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Are Pre-Service Mathematics Teachers' Teaching Concerns Related to Their Epistemological Beliefs?

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Abstract

The purposes of this study were to evaluate the effect of year on pre-service teachers' epistemological beliefs and their teaching concerns as well as to investigate the relationship between teaching concerns and epistemological beliefs. One hundred seventy seven mathematics pre-service teachers enrolled in the Department of Secondary Mathematics Education in two universities participated in the present study. Two instruments: Teaching Concerns Checklist and Schommer Epistemological Questionnaire were used for data collection. Two MANOVAs were conducted to determine the effect of year on pre-service mathematics teachers' epistemological beliefs and their teaching concerns. In order to find out the relationship between pre-service teachers' teaching concerns and their epistemological beliefs, canonical analysis was conducted. It was found that there were no significant mean differences among pre-service teachers attending different years regarding teaching concerns, whereas there was a significant effect of year on pre-service teachers' epistemological beliefs. Apart from that, canonical analysis revealed a significant relationship between teaching concerns and epistemological beliefs.

Key words: *epistemological beliefs; pre-service teachers; teacher education programs; teaching concerns.*

Introduction

Teaching concerns and epistemological beliefs are two important constructs in teacher education that have been studied extensively (e.g. Conley, Pintrich, Vekiri,

& Harrison, 2004; Fuller, 1969; Pigge & Marso, 1997; Schommer, 1990; Swennen, Jörg & Korthagen, 2004). Examination of pre-service teachers' teaching concerns by research studies is important since its determination will provide teacher educators with an opportunity to deal with pre-service teachers' teaching concerns. Similarly, studying pre-service teachers' epistemological beliefs is vital because this construct is closely related to their teaching practice, such as application of teaching methods (Chan & Elliott, 2004). Despite various studies about pre-service teachers' teaching concerns and epistemological beliefs respectively, there has been no research study in the related literature that investigates the relationship between teaching concerns and epistemological beliefs.

Theoretical Framework

Teaching Concerns

It is important for the researchers to understand the meaning of teaching concerns. Fuller (1969) defined teaching concerns as perceived problems or worries of the teachers. Another definition was made by Hall, George, and Rutherford (1979) as "the composite representation of the feelings, preoccupation, thought, and consideration given to a particular issue or task" (p. 5). Moreover, "constructive frustration" and "anticipation" are also elements of concern (Fuller, 1970).

Fuller, Parsons and Watkins (1974) explained the teaching concern concept as "expressions of felt need which probably possess motivation for relevant learning" (p. 2). To clarify, teachers who have the concern to motivate students in their class will possess the need and motivation to learn about the ways of how to motivate students in class. So it can be concluded that pre-service teachers having some teaching concerns is not essentially negative. Teacher education programs considering pre-service teachers' concerns will be useful in terms of dealing with these. So, it is important to detect pre-service teachers' teaching concerns in teacher education programs and find ways of dealing with them before entrance to the occupation. Agreeing with Fuller (1969), and Fuller, Parsons and Watkins (1974), in the present study we consider teaching concerns, as perceived problems or worries of pre-service teachers, as not essentially negative, but we believe that instead concerns may cause pre-service teachers to strive to find ways of dealing with these concerns.

As Fuller (1969) stated, teaching concerns have a developmental nature; teachers in their career at first have self-related concerns, which are self-survival concerns involving concerns about classroom management, and being appreciated by other people like students, colleagues, principal and parents. After the diminishment of self-survival concerns, the second stage consisting of task-related teaching concerns begins to emerge. This type of concerns is related to the nature of the profession such as inflexibility of the curriculum, lack of class time and administrative issues. The final stage comprises the impact-related concerns, i.e. concerns about students' learning. These teachers have concerns about whether they could influence their students'

learning and fulfill their social, psychological and emotional needs. According to Fuller (1969), these concerns occur in a developmental sequence. However, inconsistent findings have been reported in related studies about the nature of development of teaching concerns. Though some studies supported the simultaneous occurrence of all types of teaching concerns (Boz & Boz, 2010; Pigge & Marso, 1997; Smith & Sanche, 1993), there are some studies indicating the distinct developmental sequence of teaching concerns (Butler & Smith, 1989; Fuller, 1969).

In the related literature, teachers' teaching concerns were found to be related to various aspects such as teachers' gender, contextual factors as the institution they are working in or the subject they are teaching and teaching experiences. Another aspect is the pre-service/in-service teachers' beliefs. Studies by Ghaith and Shabaan (1999), and Boz and Boz (2010) reported the relationship between teacher efficacy beliefs and their teaching concerns. More efficient teachers, who have confidence in their ability to teach, were more likely to have less teaching concerns. Similarly, Cho, Kim, Svinicki and Decker (2011) found teacher efficacy to be the predictor of the impact-related teaching concerns. Moreover, pre-service teachers' beliefs about teaching, which were formed as a result of their previous school experiences, are influential in their teaching concerns (Haritos, 2004). Another type of belief system consists of the beliefs about the nature of knowledge, which is called epistemological beliefs.

Epistemological Beliefs

Epistemological beliefs refer to beliefs about the nature of knowledge and learning (Schommer, 1990). The research by Perry (1968) served as an initiative for other researchers investigating epistemological beliefs. Perry (1968) reported that epistemological beliefs of college undergraduates showed developmental sequence, that is, at the first year of their studies they believed in the simplicity and certainty of knowledge; however, as they progressed through their university education years, their views about the nature of knowledge changed, i.e. they came to realize that knowledge is complex and tentative. Similar to Perry's (1968) research, King and Kitchener (1994), and Belenky, Clinchy, Goldberger and Tarule (1986) found that epistemological beliefs developed in stages from simple to complex.

Unlike the above researchers, Schommer (1990) criticized the uni-dimensional and developmental nature of epistemological beliefs and asserted that epistemological beliefs do not develop in stages. Instead, a person may have more than one belief at the same time. Moreover, Schommer (1994) mentioned that the degree of sophistication varies among these beliefs. To clarify, a person may have sophisticated beliefs about the certainty of knowledge, however, at the same time, he or she may have the naive belief that knowledge is handed by authority. Schommer (1990) stated that belief system of a person was observed in five categories and each of them ranges from naive to sophisticated: a) *simple knowledge,* indicates views that range from 'knowledge is simple' (consisting of isolated bits of information) to 'knowledge is complex' (composed of

interrelated concepts) b) *certain knowledge* (whether knowledge is certain or tentative) c) *omniscient authority* (related to authority as the only source for obtaining knowledge on the one hand to whether personal reasoning is vital for knowledge construction) d) *innate ability* (whether learning is innate or can be developed over time), and e) *quick learning* (beliefs concerning the speed of learning, i.e. whether it is quick or takes place gradually). Schommer (1990) took a more quantitative approach than the researchers supporting the uni-dimensional nature of epistemological beliefs and developed an epistemological belief questionnaire to measure people's epistemological beliefs. Despite her hypothesized five belief structure, four factor structures comprising simple knowledge, certain knowledge, innate ability and quick learning were observed in the studies with junior college and university students (Schommer, 1990), and with high school students (Schommer, 1993). However, other researchers using the same instrument as Schommer (1990) found different factor structures that vary with the characteristics of the sample. To illustrate, Qian and Alvermann (1995) observed the following three factor structures: innate ability, quick learning and simple-certain knowledge as one factor even though the study was conducted with high school students, just as Schommer's (1993) study.

Research studies have been conducted regarding the relationship of various factors (e.g. instruction, grade level, academic performance) with epistemological beliefs. It was found that epistemological beliefs are related to academic achievement (Conley, Pintrich, Vekiri, & Harrison, 2004; Hofer & Pintrich, 1997; Schommer, 1990; Schommer, Crouse, & Rhodes, 1992; Schommer & Walker, 1997). Students with naive epistemological beliefs tend to have problems in text comprehension and low academic performance. In terms of grade level, research findings revealed the complexity of participants' epistemological beliefs as they move throughout their schooling years (Brownlee, Purdie, & Boulton-Lewis, 2001; Paulsen & Wells, 1998; Schommer, 1998; Schommer-Aikins, Calvert, Gariglietti, & Bajaj, 1997). Moreover, teachers' conceptions about teaching were influenced by their epistemological beliefs. Teachers with naive epistemological beliefs tend to apply traditional teaching methods while teachers having more sophisticated epistemological beliefs are more constructivist-oriented (Chan & Elliott, 2004).

We think that there may also exist a relationship between pre-service teachers' teaching concerns and their epistemological beliefs. We believe that pre-service teachers with naive epistemological beliefs tend to be more concerned. However, this relationship has not been mentioned explicitly in the literature. Nevertheless, in related literature, it has been reported that students with sophisticated epistemological beliefs tend to be more self-efficacious (Hofer, 1994; Neber & Schommer-Aikins, 2002). Moreover, it has also been reported that pre-service teachers having high self-efficacy tend to have lower teaching concerns (Boz & Boz, 2010; Ghaith & Shabaan, 1999). Therefore, we believe that epistemological beliefs may also be related to teaching concerns. Similarly, epistemological beliefs affect the teaching approaches teachers use. For example, teachers with naive epistemological beliefs tend to apply traditional

teaching methods (Chan & Elliott, 2004). Likewise, teaching concerns are also influential in the decision of selecting a teaching method. To clarify, teachers having concerns about their subject matter avoid applying constructivist teaching strategies in class (Aydın, Boz, & Boz, 2010). This also provides evidence for the relationship between teaching concerns and epistemological beliefs. Moreover, logically, students who think that learning is gradual will be less concerned since they would believe that their concerns will decrease with time when they learn to deal with these. The same trend is also expected to be observed regarding the relationship between innate ability and teaching concerns. However, no research study was encountered in related literature that investigates the relationship between teaching concerns and epistemological beliefs.

Research questions for the present study are:

a) How do teaching concerns of pre-service mathematics teachers differ across year groups?
b) How do epistemological beliefs of pre-service mathematics teachers differ across year groups?
c) Are pre-service mathematics teachers' teaching concerns related to their epistemological beliefs? If so, how?

Methodology

Participants

One hundred and seventy seven mathematics pre-service teachers enrolled in the Department of Secondary Mathematics Education in two universities, located in the central part of Turkey, participated in the present study. Convenience sampling was used to select the participants. In Turkey, all high school graduates are entitled to take a central exam in order to continue their education at universities. This exam is conducted by Student Selection and Placement Centre every year. The universities in the current sample accept students to the Secondary Mathematics Education Department with scores that are in the top ten range.

Forty two (42) of the students in our sample were at the 2nd year of their program while fifty seven (57) and seventy eight (78) of them were enrolled in the 4th and 5th year respectively. In terms of gender, female students constituted the majority of the sample (113 females) and there were 60 male student teachers, with four participants not reporting their gender. Upon graduation, they will teach mathematics to high school students. They have both content (mathematics) and pedagogical (theoretical as well as practical) courses to complete before graduation. As they move through the program, the number of pedagogical and mathematical courses they take increases. To clarify, at the time of the study, 2nd year students completed three pedagogical courses, namely "Introduction to Education", "Educational Psychology" and "Turkish Educational System and School Management", and basic mathematics courses: "Linear Algebra", "Analytical Geometry", "Discrete Mathematics". In the final year of their

program, they take two practical courses. "School Experience" course is the first course, where they are placed at high schools in order to observe mathematics teachers' instruction. The other course, "Teaching Practice" also involves school placement, where pre-service teachers have the chance to teach mathematics in high schools. At the time of the study, only the fifth year students completed the "School Experience" course and they were taking "Teaching Practice".

Instruments

Two instruments were used for data collection. One is the "Teaching Concerns Checklist" developed by Borich (1992). For the present study, the Turkish version of the instrument translated and validated by Boz (2008) was used. Though three items, which are "Insufficient clerical help for teachers", "Too many extra duties and responsibilities" and "Not enough assistance from specialized teachers" did not load to any factor in the translated version because their loadings were lower than the cut-off point taken as 0.28 as suggested by Stevens (2002). Like the original checklist, the instrument was found to have a three-factor-structure and measured teaching concerns in terms of *self* (17 items), *task* (10 items) and *impact* (15 items) using a five point Likert scale. The higher score they get from the teaching concerns checklist, the more teaching concerns pre-service teachers have. The overall Cronbach's alpha value was 0.96. The table below shows sample statements for items for each factor.

Table 1.
Sample statements for self, task and impact factor of teaching concerns checklist

	Number of items	Sample statements	Cronbach's alpha
Self related	17	Appearing competent to parents Whether the students respect me	0.93
Task related	10	The rigid instructional routine Working with too many students each day	0.83
Impact related	15	Recognizing social and emotional needs of students Understanding why certain students make slow progress	0.92

In the present study, confirmatory factor analysis that was carried out in order to confirm the factor structure of the translated instrument showed a good fit of the factor structure. The goodness-of-fit index was $\chi^2 = 1736.09$ ($df = 816$, $p < .00$), $\chi^2/df = 2.12$. Root Mean Square Error of Approximation (RMSEA) value was 0.08 having 90% confidence interval with the range of 0.075 to 0.085. Comparative-Fit-Index (CFI) was 0.96 and Standardized Root Mean Square Residual (SRMR) was found to be 0.078. These values indicated a good fit. Values of RMSEA and SRMR less than 0.08 and 0.10 respectively, as well as the ratio of (χ^2/df) below 3 were reported as acceptable values for the fit of model (Browne & Cudeck, as cited in Kline, 1998). Moreover, Arbuckle and Wothke (1999) state that CFI values greater than .95 show a good fit.

The other instrument was Schommer Epistemological Questionnaire developed by Schommer (1990). Translated version of this questionnaire (Topcu & Yilmaz-Tuzun, 2006) was used in the current study. It is a five-point Likert type scale that contains 63 items aimed to measure participants' epistemological beliefs. The higher the score the participants get, the more naive epistemological beliefs they have. The instrument measures five hypothesized epistemological belief structure: *simple knowledge, certain knowledge, omniscient authority, innate ability* and *quick learning.* There are also subset dimensions belonging to those hypothesized belief structures. Table 2 gives information about subset dimensions, hypothesized epistemological beliefs and sample item for each subset. Twelve subsets were calculated based on the sum of related items belonging to that subset.

Table 2.
Sample statements for each subset dimension of the epistemological belief questionnaire

Hypothesized epistemological belief	Subset dimensions	Sample item
Simple knowledge	Seek single answers (11 items)	"Most words have one clear meaning"
	Avoid integration (8 items)	"I try my best to combine information across chapters or even across classes"
Certain knowledge	Avoid ambiguity (5 items)	"I find it refreshing to think about issues that authorities can't agree on"
	Knowledge is certain (6 items)	"Truth is unchanging"
Omniscient authority	Do not criticize authority (6 items)	"Often, even advice from experts should be questioned"
	Depend on authority (6 items)	"When I encounter a difficult problem in life, I consult with my parents"
Innate ability	Can't learn how to learn (5 items)	"Everyone needs to learn how to learn"
	Success is unrelated to hard work (4 items)	"Getting ahead takes a lot of work"
	Ability to learn is innate (4 items)	"The ability to learn is innate"
Quick learning	Learning is quick (5 items)	"Successful students understand things quickly"
	Learn the first time (3 items)	"Going over and over a difficult textbook chapter usually won't help you understand it"
	Concentrated effort is a waste of time (2 items)	"If a person tries too hard to understand a problem, they will most likely end up being confused"

To provide the factor structure of the questionnaire, principal component analysis with oblique rotation based on eigenvalues greater than one was conducted and factors were found by using the cut-off point of 0.50 like Schommer (1990). Factors were named based on high loadings of items belonging to that factor. As seen from Table 3, three factors were loaded. The first factor was labeled "Innate Ability", the second was named "Simple Knowledge" and the third factor was labeled "Omniscient Authority". For the reliability, Cronbach's alpha values ranged from 0.25 to 0.84 for each factor. Low reliability values ranging from 0.20 to 0.60 with respect to factors of epistemological questionnaire were also reported in the study of Yilmaz-Tuzun and Topcu (2008).

Table 3.
Factor structure of the epistemological belief questionnaire

Subset dimensions	Factor 1	Factor 2	Factor 3
Do not criticize authority	0.796	0.065	- 0.329
Cannot learn how to learn	0.768	- 0.082	- 0.262
Concentrated effort is a waste of time	0.736	0.027	0.056
Avoid integration	0.735	0.179	- 0.075
Learning is quick	0.720	0.172	-0.131
Success is unrelated to hard work	0.678	- 0.2	- 0.258
Learn the first time	0.478	0.335	- 0.142
Seek single answers	- 0.052	0.798	- 0.063
Ability to learn is innate	0.327	0.629	0.210
Depend on authority	- 0.036	0.087	0.824
Knowledge is certain	0.355	0.142	- 0.491
Avoid ambiguity	-0.224	0.389	0.478
% of variance explained	32.015	12.681	8.835

Results

Table 4 reveals descriptive statistics about pre-service mathematics teachers' teaching concerns and epistemological beliefs. It is observed that participants in the present study are mostly concerned about task-related issues and the least concerned with their self-survival issues. Moreover, pre-service teachers' self, task and impact related teaching concerns increase at the 4th grade and these concerns decrease among 5th year students. To assess whether there were significant mean differences of teaching concerns across year groups, Multivariate analysis of variance (MANOVA) was conducted. A non-significant result was found (Wilks'$\lambda = 0.942$, $F(6,344) = 1.748$, $p>0.05$) indicating that self, task and impact related teaching concerns of pre-service mathematics teachers did not show any significant differences with respect to the participants' year of studies.

Table 4.
Mean scores of self-, task- and impact-related teaching concerns and innate ability, simple knowledge and omniscient authority epistemological beliefs for each year group

Year Groups	Self concern	Task concern	Impact concern	Innate ability	Simple knowledge	Omniscient authority
2	2.05	2.23	2.21	2.46	2.99	3.07
4	2.34	2.48	2.33	2.47	2.91	3.05
5	2.04	2.35	2.19	2.25	2.84	3.05
Total	2.14	2.36	2.24	2.37	2.90	3.06

* Maximum score for each factor is 5.

Regarding pre-service teachers' epistemological beliefs, participants had the most naive beliefs about omniscient authority. To clarify, they think that external authority is the main source for knowledge dissemination and personal reasoning is not involved in knowledge construction. On the other hand, they also had naive beliefs about the simplicity of knowledge, thinking that knowledge is simple, containing isolated bits of information. In terms of innate ability, they had more sophisticated beliefs as

compared to the other factors. They think that learning can be developed by time. When we look at the mean values of epistemological beliefs among 2nd, 4th and 5th year students, it was seen that pre-service teachers' beliefs on omniscient authority were nearly the same among year groups. In terms of innate ability and simple knowledge, 5th year students had more sophisticated beliefs compared to 2nd and 4th year students.

In order to understand the effect of year on pre-service mathematics teachers' epistemological beliefs, MANOVA was carried out. It was found that there was a significant effect of year on participants' epistemological beliefs (Wilks'$\lambda = 0.926$, $F(6,344) = 2.246$, $p < 0.05$). Partial eta-squared was 0.04. As a follow-up to MANOVA, only a significant effect of year on participants' beliefs regarding innate ability was found ($F(2,174) = 6.081$, $p < 0.05$) with eta-squared of 0.065, while no significant differences were found in terms of simple knowledge and omniscient authority. Post-Hoc analysis revealed significant differences among 2nd and 5th year students as well as 4th and 5th year students in terms of innate ability. Mean values for 2nd, 4th and 5th year students were 2.46, 2.47 and 2.25 respectively. In other words, 5th year students believe that learning can develop in time more than the other year groups.

In order to find out the relationship between pre-service teachers' teaching concerns and their epistemological beliefs, canonical analysis was conducted. We decided to use canonical correlation analysis (CCA) because it analyses the strength of the relationship between two constructs by looking at the internal structure of these constructs. CCA analyzes the internal structure by constructing canonical variates as a linear combination of variables and canonical weights. These canonical variates have the maximum correlation possible because the related canonical weights are chosen to achieve this. Beside these, preferring CCA over univariate analysis limits the probability of committing Type I error (Thompson, 1991 as cited in Sherry & Henson, 2005, p. 38). As Sherry and Henson (2005) point out, it is a tradition to set $\alpha = .05$ for the risk of Type 1 error. In CCA, "[b]ecause only one test was performed, the risk of committing a Type I error is minimized. Of course, even with one statistical significance test at $\alpha = .05$, one still does not know for sure whether one has committed a Type I error" (Sherry & Henson, 2005, p. 38).

Evaluation of Assumptions

Assumptions of canonical analysis such as detection of missing data and outliers, normality, linearity, homoscedasticity, multicollinearity and singularity were checked: these will be presented in the following paragraphs.

Missing Data

All of the 177 cases were accepted for analysis.

Outliers

Both univariate and multivariate outliers were checked using PASW Statistics 20. Three cases on innate ability, one case on omniscient authority and one case on task

concern with *z* scores outside (-3, +3) interval were deleted since these cases were univariate outliers. Three other cases were identified through Mahalanobis distance as multivariate outlier with $p < 0.001$. All eight cases were deleted, leaving 169 cases for canonical analysis.

Normality, Linearity, Homoscedasticity

In order to check for normality, linearity and homoscedasticity, canonical variate scores were found and then scatterplots were created. Each variate for Set 1 was paired with each variate for Set 2. From the shape of scatter plots it was concluded that the variates are normal and linear since the graphs are oval-shaped, indicating no obvious departures from normality, linearity or homoscedasticity. Furthermore, in order to further explore normality, skewness and kurtosis tests showed no departure from normality.

Canonical Analysis

After checking the assumptions, canonical correlation analysis was conducted. The initial hypothesis is that scores in the teaching concerns and the epistemological beliefs are correlated. To test this hypothesis, we conducted a canonical correlation analysis. The analysis included three variables with the teaching concerns scores (self concern, task concern, and impact concern) and three variables with the epistemological beliefs scores (innate ability, simple knowledge, omniscient authority). Thus, we extracted three canonical roots. The overall model is significant with a Wilks's λ of .894, $F(9, 396.85) = 2.065$, $p < .05$, however, the individual tests of significance show that only the first canonical root is significant at $p < 0.05$.

In order to find the magnitude of this relationship, we computed $1 - \lambda$ and we found an overall effect of =.11. Therefore, the full canonical model was both statistically significant and had a small effect size.

In order not to "risk interpreting an effect that may not be noteworthy or replicable in future studies" (Sherry & Henson, 2005, p. 42) we interpreted only the first function. The other functions have squared canonical correlation below .10. The squared canonical correlation for the first function was .10 and hence it explains 10% of the variance within itself, and this function is statistically significant at .05 level.

In Table 5 the standardized canonical function coefficients and structure coefficients for Function (Variate) 1 are presented. This table also shows the squared structure coefficients.

When we look at the Function 1 coefficients, we see that relevant criterion variable was primarily *Self* (Self Concern). The variables *Task* (Task Concern) and *Impact* (Impact Concern) made secondary contributions to the synthetic criterion variable (Set 1). The squared structure coefficients supported this conclusion since these coefficients showed the amount of variance the observed variable can contribute to the synthetic criterion variable. Self concerns also tended to have the largest coefficient.

The predictor variable set in Function 1, innate ability, was the primary contributor to the predictor synthetic variable.

Table 5.
Canonical Solution for epistemology Predicting Concern for Function 1

	Function 1		
Variables	*Coef.*	r_s	r_s^2 *(%)*
Self	1.475	.883	.780
Task	-.091	.330	.109
Impact	-.701	.388	.151
R_c^2		.10	
Innate ability	1.001	.991	.982
Simple knowledge	-.077	.131	.017
Omniscient authority	-.098	-.180	.032

Note: Coef. = standardized canonical function coefficient;
r_s = structure coefficient; r_s^2 = squared structure coefficient

These results were generally supportive of the theoretically expected relationships between self-related concerns and epistemological beliefs.

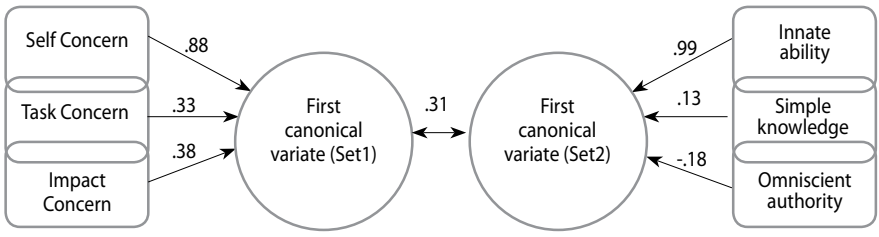

Figure 1. Loadings and canonical correlations for the first canonical variate pair.

The summary of canonical correlation analysis can be seen in Figure 1. As can be seen from this figure, self concern (self) has the highest correlation with the first canonical variate (Set 1), impact concern (impact) follows and finally, task concern has the smallest correlation. On the other hand, innate ability has the highest correlation with the second canonical variate (Set 2), omniscient authority follows (negatively correlated), and finally, the smallest correlation was found for simple knowledge. Possibly, self concern and innate ability were the main causes for these two sets of variables having canonical correlation as discussed in the next section.

Thus we find that the canonical correlation coefficient between the first roots is 0.31 and we can assume that the teaching concern scores and the epistemological belief scores are correlated in the population.

Discussion and Conclusion

The current study investigated teaching concerns and epistemological beliefs of pre-service mathematics teachers and the relationship of these two constructs. First, this study showed that pre-service mathematics teachers were mostly concerned about task related issues, which involve issues such as the inflexibility of curriculum, crowded

classrooms, too many regulations for teachers, etc. On the other hand, they were least concerned about self-survival issues. Moreover, on the contrary to Fuller's (1969) model, this study supported the simultaneous development of teaching concerns rather than distinct stages because pre-service teachers with self-related concerns expressed task- and impact-related teaching concerns at the same time.

Regarding the difference in teaching concerns among pre-service teachers of different study year groups, an increase for all types of teaching concerns was observed among 4th year students and their teaching concerns decreased when they were at the 5th year of their program. However, these differences were not statistically significant. The reason for the increase in teaching concerns among 4th grade students may be that pre-service teachers took more pedagogical courses than 2nd year students and became aware of the reality of the teaching profession. Also, since they did not have the chance to put their theoretical knowledge into practice, they may have become confused. However, at the fifth year, they were placed at high schools to observe their mentors' instruction; they had the chance to talk to their mentors about these concerns and ways of dealing with them. Therefore, their concerns may have decreased when they were at the final year of the program. However, these are just speculations and need to be supported by empirical research. Therefore, for a future study, interviews with pre-service teachers could be conducted to understand the nature of their teaching concerns and the reasons for the change in these concerns with year groups.

Regarding epistemological beliefs, participants had the most naive belief about omniscient authority. They believed that knowledge was acquired through transmission from authority rather than constructed through the use of personal reasoning. This is not a surprising result when we consider the educational system of our country. Education is traditional with the teacher giving information and with little student-student interaction; these experiences throughout their education may have caused the development of naive beliefs about omniscient authority. This explains the importance of culture for students' epistemological beliefs (Chan & Elliot, 2000). Moreover, they also had naive beliefs about the nature of knowledge; they believed that knowledge is simple, involving discrete bits of information rather than interrelated sets of concepts. This may also be due to the fact that they are not encouraged to link their knowledge with other concepts in the course of their education. Compared to simplicity of knowledge and omniscient authority, they had more sophisticated beliefs about innate ability. This means that they believed that ability is not innate, but can be developed in time.

When we look at the development pattern of epistemological beliefs across year groups, compared to 2nd and 4th year students, 5th year students had more sophisticated beliefs about the innate ability and simple knowledge, and this finding is consistent with literature indicating the increase in sophistication of epistemological beliefs with year groups (Paulsen & Wells 1998; Schommer, 1998; Schommer-Aikins et al., 1997). However, the view about authority's role on knowledge dissemination still remained similar to the other year group students.

Nonetheless, the present study revealed the relationship between pre-service teachers' teaching concerns and their epistemological beliefs. It means that pre-service teachers with high teaching concerns tend to have more naive epistemological beliefs. Considering the fact that self-related concerns constitute the major part of first variate set, which is 88% and innate ability makes up the 90% of the second variate set, a relationship between pre-service teachers' self-related teaching concerns and their epistemological beliefs about innate ability would have caused the relationship between these two constructs. To clarify, if a person has higher self-related teaching concerns, they tend to have more naive beliefs about innate ability meaning that they believe that ability is innate and cannot be developed in time. This finding is also consistent with what we hypothesized.

In teacher education programs, it is important to deal with teaching concerns. The present study indicated that participants had concerns about task related issues such as crowded classes, inflexibility of curriculum, etc. Therefore, teacher education programs should provide ways of dealing with these concerns. For example, issues like how to deal with crowded classes, inflexibility of curriculum, etc. should be discussed in teacher education programs.

Moreover, we found a relationship between teaching concerns and epistemological beliefs. It should be noted that this relationship is not a cause-effect type association, because this study is not an experimental study and we do not use the terminology of dependent-independent variables. Rather we used the terms criterion and predictor variables. Therefore, we do not claim that epistemological beliefs are the cause of concerns or vice versa, we claim that if we have one's epistemological belief score we can predict that person's concern score. Thus, this implies a relationship between epistemological beliefs and teaching concerns. This correlational relationship can be further investigated in future studies. For example, in an experimental design study one can try to enhance prospective teachers' epistemological beliefs during a period of time and at the end check if there is any change in prospective teachers' teaching concerns. Nevertheless, we think that while considering the relationship between teaching concerns and epistemological beliefs, it is also important to enhance students' epistemological beliefs. It could be done through the application of instruction based on the constructivist approach. It is mentioned that inquiry based instruction enhances students' epistemological beliefs (Tsai, 1999). Conley et al. (2004) mentioned the effectiveness of hands-on instruction on students' epistemological beliefs. Another way of enhancing students' epistemological beliefs is by means of encouraging students to reflect on their epistemological beliefs (Brownlee et al., 2001). As a future study, we could recommend the evaluation of implementation of different teaching strategies on students' epistemological beliefs in teacher education programs. In addition, since we selected the sample conveniently, in a future study we would recommend the replication of the present study with a randomly selected sample.

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Jesu li strahovi budućih nastavnika matematike povezani s njihovim epistemološkim uvjerenjima?

Sažetak

Svrha ove studije jest procijeniti učinak epistemoloških uvjerenja i strahova vezanih uz poučavanje na buduće nastavnike, danas studente, kao i istražiti odnos strahova vezanih uz poučavanje i epistemoloških uvjerenja. U studiji je sudjelovalo sto sedamdeset sedam studenata matematike upisanih na Odsjek za poučavanje matematike u srednjoj školi pri dva sveučilišta. Za prikupljanje podataka korištena su dva instrumenta: kontrolna lista strahova vezanih uz poučavanje i Schommer epistemološki upitnik. Provedena su dva MANOVA testa s ciljem određivanja učinaka na buduće nastavnike matematike, danas studente, odnosno njihova epistemološka uvjerenja i strahovi vezani uz poučavanje. S ciljem boljeg upoznavanja s odnosom strahova vezanih uz poučavanje budućih nastavnika i njihovih epistemoloških uvjerenja provedena je kanonska analiza. Otkriveno je da nema značajnijih srednjih razlika među studentima na različitim godinama studija u pogledu strahova vezanih uz poučavanje, a da postoji značajna razlika kod studenata različitih studijskih godina u pogledu epistemoloških uvjerenja. Osim toga, kanonska je analiza ukazala na važnu vezu između strahova vezanih uz poučavanje i epistemoloških uvjerenja.

Ključne riječi: *budući nastavnici matematike; epistemološka uvjerenja; program obrazovanja nastavnika; strahovi vezani uz poučavanje.*

Uvod

Strahovi vezani uz poučavanje i epistemološka uvjerenja dva su važna pojma u obrazovanju učitelja i stoga su oba detaljno proučavana (primjerice, Conley, Pintrich, Vekiri i Harrison, 2004; Fuller, 1969; Pigge i Marso, 1997; Schommer, 1990; Swennen, Jörg i Korthagen, 2004). Znanstvena istraživanja strahova vezanih uz poučavanje kod budućih nastavnika od velike su važnosti jer upravo njihovo utvrđivanje omogućuje učiteljima mentorima da se pozabave strahovima vezanim uz poučavanje kod budućih

nastavnika. Slično tomu, proučavanje epistemoloških uvjerenja kod budućih nastavnika od ključne je važnosti jer je taj pojam blisko povezan s njihovom učiteljskom praksom, odnosno primjenom nastavnih metoda (Chan i Elliott, 2004). Premda su provedene razne studije o strahovima vezanim uz poučavanje i epistemološka uvjerenja kod budućih učitelja, ni jedna istraživačka studija u stručnoj literaturi nije istražila odnos strahova vezanih uz poučavanje i epistemoloških uvjerenja.

Teorijski okvir

Strahovi vezani uz poučavanje

Za istraživača je važno shvatiti značenje pojma strahova vezanih uz poučavanje. Fuller (1969) definira strahove vezane uz poučavanje kao percipirane probleme i brige nastavnika. Prema definiciji koju su iznijeli Hall, George i Rutherford (1979), oni su „ukupno predstavljeni osjećaji, preokupacije, misli i razmatranja koja se tiču određenog pitanja ili zadatka" (str. 5). Nadalje, sastavnice strahova su i „konstruktivna frustracija" i „iščekivanje" (Fuller, 1970).

Fuller, Parsons i Watkins (1974) objašnjavaju pojam strahova vezanih uz poučavanje kao: „izraz unutarnje potrebe koja vjerojatno pretpostavlja motivaciju za relevantno učenje" (str. 2). Drugim riječima, učitelji koji strahuju u vezi s motivacijom učenika u razrednom odjelu posjeduju potrebu i motivaciju da saznaju više o načinima motivacije učenika. Dakle, nameće se zaključak da strahovi vezani uz poučavanje kod budućih učitelja nisu u potpunosti negativna pojava. Stoga se programi obrazovanja učitelja koji uzimaju u obzir njihove strahove pokazuju uspješnima u njihovu otklanjanju. Dakle, važno je detektirati strahove vezane uz poučavanje kod budućih učitelja u programima obrazovanja nastavnika te pronaći načine kako ih otkloniti prije ulaska u profesionalni svijet. U skladu sa saznanjima Fullera (1969), kao i Fullera, Parsonsa i Watkinsa (1974), u ovoj studiji strahove vezane uz poučavanje razmatramo kao percipirane probleme ili brige budućih nastavnika koji nisu nužno negativni, već smatramo da bi, sasvim suprotno, strahovi mogli potaknuti buduće nastavnike na pokušaj rješavanja i otklanjanja istih.

Prema Fulleru (1969), strahovi vezani uz poučavanje po svojoj su naravi razvojni; tijekom karijere nastavnici najprije imaju strahove vezane uz poimanje vlastitog „ja", a to su strahovi vezani uz samoodržanje i tiču se briga u pogledu upravljanja razredom i ugleda u očima drugih, ponajprije učenika, kolega, ravnatelja i roditelja. Nakon što ti strahovi nestanu, dolazimo do druge faze u kojoj se pojavljuju strahovi vezani uz specifične zadaće. Taj tip strahova tiče se naravi zanimanja, točnije nefleksibilnosti kurikula, nedostatka vremena na nastavnom satu i administrativnih problema. U posljednjoj fazi pojavljuju se strahovi vezani uz učinak, odnosno proces učenja učenika. Ti nastavnici brinu se u vezi s tim mogu li utjecati na učenje svojih učenika te ispuniti njihove društvene, psihološke i emocionalne potrebe. Prema Fulleru (1969), navedeni se strahovi pojavljuju u razvojnom slijedu. Međutim, u posljednjim studijama bilježimo nedosljedna saznanja u pogledu naravi razvoja strahova vezanih

uz poučavanje. Premda neke studije podržavaju teoriju istodobne pojave svih oblika strahova vezanih uz poučavanje (Boz i Boz, 2010; Pigge i Marso, 1997; Smith i Sanche, 1993), prema drugima se ti strahovi pojavljuju u vrlo specifičnom razvojnom slijedu (Butler i Smith, 1989; Fuller, 1969).

Kako proizlazi iz relevantne literature, strahovi vezani uz poučavanje povezani su s raznolikim aspektima kao što su spol nastavnika, kontekstualni čimbenici poput ustanove u kojoj se nastava odvija ili nastavnog predmeta, kao i iskustava u nastavnom procesu. Još jedan važan čimbenik predstavljaju uvjerenja kako budućih učitelja tako i nastavnika koji rade u školama. U istraživanjima koje su proveli Ghaith i Shabaan (1999), Boz i Boz (2010) proučavan je međuodnos uvjerenja učitelja o vlastitoj uspješnosti i njihovih strahova vezanih uz poučavanje. Uspješniji nastavnici koji imaju samopouzdanja u pogledu vlastite sposobnosti poučavanja gotovo uvijek imaju manje strahova vezanih uz poučavanje. Slično tomu, Cho, Kim, Svinicki i Decker (2011) otkrili su da je uspješnost nastavnika naznaka strahova vezanih uz poučavanje koji se tiču učinka. Nadalje, uvjerenja budućih nastavnika u pogledu poučavanja oblikovana kao rezultat prethodnih nastavnih iskustava imaju značajan utjecaj na njihove strahove vezane uz poučavanje (Haritos, 2004). Posljednji tip sustava uvjerenja sastoji se od uvjerenja o naravi znanja, koja se nazivaju još i epistemološkim uvjerenjima.

Epistemološka uvjerenja

Epistemološka uvjerenja odnose se na narav znanja i učenja (Schommer, 1990). Istraživanje Perryja (1968) poslužilo je kao poticaj drugim znanstvenicima koji su se bavili epistemološkim uvjerenjima. Naime, Perry (1968) je ustvrdio da epistemološka uvjerenja studenata iskazuju razvojni slijed, odnosno da na prvoj godini vjeruju u jednostavnost i izvjesnost znanja, međutim, nakon toga pogled na narav znanja se mijenja i počinju ga shvaćati kao kompleksan i provizoran pojam na kasnijim godinama studija. U skladu s Perryjevim (1968) saznanjima, King i Kitchener (1994), Belenky, Clinchy, Glodberger i Tarule (1968) došli su do rezultata prema kojima se epistemološka saznanja razvijaju u stadijima, od jednostavnih prema kompleksnima.

Za razliku od spomenutih znanstvenika, Schommer (1990) kritizira jednodimenzionalnu i razvojnu narav epistemoloških uvjerenja te tvrdi da se ona ne razvijaju u fazama. Umjesto toga, pojedinac istodobno može imati i nekoliko uvjerenja. Štoviše, Schommer (1994) napominje da stupanj sofisticiranosti između tih uvjerenja varira. Da pojasnimo, neka osoba može imati sofisticirana uvjerenja u pogledu izvjesnosti znanja, međutim u isto vrijeme možda naivno vjeruje da je autoritet izvor znanja. Schommer (1990) tvrdi da se sustav uvjerenja pojedinca sastoji od pet kategorija, a svaka od njih ima opseg od naivnog do sofisticiranog: a) *jednostavnost znanja,* vjerovanje prema kojemu je znanje jednostavno, to jest da se sastoji od izoliranih djelića informacija, u odnosu na vjerovanje da je znanje složeno, odnosno sastavljeno od međusobno povezanih mentalnih pojmova; b) *izvjesnost znanja* (bilo ono izvjesno ili provizorno); c) *sveznajući autoritet* povezan s autoritetom

kao jedinim izvorom znanja do pitanja o tome je li osobno promišljanje pojedinca ključno za građenje sustava znanja; d) *urođene sposobnosti* (je li učenje urođeno ili se s vremenom razvija) i e) *brzo učenje*, koje se tiče raspona učenja, odnosno odvija li se proces učenja brzo ili postupno. Schommer (1990) se pri istraživanju tih pitanja koristila kvantitativnim pristupom, za razliku od svojih prethodnika koji su podržavali jednodimenzionalnu narav epistemoloških uvjerenja i razvila upitnik o epistemološkim uvjerenjima koji mjeri epistemološka uvjerenja neke osobe. Usprkos hipotezi o strukturi koja se sastoji od pet uvjerenja, u studijama je proučavana struktura od četiri čimbenika: jednostavnost znanja, izvjesnost znanja, urođena sposobnost i brzo učenje (Schommer, 1990) na učenicima srednje škole i studentima (Schommer, 1993), kao i učenicima srednje škole. Međutim, drugi znanstvenici koji su upotrijebili isti instrument kao Schommer (1990) došli su do drugačije strukture čimbenika koja varira ovisno o obilježjima proučavanog uzorka. Na primjer, Qian i Alvermann (1995) uočili su strukturu od tri čimbenika: urođena sposobnost, brzo učenje i jednostavnost – izvjesnost znanja, premda je istraživanje provedeno na učenicima srednje škole, baš kao i kod Schommer (1993).

Dosadašnja istraživanja provodila su se u odnosu na razne čimbenike (primjerice, metoda poučavanja, razina znanja/ocjena, akademski rezultati) u pogledu epistemoloških uvjerenja. Izveden je zaključak da su epistemološka uvjerenja povezana s akademskim rezultatima (Conley, Pintrich, Vekiri, i Harrison, 2004; Hofer i Pintrich, 1997; Schommer, 1990; Schommer i Walker, 1997; Schommer, Crouse i Rhodes, 1992). Studenti s naivnim epistemološkim uvjerenjima obično imaju problema s razumijevanjem teksta i lošije akademske rezultate. U pogledu razine znanja, odnosno ocjene, rezultati istraživanja otkrivaju kompleksnost epistemoloških uvjerenja ispitanika prema godini školovanja (Brownlee, Purdie, i Boulton-Lewis, 2001; Paulsen i Wells 1998; Schommer, 1998; Schommer-Aikins, Calvert, Gariglietti, i Bajaj, 1997). Nadalje, epistemološka uvjerenja utječu i na razmišljanja nastavnika o poučavanju. Učitelji s naivnim epistemološkim uvjerenjima obično se drže tradicionalnih metoda poučavanja, dok su učitelji koji imaju sofisticiranija epistemološka uvjerenja ipak više konstruktivistički usmjereni (Chan i Elliott, 2004).

Mi smatramo da isto tako možda postoji i poveznica strahova budućih učitelja vezano uz poučavanje te njihovih epistemoloških uvjerenja. Pretpostavljamo da budući učitelji s naivnim epistemološkim uvjerenjima imaju i više strahova. No taj odnos dosad u literaturi nije izravno spominjan. Međutim, isto se tako u literaturi spominje kako su studenti sa sofisticiranijim epistemološkim uvjerenjima obično uspješniji (Hofer, 1994; Neber i Schommer-Aikins, 2002). Nadalje, spomenuto je i da budući nastavnici koji sami sebe smatraju uspješnijima, imaju manje strahova vezanih uz poučavanje (Boz i Boz, 2010; Ghaith i Shabaan, 1999). Stoga smatramo da su epistemološka uvjerenja možda povezana sa strahovima vezanima uz poučavanje. Slično tomu, epistemološka uvjerenja utječu na nastavnički pristup poučavanju. Na primjer, učitelji s naivnim epistemološkim uvjerenjima obično se drže tradicionalnih metoda

poučavanja (Chan i Elliott, 2004). Isto tako, strahovi vezani uz poučavanje utjecajni su i u procesu odlučivanja o odabiru metode poučavanja. Da pojasnimo, nastavnici koji imaju strahove vezane uz predmet poučavanja izbjegavaju konstruktivističke strategije poučavanja na nastavi (Aydın, Boz i Boz, 2010). To je i dokaz odnosa između strahova vezanih uz poučavanje i epistemoloških uvjerenja. Dakle, što je logično, studenti koji smatraju da je učenje postupni proces, imat će manje strahova jer smatraju da će im se strahovi s vremenom smanjiti kada ih nauče kontroliratii. Očekujemo da ćemo otkriti da je isti taj trend prisutan u odnosu između urođenih sposobnosti i strahova vezanih uz poučavanje. No u proučenoj literaturi nismo naišli na istraživanje koje se pozabavilo suodnosom strahova vezanih uz poučavanje i epistemoloških uvjerenja.

Dakle, istraživačka pitanja ove studije su sljedeća:

a) Kako se strahovi vezani uz poučavanje kod studenata nastave matematike razlikuju prema godini studija?
b) Kako se epistemološka uvjerenja kod studenata nastave matematike razlikuju prema godini studija?
c) Jesu li strahovi vezani uz poučavanje kod studenata nastave matematike povezani s njihovim epistemološkim uvjerenjima? Ako jesu, kako?

Metodologija

Ispitanici

Sto sedamdeset sedam studenata nastave matematike upisanih na Odsjek za sekundarnu znanost i nastavu matematike pri dva sveučilišta u središnjoj Turskoj sudjelovalo je u ovoj studiji. Za odabir ispitanika korišteno je uzorkovanje prema podobnosti. Naime, u Turskoj svi maturanti imaju pravo pristupiti središnjem državnom ispitu u slučaju da žele nastaviti obrazovanje na sveučilištu. Taj ispit svake godine provodi Centar za odabir i razmještaj studenata. Sveučilišta iz ovoga uzorka na Odsjek za sekundarnu znanost i nastavu matematike primaju učenike s ocjenama u najboljih deset posto.

Četrdeset dva (42) studenta u našem uzorku bila su na drugoj studijskoj godini, a pedeset sedam (57) i sedamdeset osam (78) bilo je na četvrtoj i petoj studijskoj godini. U pogledu spola ispitanice su činile veći dio uzorka (113), studenata je bio 60, dok se četiri studenta nisu izjasnila na pitanje o spolu. Nakon diplome ti će studenti poučavati učenike srednjih škola matematici. Na studiju polaze sadržajne (matematičke) i pedagoške (teorijske i praktične) kolegije. Na višim godinama studija broj pedagoških i matematičkih kolegija se povećava. Tako su studenti iz našega uzorka s druge godine studija slušali tri pedagoška kolegija („Uvod u odgoj i obrazovanje", „Edukacijska psihologija" i „Turski obrazovni sustav i upravljanje školama"), kao i osnovne matematičke kolegije („Linearna algebra", „Analitička geometrija", „Diskretna matematika"). Tijekom posljednje godine studija studenti imaju dva praktična kolegija. Prvi od njih je „Školsko iskustvo", kada su smješteni u srednje škole radi promatranja nastave matematike svojih mentora. Drugi je „Nastavna praksa", pri čemu su također

smješteni u škole, ali sada imaju priliku poučavati matematiku u srednjoj školi. U vrijeme provođenja studije samo su studenti završne, pete godine, dovršili kolegij „Školsko iskustvo" i započeli slušati kolegij „Nastavna praksa".

Instrumenti

Za prikupljanje podataka korištena su dva instrumenta. Prvi je „Kontrolna lista strahova vezanih uz poučavanje" koju je razvio Borich (1992). Za ovu studiju korištena je turska inačica koju je prevela i validirala Boz (2008). Premda tri predmeta s originalnog popisa, točnije „nedostatna administrativna potpora nastavnicima", „previše dodatnih dužnosti i odgovornosti" i „nedovoljna podrška specijaliziranih nastavnika" nisu bili značajni za čimbenike u prevedenoj inačici jer su bili zastupljeni s manje od 0,28, što je prema Stevens (2002) dovoljno za otpis, instrument je u konačnici poprimio strukturu od tri čimbenika te je strahove vezane uz poučavanje mjerio prema strahovima u vezi s poimanjem *vlastitog ja* (17 točaka), *izvršenja zadatka* (10 točaka) i *učinka* (15 točaka) prema skali Likertova tipa od pet stupnjeva. Dakle, što viši rezultat ostvare prema kontrolnom popisu strahova vezanih uz poučavanje, to budući nastavnici imaju više tih strahova. Opća vrijednost Cronbach alfa iznosila je 0,96. Tablica 1 prikazuje obrazac izjava za sastavne točke svakog čimbenika.

Tablica 1.

U ovoj studiji analiza potvrdnog čimbenika koja je provedena kako bi se potvrdila struktura čimbenika u instrumentu odgovarala je strukturi čimbenika. Indeks primjerenosti iznosio je $\chi^2 = 1736{,}09$ ($df = 816$, $p < {,}00$), $\chi^2/df = 2{,}12$. Vrijednost RMSEA iznosila je 0,08 posto s intervalom uvjerenja od 90 % i rasponom od 0,075 do 0,085. CFI indeks iznosio je 0,96, a SRMR 0,078. Sve te vrijednosti upućuju na to da instrument odgovara uzorku. Vrijednosti RMSEA i SRMR bile su niže od 0,08 te 0,10, a omjer (χ^2/df) ispod 3 prihvaćen je kao podobna vrijednost za model (Browne i Cudeck, prema Kline, 1998). Nadalje, Arbuckle i Wothke (1999) iskazuju da CFI vrijednosti iznad ,95 također odgovaraju.

Drugi korišteni instrument bio je Schommer epistemološki upitnik (Schommer, 1990). U ovoj studiji upotrijebljena je inačica (Topcu i Yilmaz-Tuzun, 2006). Sastoji se od skale Likertova tipa od pet stupnjeva koja sadrži 63 kategorije koje mjere epistemološka uvjerenja ispitanika. Što viši rezultat ispitanik ostvari, to su mu naivnija epistemološka uvjerenja. Instrument mjeri strukturu od pet pretpostavljenih epistemoloških uvjerenja: *jednostavnost znanja, izvjesnost znanja, sveznajući autoritet, urođenu sposobnost i brzinu učenja*. Tu su i potkategorije za svaku od pretpostavljenih struktura uvjerenja. U Tablici 2 nalaze se podaci o navedenim potkategorijama, epistemološkim uvjerenjima i uzorku. Na temelju zbroja povezanih točaka izvedeno je dvanaest potkategorija.

Tablica 2.

Radi utvrđivanja faktorske strukture upitnika, provedena je analiza glavnih sastavnica sa kosokutnom rotacijom na srednjim vrijednostima iznad jedan, a

faktori su utvrđeni točkom otpisa od 0,50 kao kod Schommer (1990). Faktori su nazivani prema najprisutnijim točkama koje pripadaju tome faktoru. Kao što je vidljivo iz Tablice 3, tri čimbenika su najprisutnija. Prvi je „urođena sposobnost", drugi „jednostavnost znanja" i treći „sveznajući autoritet". Radi pouzdanosti, Cronbach alfa vrijednosti za svaki čimbenik imale su raspon od 0,25 do 0,84. Niske vrijednosti u pogledu pouzdanosti od 0,20 do 0,6 prema čimbenicima epistemološkog upitnika primijećene su i u studiji Yilmaz-Tuzun i Topcu (2008).

Tablica 3.

Rezultati

U Tablici 4 nalazi se opisna statistika u pogledu strahova vezanih uz poučavanja i epistemoloških uvjerenja budućih nastavnika matematike. Uočeno je da sudionici ove studije uglavnom imaju strahove vezane uz izvođenje zadataka i da najmanje strahova imaju u pogledu samoodržavanja. Nadalje, strahovi budućih nastavnika vezani uz poimanje vlastitog ja, zadatke i učinak povećavaju se na četvrtoj godini studija, ali padaju kod studenata pete godine. S ciljem procjene srednjih razlika strahova vezanih uz poučavanje na različitim studijskim godinama provedena je MANOVA analiza. Otkriven je ne vrlo značajan rezultat (Wilksova $\lambda = 0{,}942$, $F(6{,}344) = 1{,}748$, $p > 0{,}05$) prema kojemu strahovi budućih nastavnika vezani uz poimanje vlastitog ja, zadatke i učinak ne iskazuju značajne razlike s obzirom na godinu studija.

Tablica 4.

U pogledu epistemoloških uvjerenja budućih nastavnika matematike, uočeno je da ispitanici imaju najnaivnija uvjerenja u vezi sa sveznajućim autoritetom. Točnije, smatraju da je vanjski autoritet glavni izvor širenja znanja i da promišljanje i zaključivanje pojedinca nije uključeno u izgradnju sustava znanja. S druge strane, također imaju naivna uvjerenja u vezi s jednostavnosti znanja te smatraju kako je znanje jednostavno, odnosno da se sastoji od izoliranih djelića informacija. U pogledu urođenih sposobnosti iskazali su sofisticiranost uvjerenja u odnosu na ostale čimbenike. Smatraju da se učenje s vremenom razvija. Kada sagledamo srednje vrijednosti epistemoloških uvjerenja studenata druge, četvrte i pete godine, uviđamo da se uvjerenja budućih nastavnika u vezi sa sveznajućim autoritetom među studentima različitih godina gotovo uopće ne razlikuju. U pogledu urođenih sposobnosti i jednostavnosti znanja, studenti pete godine imali su sofisticiranija uvjerenja od studenata druge i četvrte godine.

S ciljem boljeg razumijevanja učinka epistemoloških uvjerenja budućih nastavnika matematike ovisno o godini studija provedena je MANOVA analiza. Otkriveno je da zaista postoji značajan učinak studijske godine na epistemološka uvjerenja ispitanika (Wilksova $\lambda = 0{,}926$, $F(6{,}344) = 2{,}246$, $p<0{,}05$). Djelomični eta korijen iznosio je 0,04. Utvrđen je značajan učinak studijske godine na epistemološka uvjerenja ispitanika vezana uz urođene sposobnosti ($F(2{,}174) = 6{,}081$, $p<0{,}05$) s eta korijenom 0,065, a

kod kategorija jednostavnosti znanja i sveznajućeg autoriteta nisu otkrivene značajnije razlike. Naknadna analiza ukazuje na značajne razlike između studenata druge i pete, četvrte i pete studijske godine u odnosu na urođene sposobnosti. Srednja vrijednost za studente druge godine iznosila je 2,46, četvrte 2,47 i pete 2,25. Drugim riječima, studenti pete godine više od studenata na ostalim studijskim godinama smatraju da se učenje razvija s vremenom.

Kako bismo doznali više o odnosu strahova vezanih uz poučavanje kod budućih nastavnika i njihovih epistemoloških uvjerenja, proveli smo kanonsku analizu. Odlučili smo se za kanonsku korelacijsku analizu (CCA) jer ona analizira jakost odnosa dvaju konstrukata tako što proučava njihovu internu strukturu. CCA dakle proučava internu strukturu konstruiranjem kanonskih varijacija kao linearnih kombinacija varijabli i kanonske težine. Između kanonskih varijabli pronađena je maksimalna korelacija jer je kanonska težina odabrana kako bi se to postiglo. Osim toga, uporaba CCA umjesto analize jedne varijacije umanjuje mogućnost pogreške prvog tipa (Thompson, 1991 prema Sherry i Henson, 2005, str. 38). Prema Sherry i Henson (2005), uobičajeno je za pogrešku prvog tipa odrediti $\alpha = ,05$. S CCA „s obzirom da je proveden jedan ispit, rizik počinjenja pogreške prvog tipa je minimalan. Naravno, čak i s jednim statistički značajnim ispitom $\alpha = ,05$, i dalje ne možemo sa sigurnošću utvrditi da je došlo do pogreške prvog tipa" (Sherry i Henson, 2005, str. 38).

Procjena pretpostavki

Provjerene su pretpostavke kanonske analize kao što su odbačeni podatci, vrijednosti izvan obrasca, normalnost, linearnost, homoscedastičnosti, multikolinearnost i singularnost pa ćemo ih predstaviti u ulomcima koji slijede.

Odbačeni podatci

Svih 177 slučajeva prihvaćeno je u analizi.

Vrijednosti izvan obrasca

Provjerene su i jednovarijacijske i multivarijacijske vrijednosti izvan obrasca koristeći PASW Statistics 20. Izbrisana su tri slučaja vezana uz urođene sposobnosti, jedan vezan uz sveznajući autoritet i jedan vezan uz izvođenje zadataka sa Z rezultatom izvan (-3, +3) s obzirom na to da je riječ o jednovarijacijskim vrijednostima izvan obrasca. Još tri slučaja otkrivena su putem Mahalanobis udaljenosti kao multivarijacijska vrijednost izvan obrasca s $p<0,001$. Svih osam slučajeva izbrisano je i za kanonsku analizu preostalo je njih 169.

Normalnost, linearnost, homoscedastičnost

Radi provjere normalnosti, linearnosti i homoscedastičnosti utvrđeni su kanonski varijacijski rezultati nakon čega je izrađena matrica raspršenja. Svaka varijacija za Set 1 uparena je s varijacijom za Set 2. Iz oblika matrice raspršenja izveden je zaključak da su varijacije normalne i linearne, a kako su grafovi ovalnog oblika, nema očiglednih

odmaka od normalnosti, linearnosti i homoscedastičnosti. Nadalje, s ciljem dodatne provjere normalnosti, testovi asimetrije i distribucije prema vjerojatnosti nisu pokazali odmak od normalnosti.

Kanonička analiza

Nakon provjere pretpostavki, izvedena je kanonska korelacijska analiza. Početna hipoteza bila je da su rezultati koji se tiču strahova vezanih uz poučavanje i oni koji se tiču epistemoloških uvjerenja međusobno povezani. Radi provjere te hipoteze provedena je kanonska korelacijska analiza. Ona se sastoji od tri varijable na području strahova vezanih uz poučavanje (poimanje vlastitog ja, izvršenje zadataka i učinak) i tri varijable na području epistemoloških uvjerenja (urođene sposobnosti, jednostavnost znanja, sveznajući autoritet). Stoga smo izveli tri kanonska korijena. Generalni je model statistički značajan s Wilksovom λ ,894, $F(9, 396{,}85) = 2{,}065$, $p < ,05$, no pojedinačni testovi pokazuju da je samo prvi kanonski korijen značajan pri $p < 0{,}05$.

Radi utvrđivanja opsega tog odnosa izračunali smo 1- λ i otkrili opći učinak =,11. Dakle, puni kanonski model statistički je značajan i odlikuje ga niski učinak.

Kako bismo izbjegli „rizik tumačenja učinka koji nije vrijedan spomena ili se ne može replicirati u budućim istraživanjima" (Sherry i Henson, 2005, str. 42), protumačili smo samo prvu funkciju. Kod ostalih je funkcija kvadrirana kanonička korelacija niža od ,10. Kvadratna kanonska korelacija za ovu funkciju iznosi ,10 pa stoga objašnjava 10% varijacije, pa je statistički značajna s ,05.

U Tablici 5 predstavljeni su koeficijenti kanonske funkcije i strukturni koeficijenti za funkciju (varijaciju) 1. U istoj tablici prikazani su i kvadratni strukturni koeficijenti.

Kada proučimo koeficijente funkcije 1, jasno je da je varijabla relevantnog kriterija ponajprije bila poimanje vlastitog ja (strahovi vezani uz poimanje vlastitoga ja). Varijable zadatak (strahovi vezani uz izvođenje zadatka) i učinak (strahovi vezani uz učinak) sekundarno su doprinijele varijabli sintetskog kriterija (Set 1). Kvadratni strukturni koeficijenti podržavaju takav zaključak jer iskazuju količinu varijacije kojom promatrana varijabla može doprinijeti varijabli sintetskog kriterija. Strahovi vezani uz poimanje vlastitog ja najčešće su imali najviši koeficijent.

Tablica 5.

Varijabla prediktora u funkciji 1, urođena sposobnost, najviše je doprinijela varijabli sinteze prediktora.

Rezultati su uglavnom u skladu s teorijskim očekivanim međuodnosom strahova vezanih uz poimanje vlastitog ja i epistemoloških uvjerenja.

Slika 1.

Na Slici 1 prikazan je sažetak kanonske korelacijske analize. Kao što se vidi iz slike, strahovi vezani uz poimanje vlastitog ja imaju najvišu korelaciju s prvom kanonskom varijacijom (Set 1), slijede ih strahovi vezani uz učinak, a na kraju se s najnižom korelacijom nalaze strahovi vezani uz izvođenje zadataka. S druge strane, urođena

sposobnost ima najvišu korelaciju s drugom kanonskom varijacijom (Set 2), slijedi sveznajući autoritet (s negativnom korelacijom) i na kraju s najnižom korelacijom dolazi jednostavnost znanja. Moguće je da su strahovi vezani uz poimanje vlastitog ja i urođene sposobnosti glavni uzroci zašto ta dva seta varijabli imaju kanonsku korelaciju oblika koji ćemo raspraviti u sljedećem dijelu.

Stoga zaključujemo da je kanonski korelacijski koeficijent između prvog korijena 0,31 te pretpostavljamo da su u obrađenom uzorku rezultati strahova vezanih uz poučavanje i rezultati epistemoloških uvjerenja u korelaciji.

Rasprava i zaključak

U ovoj studiji istraženi su strahovi budućih nastavnika matematike vezani uz poučavanje, njihova epistemološka uvjerenja te međuodnos tih dvaju konstrukata. Prvo, dokazano je da su budući nastavnici matematike ponajviše zabrinuti u vezi problema izvođenja i izvršenja zadataka, pri čemu se misli na probleme u pogledu nefleksibilnosti kurikula, prevelikog broja učenika u razrednim odjelima, prevelike količine zakona i pravila za nastavnike i slično. S druge strane, studenti su najmanje strahovali u pogledu samoočuvanja. Štoviše, suprotno modelu Fuller (1969), ova studija podržava poimanje o istodobnom razvoju strahova vezanih uz poučavanje umjesto teorije o odvojenim fazama jer su naši budući nastavnici istodobno imali strahove vezane uz poimanje vlastitog ja te strahove vezane uz izvršenje zadataka i učinak na učenike.

S obzirom na to koliko se strahovi vezani uz poučavanje razlikuju prema godini studija, kod studenata četvrte godine uočen je porast svih oblika strahova vezanih uz poučavanje, no njihovi su strahovi umanjeni na petoj godini studijskog programa. No te razlike nisu od statističkog značaja. Razlog porasta strahova vezanih uz poučavanje kod studenata četvrte godine možda se može pronaći u činjenici što su odslušali više pedagoških kolegija nego studenti druge godine pa su time postali svjesniji realnosti nastavničkog zvanja. Također, kako nisu dobili priliku iskušati teorijska znanja u praksi, vjerojatno su zbunjeni. Međutim, na petoj godini studija smješteni su u srednje škole u kojima promatraju nastavu učitelja mentora, pa su dobili priliku s njima razgovarati o strahovima i načinu njihova rješavanja. Tu se, dakle, može pronaći razlog smanjenju strahova na završnoj godini studijskog programa. No sve su to opravdana nagađanja koja se tek trebaju potvrditi empirijskim istraživanjima. Stoga za neke buduće studije preporučujemo provođenje intervjua sa studentima radi boljeg razumijevanja naravi njihovih strahova vezanih uz poučavanje i razloga za promjenu tih strahova kod različitih studijskih grupa ovisno o godini studija.

U pogledu epistemoloških uvjerenja ispitanici su imali naivna uvjerenja vezana uz sveznajući autoritet. Smatraju da se znanje dobiva prijenosom autoriteta umjesto promišljanjem u procesu izgradnje vlastitog sustava znanja. Taj rezultat ne predstavlja iznenađenje sagledamo li pomnije obrazovni sustav naše zemlje. Ti studenti primali su tradicionalno obrazovanje u kojemu nastavnik prenosi informacije i u kojemu

je omjer interakcije učenika vrlo nizak: upravo takva iskustva u vlastitom procesu obrazovanja možda su utjecala na razvoj naivnih uvjerenja o sveznajućem autoritetu. To ukazuje na važnost kulture u epistemološkim uvjerenjima studenata (Chan i Elliott, 2005). Štoviše, naivna uvjerenja zabilježena su i u pogledu naravi znanja jer studenti smatraju da je znanje jednostavno i da se sastoji od odvojenih djelića informacija, a ne međusobno povezanih skupina pojmova. I tome se uzrok može naći u činjenici što ih se tijekom obrazovanja ne potiče na to da znanje povezuju s drugim mentalnim pojmovima. U odnosu na jednostavnost znanja i sveznajući autoritet, kada je riječ o urođenim sposobnostima, studenti su iskazali sofisticiranija uvjerenja. To znači da vjeruju da sposobnosti nisu urođene, već da se s vremenom razvijaju.

Kada sagledamo razvojni obrazac epistemoloških uvjerenja prema studijskim godinama, u usporedbi sa studentima druge i četvrte godine, studenti pete godine imali su puno sofisticiranija uvjerenja o urođenim sposobnostima i jednostavnosti znanja, što je rezultat dosljedan onima predstavljenima u relevantnoj literaturi te ukazuje na veću sofisticiranost epistemoloških uvjerenja s napretkom na studiju (Paulsen i Wells 1998; Schommer, 1998; Schommer-Aikins i sur., 1997). Međutim, pogled na ulogu autoriteta u procesu prijenosa znanja čak i ovdje je ostao prilično sličan stajalištima studenata ostalih studijskih godina.

Svejednako, u ovoj je studiji utvrđen međuodnos između strahova vezanih uz poučavanje i epistemoloških uvjerenja kod studenata nastavničkog smjera matematike. Budući nastavnici koji imaju najviše strahova vezanih uz poučavanje imaju i naivnija epistemološka uvjerenja. Uzmemo li u obzir činjenicu da strahovi vezani uz poimanje vlastitog ja tvore veći dio prve skupine varijacija (88%), a urođene sposobnosti čine 90% druge skupine, odnos između strahova vezanih uz poimanje vlastitog ja i epistemoloških uvjerenja koja se tiču urođenih sposobnosti kod studenata nastavničkog smjera matematike uzrok su međuodnosa tih dvaju konstrukata. Da pojasnimo, ako pojedinac ima više strahova vezanih uz poimanje vlastitog ja, tada će imati i naivnija uvjerenja o urođenim sposobnostima, što znači kako smatra da je sposobnost urođena i da se ne razvija prolaskom vremena. To je saznanje u skladu s našom hipotezom.

Dakle, iznimno je važno pozabaviti se strahovima vezanima uz poučavanje već u programu obrazovanja budućih nastavnika. U ovoj je studiji utvrđeno da su ispitanici bili zabrinuti u pogledu problema vezanih uz izvršenje zadataka kao što su prevelik broj učenika u razrednim odjelima, nefleksibilnost kurikula i tomu slično. Stoga bi programi obrazovanja nastavnika trebali sadržavati načine rješavanja tih strahova. Primjerice, u programima bi trebalo predvidjeti raspravu o problemima kao što su prevelik broj učenika u razrednim odjelima, nefleksibilnost kurikula i sličnih, kao i prijedloge za njihovo rješavanje.

Nadalje, otkrili smo i odnos između strahova vezanih uz poučavanje i epistemoloških uvjerenja. Važno je napomenuti da taj odnos nije uzročno-posljedični jer ova studija nije eksperimentalna i nismo se koristili terminologijom ovisnih i neovisnih varijabli.

Umjesto toga upotrebljavali smo termine kriteriji i varijable prediktora. Stoga ne tvrdimo da su epistemološka uvjerenja uzrok strahova ili obrnuto, već da imamo li saznanja o epistemološkim uvjerenjima neke osobe, možemo predvidjeti njezine strahove. Stoga navedeno upućuje na to da postoji odnos između epistemoloških uvjerenja i strahova vezanih uz poučavanje. Taj korelacijski odnos bit će istražen u nekim budućim studijama. Primjerice, eksperimentalnom studijom mogu se pokušati unaprijediti epistemološka uvjerenja budućih učitelja u zadanom vremenu i na kraju provjeriti je li došlo do promjene u strahovima vezanima uz poučavanje kod istih budućih nastavnika. U konačnici, smatramo da je prilikom razmatranja odnosa između strahova vezanih uz poučavanje i epistemoloških uvjerenja važno unaprijediti epistemološka uvjerenja studenata. To se može postići putem provođenja nastave i obuke koji su utemeljeni na konstruktivističkom pristupu. Spomenuto je da poduka uemeljena na propitivanju utječe na razvoj epistemoloških uvjerenja studenata (Tsai, 1999). Conley i sur. (2004) spominju učinkovitost praktične nastave na epistemološka uvjerenja studenata. Još jedan način unapređenja epistemoloških uvjerenja studenata jest poticanje studenata na to da sami promišljaju o vlastitim epistemološkim uvjerenjima (Brownlee i sur., 2001). Za neko buduće istraživanje preporučujemo procjenu provođenja različitih strategija poučavanja na epistemološka uvjerenja studenata u programima obrazovanja nastavnika. Osim toga, s obzirom na to da je naš uzorak odabran po načelu pogodnosti, za buduća istraživanja preporučujemo replikaciju ove studije na slučajno odabranom uzorku.