

## ANALYSIS OF PRE-SERVICE TEACHERS' COGNITIVE PROFILES

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**Abstract.** *In recent years there has been increased attention to the problem of teachers' competences. The need for developing critical thinking in schools turns the focus also on the teachers' cognitive skills including not only intelligence but also cognitive reflection and implicit theories of intelligence. This study aimed to analyse pre-service teachers' (N = 344) cognitive profiles covering data from cognitive reflection test (CRT), implicit theories of intelligence test and Mannheim intelligence test (MIT, measuring verbal, numerical and spatial abilities). Significant correlations were found between cognitive reflection and other cognitive abilities. However, the implicit theories of intelligence seemed to be independent of cognitive abilities. Significant differences between senior and junior pre-service teachers were found in cognitive reflection and two MIT items. Based on the presented results, we discuss the assessment of pre-service teachers' competences and the development of critical and higher order thinking in pre-gradual teacher education.*

**Keywords:** *cognitive abilities, cognitive reflection, the implicit theory of intelligence, intelligence, pre-service teachers*

### Introduction

Teachers play an important role in the quality of the educational system and their qualities are often discussed (see e.g. Talis study, OECD, 2007). However, the research projects on teachers' personality and professional characteristics and competences are focused rather on personality traits than on cognitive skills and thinking dispositions (Jurkovič & Čavojská, 2017). It seems that teachers are increasingly "drawn from the lower parts of the general ability distribution" (Grönqvist & Vlachos, 2008, p. 1). It is advisable to discuss both pre-service and in-service teachers' cognitive skills and dispositions and their impact on students' achievement (Grönqvist & Vlachos, 2008; Rindermann, 2007; Čavojská, 2015). This study aims to analyse the cognitive profiles of Slovak pre-service teachers. Based on the results of previous research three research questions were posed:

a) Are there any differences in cognitive profiles between junior and senior pre-service teachers? b) Are pre-service teachers' general cognitive abilities linked to their cognitive reflection? c) Are pre-service teachers' general cognitive abilities linked to their implicit theories of intelligence?

### **General cognitive abilities, cognitive reflection and implicit theories of intelligence**

According to Rindermann (2007), the past century of empirical research demonstrated that *general cognitive abilities* (intelligence and literacy) are relevant for individuals and society, as they are linked with e.g. job performance, longevity or economic wealth. General cognitive abilities or intelligence tests are used to assess cognitive skills across all levels of education and professional life (cf. Raven et al., 1991; Frederick, 2005; Rindermann, 2007; Conrad et al., 1993 etc.). Recently, some researchers warn that the cognitive abilities of teachers have declined over time. For example, according to Grönqvist and Vlachos (2008), the average cognitive ability among Swedish new teachers has declined by about 20 percentile ranks over a 15 years' period. In Slovakia, Kosturková (2013) described unsatisfactory results in critical thinking among Slovak secondary school teachers, and Čavojová (2015) reported the IQ scores among pre-service teachers with the range from 65 to 135. However, recent studies (cf. Sternberg, Roediger, & Halpern, 2007; Kahnemann, 2011; Sternberg, 2011; Frederick, 2005; Čavojová, 2016; Čavojová & Jurkovič, 2017 etc.) highlight, that the level of general cognitive abilities (g-factor) does not explain individuals' dispositions for rationality, critical thinking or decision making. And these dispositions are extremely important for the 21<sup>st</sup> century teachers.

One of the concepts with relevant predictive value in rationality tasks is a *cognitive reflection*. Frederick (2005, p. 35) characterized cognitive reflection as “the ability or disposition to resist reporting the response that first comes to mind.” In other words, it is the ability to suppress an intuitive incorrect answer and to make an effort to look for the correct one. It seems that cognitive reflection may help individuals to suppress impulsive intuitive behaviour (Jurkovič & Čavojová, 2017). As such, cognitive reflection is a disposition that might influence teachers' decision making in various challenging situations. Along with critical thinking skills (Sternberg, Roediger, & Halpern, 2007) and cognitive styles (e.g., ambiguity tolerance or risk-taking) cognitive reflection may help to prevent teachers from labelling, stereotyping and cognitive biases, which are often related to teachers' beliefs about the nature of pupils' characteristics (Huber & Seidel, 2018).

Pre-service teachers may hold different perceptions about the intellectual abilities of their pupils. Dweck (2014) described these perceptions as *implicit*

***theories or “self-theories” of intelligence.*** Some people believe that intelligence is almost unchangeable, they hold an entity theory. The others view intelligence and as a malleable quality that can be developed, they represent an incremental theory (Sokolová, Jursová Zacharová, & Lemešová, 2017). Based on Dweck's and her colleagues' research (Dweck, 2000; Blackwell, Trzesniewski, & Dweck, 2007; Rattan, Good, & Dweck, 2012), people on both ends of the self-theory continuum show equal intellectual abilities, but their self-theories may affect the way they learn and their motivation. The teachers holding an entity theory of intelligence may tend to judge lower achieving students to have the low ability (Rattan et al., 2012) and thus influence their motivation towards learning. Teachers' self-theories of intelligence may shape their responses to various educational situations and sensitivity towards diversity in the classroom. Rigid perception of intellectual abilities may lead to labelling, stereotyping and teacher-centred approach especially among new teachers in their transition into practice. On the other hand, teaching efficacy was associated with the teachers' belief that intelligence is changeable (Deemer, 2004).

## **Method**

### ***Participants***

The participants in this study were pre-service teachers studying at Comenius University in Bratislava, Slovakia ( $N = 344$ ), with 312 (90.7 %) female and 32 (9.3 %) male participants. The average age of the sample was 21.20 ( $SD = 2.063$ ) with the range from 18 to 36 years. Junior pre-service teachers ( $N = 217$ ) studied at the bachelor's level of teacher training and senior pre-service teachers ( $N = 127$ ) studied at the master's level. All participants had finished their secondary school studies and were studying at the University for their Degree in teacher training programme for pre-primary (pupils from 3 to 6 years of age), primary (pupils from 6 to 10 years of age), or secondary education (pupils between 10 and 19 years of age).

### ***Instruments***

The data were collected via four paper instruments and analysed using IBM SPSS 17.0. The questionnaires were distributed by the lecturers during their introductory psychology courses for pre-service teachers. The items covered also demographic data and the informed consent. All participants were treated in accordance with American Psychological Association ethical guidelines (APA, 2002). The instruments were used in the following order:

*Theories of Intelligence Questionnaire – TIQ* (Dweck, 2000). The questionnaire items were rated on a 6-point Likert-type scale with the range from 1 (strongly agree) to 6 (strongly disagree). The scale consists of four entity theory

statements (e.g. “you have a certain amount of intelligence, and you really can’t do much to change it.”); and four incremental theory statements (e. g. “You can always greatly change how intelligent you are.”; Dweck, 2000). The incremental theory items were reverse scored. It means that low scores represent pure entity theory and high scores represent pure incremental theory with the range of 1 to 6. The internal consistency of an instrument in our sample was adequate with  $\alpha = 0.823$ .

*Cognitive Reflection Test – CRT* (Frederick, 2005). Cognitive reflection test is a three-item measure of one type of cognitive ability. As the author reports (Frederick, 2005, p. 26), CRT scores are “predictive of the types of choices that feature prominently in tests of decision-making theories, like expected utility theory and prospect theory”. The participants are supposed to solve three tasks, with a maximum score of 3. Within the sample of American university students ( $N = 3428$ ), the mean CRT score was 1.24 (Frederick, 2005). In the Italian study, Baldi et al. (2013) reported the mean CRT score 1.29 among 168 (84 men) undergraduate students for Arts, Humanities, Sociology and Philosophy courses). Based on the Slovak study conducted by Čavojová and Jurkovič (2017), the CRT score was lower among pre-service teachers ( $M = .82$ ) than among in-service teachers ( $M = 1.42$ ).

*Mannheim Intelligence Test – MIT* (Conrad et al., 1991). The MIT test consists of 10 subscales (order of figures, meaning of words, domino, groups of letters, order of numbers, word relationships, mosaics, proverbs, numerical symbols, and impossibilities). These subscales cover verbal, numerical and spatial cognitive abilities (see Table 1). Each subscale has 7 items. MIT is suitable for both individual and group assessment of general cognitive abilities among adolescents and adults (from 12 to 45 years of age). The test has been standardised for general Slovak population.

*Raven Progressive Matrices Test - Advanced – APM* (Raven et al., 1991). This nonverbal intelligence test consists of two sets. Set 1 comprises 12 items and set 2 comprises 36 more advanced items. This test is suitable for both individual and group assessment of general cognitive abilities among adults (from the age of 18). Raven's test was used with 96 participants to compare the results with the MIT results. The test has been standardised for general Slovak population.

## Results

In the MIT test, the participants reached in all subscales the scores slightly above scale average ( $M = 3.5$ ), with the exception of subscale 10 (impossibilities) with a mean score slightly below the scale average (see Table 1). Compared to the norms for general Slovak population, pre-service teachers showed moderate performance in MIT ( $M = 41.09$ ;  $SD = 8.322$ ) with the range of total score from

16 to 60. The mean score in the CRT test was .60 (SD = .84) in this sample, which is a score below test average ( $M = 1.5$ ). Only 4.4 % of participants solved correctly all three items and 59 % of participants were not able to solve any of the items.

As far as the CRT data were not normally distributed (Kolmogorov-Smirnov  $Z = 6.522$ ;  $p = .000$ ), non-parametric comparison was performed to analyse the cognitive profiles of junior and senior pre-service teachers. The significant difference was found in cognitive reflection, where senior pre-service teachers had higher scores with medium size effect ( $U = 10992$ ;  $p = .000$ ;  $\eta^2 = .015$ ;  $d = .343$ ). Senior pre-service teachers had also significantly higher scores in MIT subscale “mosaics” ( $U = 11733$ ;  $p = .020$ ;  $\eta^2 = .015$ ;  $d = .25$ ), which is a subscale measuring spatial abilities. In a subscale “order of figures” senior pre-service teachers had significantly lower performance ( $U = 11754$ ;  $p = .019$ ;  $\eta^2 = .015$ ;  $d = .247$ ).

Table 1 Descriptive statistics of TIQ, CRT and MIT scores

	Total (N = 344)				Junior pre-service teachers (n = 217)		Senior pre-service teachers (n = 127)	
	Min	Max	M	SD	M	SD	M	SD
TIQ	1	6	4.01	.856	4.04	.801	3.95	.942
CRT	0	3	.60	.838	<b>.47</b>	<b>.758</b>	<b>.80</b>	<b>.926</b>
order of figures	0	7	5.34	1.376	<b>5.48</b>	<b>1.295</b>	<b>5.11</b>	<b>1.481</b>
meaning of words	0	7	3.74	1.135	3.68	1.165	3.85	1.077
domino	1	7	3.80	1.268	3.71	1.238	3.95	1.308
groups of letters	0	7	4.01	1.699	4.10	1.687	3.85	1.714
order of numbers	0	7	4.00	1.385	4.02	1.344	3.97	1.458
word relationships	0	7	4.62	1.460	4.61	1.455	4.64	1.473
mosaics	0	7	4.65	1.987	<b>4.48</b>	<b>1.960</b>	<b>4.95</b>	<b>2.005</b>
proverbs	0	7	3.92	1.253	3.92	1.241	3.91	1.279
numerical symbols	0	7	3.79	1.788	3.75	1.844	3.84	1.692
impossibilities	0	7	3.22	1.275	3.20	1.203	3.27	1.394
MIT: total score	16	60	41.09	8.322	40.95	8.240	41.34	8.486

We found significant correlations between the CRT scores and the total scores of the MIT ( $N = 344$ ,  $r = .390$ ,  $p = .000$ ; Table 2). There were also significant positive correlations between the CRT scores and the MIT scores in the individual subscales. The only exceptions were the subscales “meaning of words” and “proverbs”. These are focused on verbal abilities. Significant

correlations were found also between CRT and APM total scores ( $N_2 = 96$ ,  $r = .572$ ,  $p = .000$ ; Table 3).

The mean score in the TIQ test in our sample was 4.01 (SD = .856), with minimal difference between junior and senior pre-service teachers. The mean score is above scale average (M = 3), which indicates a tendency to prefer the incremental theory of intelligence. The most of our sample (n = 188, 55 %) reached scores from 3.5 to 4.5, 76 (22 %) participants had scores below 3.49 and 80 (23 %) participants had scores above 4.5. We did not find a significant correlation between MIT and TIQ scores, however, a slight negative significant correlation was found between TIQ and CRT scores (Table 2).

Table 2 Correlation matrix of (N = 344)

	age	TIQ	CRT	MIT
age	1			
TIQ	.023	1		
CRT	.131*	-.109*	1	
MIT: total score	-.021	.008	.390**	1

\*\* Correlation is significant at the 0.01 level (2-tailed).

\* Correlation is significant at the 0.05 level (2-tailed).

Table 3 Correlation matrix of APM, MIT and CRT scores (N = 96)

	CRT	MIT: total	APM: set 1	APM: set 2	APM: total
CRT	1				
MIT: total	.487**	1			
APM: set 1	.142	.038	1		
APM: set 2	.562**	.608**	.133	1	
APM: total	.572**	.577**	.332**	.976**	1

\*\* Correlation is significant at the 0.01 level (2-tailed).

\* Correlation is significant at the 0.05 level (2-tailed).

## Discussion

The main goal of our study was to compare junior and senior pre-service teachers' cognitive profiles and analyse the link between general cognitive abilities, cognitive reflection and implicit theories of intelligence. Pre-service teachers' performance in general cognitive abilities tests was moderate, but their

cognitive reflection was lower than reported for comparable general samples in the original research (Frederick, 2005). Similar results were reported by Čavoјová (2015), in her sample of Slovak teachers, only 8.8 % of participants solved all three tasks of CRT ( $M = .75$ ,  $MDN = 0$ ,  $SD = .99$ ). Based on these results it seems that Slovak pre-service teachers tend to prefer intuitive cognitive processing, which is opposed to analytical, controlled, relatively slow, rational processing (Stanovich & West, 2000, 2008). These results lead to a question, how cognitive abilities of teachers affect pupils and their learning. According to Grönqvist and Vlachos (2008), the teacher's position in the overall general ability distribution has no statistically significant effect on average students achievement.

Jurkovič & Čavoјová (2017) expected that more experienced teachers have more rational thinking dispositions, are more cognitively reflective in comparison to novice teachers. In our sample, we found a positive significant correlation between age and cognitive reflection. The significant differences were found between junior and senior pre-service teachers in cognitive reflection and two subscales of general cognitive ability test MIT. Senior pre-service teachers had higher scores in the CRT than their less experienced colleagues, which follows the trend described by Jurkovič & Čavoјová (2017). However, there was no significant difference in total scores of MIT (general cognitive abilities) between these groups.

Similarly to Frederick (2005) we also found significant correlations between CRT and general abilities tests scores (MIT and APM). Despite the fact, that the CRT was designed to measure cognitive reflection, the performance in CRT is enhanced by verbal and numerical abilities, which are measured by MIT. The overlap between these tests suggests that there might be a link between these concepts (Frederick, 2005).

The results in the TIQ test showed a neutral or a slight tendency to the incremental theory of intelligence among pre-service teachers, however, the implicit theories of intelligence seemed to be independent of general cognitive abilities. The slight negative correlation between the TIQ and CRT scores raises a question if the intuitive decision making could be a predictor of rigid, entity theory of intelligence. This question requires a further investigation, as far as the fixed mindset (entity theory of intelligence, Dweck, 2000) may lead to the negative impact of so called Pygmalion effect or self-fulfilling prophecy in the classroom. According to Huber and Seidel (2018) teachers perceive moderate to strong connections between general cognitive ability, prior achievement, interest, and self-concept. Teachers also tend to overgeneralize the pupils' characteristics. Pre-service teachers holding an entity theory of intelligence may tend to judge lower achieving pupils as those with the lower ability (Rattan et al., 2012), lower intelligence, but also lower motivation. From this point of view, the teachers' theory of intelligence could have a more important impact on pupils' achievement

than their general cognitive abilities. Furthermore, according to Grönqvist and Vlachos (2008), high-ability pupils benefit from being taught by a teacher with high cognitive abilities, but such a match could even be detrimental for lower achieving pupils.

As it is typical for the teaching profession in many countries, most of our sample were female pre-service teachers (90.7 %). This gender heterogeneity limits the gender comparison, generalization of our results, and also might affect the results. According to Kohut et al. (2016), especially in verbal abilities items, we can expect a potential source of gender bias.

### **Conclusion**

Based on the presented results, Slovak pre-service teachers showed moderate general cognitive abilities and a low level of cognitive reflection. Senior pre-service teachers had significantly higher scores in the cognitive reflection test and in one non-verbal subscale of MIT. Junior pre-service teachers scored significantly higher only in one numerical subscale of MIT. No significant differences were found in the rest of MIT subscales and the implicit theories of intelligence between the two groups. Even we cannot provide a scientific evidence of how their cognitive profiles may affect their decision making in the classroom or their pupils' achievement, we suggest to pay more attention to the assessment and development of critical thinking and related cognitive styles (e.g. ambiguity tolerance) in the pre-gradual teacher training. Teacher training courses in psychology and other disciplines should provide pre-service teachers with opportunities to develop these dispositions and skills but also understand their cognitive dispositions and their potential influence on decision making in their future professional life.

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