs. Beliefs are relatively stable entities, and belief shifts require much time and influence. The relationship between beliefs and behaviour is examined how beliefs influence action and how beliefs are shaped by experiences. In technology integration in teaching the relationship between beliefs and action is very complex.

In a simple words, the technology supported teaching forms an important part in teachers work and therefore, the TPACK is correlated with teaching efficacy – MTEBI. This study aims to provide insight into which facets of Technological Pedagogical Content Knowledge are most significantly correlated with facets of Mathematics Teaching Efficacy Beliefs; however there are no a priori hypotheses due to the nature of this being the first study to explore the facets of TPACK in relation to the facets of MTEBI.

Related previous studies report technology integration more significant with younger teachers and less for older generations of teachers. In this study we hypothesised that there will be a negative, significant correlation between total TPACK scores and number of Years of Service.
The survey utilizing TPACK and MTEBI scales was conducted in Croatia, Serbia, Bosnia and Herzegovina and Slovenia.
Teachers at different stages of professional development require different directions in instruction. It has been found that teachers with more years of experience perceive lower self-efficacy in integrating technology in classrooms. Older teachers have had in their experience as a learner and teachers been exposed to technology much less from the side of enactive, vicarious and social influence and therefore require different instruction in this area than their less experienced colleagues. Related previous studies report technology integration more significant with younger teachers and less for older generations of teachers. In this study we hypothesised that there will be a negative, significant correlation between total TPACK scores and number of Years of Service.

The factor analysis indicated measurement constructs according to related studies utilizing TPACK and MTEBI instruments.
We conducted analysis for teachers' in participating countries. In Slovenia and BIH there were not many teachers responded and in the report we present analysis for correlation between total TPACK scores and number of Years of Service.

We were interested in teachers' assessment of TPACK and MTEBI constructs and if the significant difference exist between Serbian and Croatian teachers. The two countries were selected for comparison as they include larger sample of teachers as Slovenia and BIH. We examined Slovenia's and Croatia's samples how the TPACK constructs relate to teachers' years of service.

The samples for countries indicates a large number of female teachers.

Thee sample structure Serbia

	n	%
Gender		
Female	368	96,2
Male	15	3,9
Grade (multiple response question)		
1st	107	27,9
2nd	105	27,4
3rd	116	30,3
4th	113	29,5
5th	4	1

The sample structure Croatia

	N	%
Gender		
Female	590	97.4
Male	16	2.6
Grade		
1st	134	22.1
2nd	129	21.3

3rd	127	21.0
4th	136	22.4
Multigrade	81	13.2

The sample structure of Slovenia

	n	%
Gender		
Female	53	96,4
Male	2	3,6
Grade (multiple response question)		
1st	12	21,8
2nd	20	36,4
3rd	13	23,6
4th	10	18,2
5th	10	18,2

The sample structure of Bosnia and Herzegovina

	n	%
Gender		
Female	89	83.2
Male	18	16.8
Grade (multiple response question)		
1st	18	24,0
2nd	24	32,0
3rd	22	29,3
4th	18	24,0
5th	22	29,3

A one-way between subjects ANOVA was conducted to compare the effect of years of service on PCKmath. PCKcross-cu, TK, TPK, TPCK and MTEBI. As indicated in the Table above, there was a significant effect of years of service on TK at the p<.005

Serbia – TPACK and MTEBI according to years of teacher's service

Measure	0-21 years		22-30 years		31 years and more		F (2,236)	Sig.
	M	SD	M	SD	M	SD		
PCmat	27,20	2,21	27,01	3,06	27,36	2,39	0,33	0,717
PCmed	21,25	2,48	21,10	3,06	20,97	2,82	0,18	0,833
TK	24,99	3,93	23,46	3,82	23,19	4,10	4,75	**0,010**
TPK	16,88	2,24	16,20	2,37	15,86	2,84	3,28	**0,039**
TPCK	16,10	2,72	15,49	2,78	15,02	3,03	2,61	0,076
MTEBI_SE	44,01	4,63	43,42	5,43	42,36	4,93	1,87	0,156
MTEBI_OE	30,57	4,27	31,02	4,59	30,73	3,65	0,26	0,770

p<.001 **level**
p<.05 level

A one-way between subjects ANOVA was conducted to compare the effect of years of service on PCKmath, PCKcross-cu, TK, TPK, TPCK and MTEBI. According to Croatian sample, there is a negative correlation between years of service and TPACK constructs of technology knowledge and a positive correlation between years of service and TPACK constructs of content pedagogical knowledge.

Croatia – TPACK and MTEBI according to years of teacher's service

Measure	0-21 years		22-30 years		31 years and more		F(2, 603)	Sig.
	M	SD	M	SD	M	SD		
PCmat	25,91	2,50	26,66	2,66	26,98	2,45	9,44	**0,000**
PCmed	19,88	2,76	20,71	2,97	21,42	2,57	15,63	**0,000**
TK	23,09	4,05	21,85	4,33	21,40	3,98	9,06	**0,000**
TPK	16,11	2,36	15,60	2,58	15,57	2,36	3,19	**0,042**
TPCK	11,87	1,91	11,59	1,89	11,52	1,99	1,80	0,165
MTEBI_SE	44,70	5,43	44,84	5,47	45,24	4,83	0,57	0,567
MTEBI_OE	26,45	3,76	25,84	4,19	26,85	4,62	2,95	0,053

p<.001 **level**
p<.05 level

A one-way between subjects ANOVA was conducted to compare the effect of years of service on PCKmath, PCKcross-cu, TK, TPK, TPCK and MTEBI. As indicated in the Table above, in Slovenia's sample, there were no significant effects of years of service on different domains of TPACK and MTEBI questionnaires.

Slovenia – TPACK and MTEBI according to years of teacher's service

Measure	0-21 years		22-30 years		31 years and more		F (2,78)	Sig.
	M	SD	M	SD	M	SD		
PCmat	10,92	2,86	11,00	2,58	8,83	2,44	2,61	0,086
PCmed	10,71	3,03	9,86	3,02	7,75	2,73	4,03	**0,025**
TK	12,50	4,52	13,43	4,31	14,00	3,93	0,51	0,606
TPK	8,33	2,28	8,43	2,37	7,17	1,53	1,37	0,265
TPCK	9,29	2,99	8,86	2,97	8,67	2,27	0,22	0,805
MTEBI_SE	33,18	5,01	35,71	1,80	35,60	2,41	1,75	0,188
MTEBI_OE	24,23	4,33	26,43	3,91	23,90	3,78	0,91	0,410

p<.001 **level**
p<.05 leve

A one-way between subjects ANOVA was conducted to compare the effect of years of service on PCKmath, PCKcross-cu, TK, TPK, TPCK and MTEBI. As indicated in the Table above, there were no significant effects of years of service on different domains of TPACK and MTEBI questionnaires.

Bosnia and Herzegovina – TPACK and MTEBI according to years of teacher's service

Measure	0-21 years	22-30 years	31 years and more	F (2,78)	Sig.

	M	SD	M	SD	M	SD		
PCmat	24,64	2,34	24,88	3,24	24,00	1,00	0,17	0,844
PCmed	19,93	1,67	19,88	2,87	19,67	1,15	0,03	0,971
TK	22,45	3,51	21,29	3,39	23,00	3,61	0,80	0,452
TPK	15,67	2,06	14,76	1,99	16,00	0,00	1,44	0,244
TPCK	14,90	1,96	13,94	2,46	15,00	1,00	1,48	0,234
MTEBI_SE	37,92	6,55	41,18	7,35	35,67	8,14	1,82	0,169
MTEBI_OE	31,02	3,81	29,76	3,42	30,85	3,73	1,67	0,195

We compared Serbia and Croatia according to all measurement constructs utilising the Cohen's d interpretation: small effect (0,2), medium effect (0,5), great effect (0,8). In all measurement constructs the difference was significant with small to medium and in all but one (MTEBI_SE – Self efficacy) construct, Serbian mean was higher.

Comparison Croatia and Serbia Means, Standard Deviations, and One-Way Analyses of Variance

Measure	Croatia		Serbia		t	Sig.	Cohen's d
	M	SD	M	SD			
PCmat - Pedagogical Content Knowledge Math	26,51	2,57	27,16	2,62	-3,29	**0,001**	-0,251
PCmed - Pedagogical Content Knowledge Cross curricular	20,67	2,84	21,12	2,80	-2,10	**0,036**	-0,161
TK – Technological knowledge	22,12	4,18	23,92	3,99	-5,74	**0,000**	-0,439
TPK - Technological Pedagogical Knowledge	15,76	2,44	16,35	2,48	-3,15	**0,002**	-0,241
TPCK – all domains integrated	14,90	2,60	15,59	2,84	-3,34	**0,001**	-0,255
MTEBI_SE – Self efficacy	44,93	5,25	43,36	5,06	3,94	**0,000**	0,301
MTEBI_OE – Outline expectancy	29,16	4,38	30,79	4,25	-4,91	**0,000**	-0,375

p<.001 level
p<.05 level

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