

Investigation of the Preschool Teacher Candidates' Philosophical Views on the Nature of Mathematics

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Abstract

Teachers' views on the nature of maths have a crucial effect on their interactions with children, their choice of method and technique to be used while preparing the curriculum, their decision on the type and frequency of activities to be applied, their behaviors in the classroom, children's attitudes towards maths and their achievement. With this research, it is aimed to examine teacher candidates' philosophical views on the nature of maths. The research is in relational scanning model. "The Scale of Philosophical Thoughts on the Nature of Mathematics" was implemented to 141 pre-school teacher candidates studying in 2019–2020, which constitute the sample of the study. As a result of the analysis, it has been found that 52.5% of teacher candidates have an absolutist view, the views of female and male teacher candidates support each other and there is a significant difference between the grade level in they study.

Keywords: pre-school, maths, mathematics, philosophy

1. Introduction

In life, maths is everywhere. Most of the things done as a part of daily life involve maths. For instance; telling the time, cooking and eating, wearing clothes, watching a sporting event, etc. include math. Daily activities include problem-solving, one-to-one relationships, classification, measurement, and putting in order (Furner & Berman, 2003; Akt: Jackman, 2005). The development of mathematical thoughts that are so impressive in individuals' lives, how they are acquired, and what affects these thoughts have been examined in many studies (Ernest, 2004; Çelik, 2015; Çelik, 2017a; Çelik, 2017b; Çelik, 2017c).

Kuryel (2010) stated that examining the development of mathematical thought will occur with the question of "Is maths discovery or invented?" This question always discussed, leads us to the philosophy of maths. Those who consider that maths has been discovered, defend the philosophical movement of absolutism, while those who consider that maths has been invented, defend the quasi-experimentalist philosophical movement. Absolutism involving logicism and formalism, argues that mathematical knowledge exists in the realm of ideas and that it is also an objective, precise and irrecoverable body of knowledge based on solid foundations of definite, unfalsifiable, universal, deductive logic and is always true regardless of individuals/situations (Baş, Işık, Çakmak, Okur, & Pekdemir, 2015). They also strictly ground on logical reasoning and ignore creativity and intuition (Handal, 2003). This movement considers maths as a set of rules, arithmetic calculations, enigmatic algebraic equations, and geometric proofs that many people should memorize (Sanalan, Bekdemir, Okur, Kanbolat, Baş, & Sağırılı, 2013). Learning mathematical knowledge means learning an unchanging structure based on a certain foundation. This understanding supports the idea that maths is all about a set of rules and that it may be sufficient for students to know only certain rules (Işıksal, Kurt, Doğan, & Çakıroğlu, 2007). According to those who adopt the quasi-experimentalist point of view, applied mathematical knowledge arises from practical knowledge, they can be falsified, however, their accuracy is accepted until they are falsified. Since they are the products of humans, they are constantly developing and changing (Akman, 2019).

The philosophical thoughts of educators about the nature of maths have led to the emergence of different perspectives in their maths education. This has directly affected the teachers' maths teaching environments, methods, classroom practices, expectations from students, and assessment techniques (Blair, 1981). For instance, a maths teacher with an absolutist point of view believes that pre-existing knowledge should be passed on to students directly. As a result, the teacher asks the students to repeat the truths conveyed to them over and

over and get mathematical knowledge. This approach, which is also an application of the behaviorism that defines learning in the context of stimulus-response (Baş, 2015), affected maths education, programs, evaluation processes, and educational models in the world until the second half of the 20th century (Moreira & Noss, 1995; Handal, 2003). Teachers, on the other hand, who have a quasi-experimentalist point of view consider that mathematical knowledge is a human product, that their students can learn this information by experimenting, and that their tasks should arrange the learning environment of students accordingly (Baki, 2008; Handal, 2003).

Various studies have been carried out to determine the attitudes, beliefs, anxieties, and thoughts of teachers and teacher candidates towards maths, to classify them under various orientations, and to show that they have positive or negative effects on teachers' practices (Lester, 2007; Philipp, 2007; Thompson, Philipp, Thompson, & Boyd, 1994). Also, with conducted studies, it has been found that teachers' beliefs in the nature of maths also affect children's maths achievement (Köller, Baumert, & Neubrand, 2000; Peterson, Fennema, Carpenter, & Loef, 1989). The achievement of the students of teachers having a constructivist view on the nature of maths has been found to be significantly higher than the achievement of the students of teachers with behavioral views (Staub & Stern, 2002). Considering that pre-school educators' perspectives on the nature of maths affect children's attitude to maths and their achievements in maths, it is significant to determine the views of the educators towards maths. Since it has been considered that teacher candidates' beliefs in the nature of maths will affect their maths teaching in future, it should be tried to get the teacher candidates the desired beliefs. Thus, a positive contribution will be made to achieving the goals targeted in maths education (Baydar & Bulut, 2002). Considering that today's pre-school teacher candidates will be the pre-school teachers of tomorrow, it is important to reveal and examine teacher candidates' views on the nature of maths.

In the study, it is aimed to examine the philosophical views of pre-school teacher candidates on the nature of maths. In line with this general purpose, the following sub-problems were sought:

- 1) Is there a significant difference in the philosophical views of the teacher candidates on the nature of maths by gender and grade levels?
- 2) What philosophical views do the teacher candidates have on the nature of maths?

2. Method

The research is in a descriptive relational survey model, one of the quantitative researches. Relational screening models, one of the quantitative researches, are research models aiming to determine the presence and/or degree of change between two or more variables (Karasar, 2008).

2.1 Population-Sample

The study group of this research consists of teacher candidates studying in the pre-school education program of a state university in the Western Black Sea Region. Convenience sampling, which is one of the purposeful sampling methods, was preferred for the research. A total of 141 teacher candidates, studying in the 1st, 2nd, 3rd and 4th grades of the pre-school education department of a state university in the Western Black Sea Region in the Spring Term, constitute the sample.

2.2 Data Collection Tools

“The Scale of Philosophical Thoughts on the Nature of Maths” developed by Sanalan et al. (2013) was used to collect data on the problems and sub-problems of the research. The scale consists of two parts. In the first part of the scale, questions were asked to determine the gender and grade levels of the teacher candidates participating in the study. The second part of the scale consists of 25 items prepared to determine the views of teacher candidates on the nature of maths. The scale is prepared in a 5-point Likert type. The items in the scale have the options of “totally disagree”, “disagree”, “undecided”, “agree” and “totally agree”. Expert views were used to ensure the face validity and content validity of the scale. Factor analysis was applied to ensure the construct validity of the scale. With the factor analysis performed, it was decided that the scale would consist of 4 factors, the factors obtained were named and the correlation coefficients were calculated to show the relationships between the factors. With expert views, these 4 factors were determined as daily life, problem-solving, the structure of maths, and mathematical thinking. Cronbach Alpha coefficients were found to determine the reliability of the scale and the internal consistency of all factors. The Cronbach Alpha reliability coefficient of the scale was calculated as 0.854. This value indicates that the scale is a reliable measurement tool.

2.3 Data Collection

To examine the philosophical views of pre-school teacher candidates on the nature of maths, “the Scale of Philosophical Thoughts on the Nature of Maths” developed by Sanalan et al. (2013) was implemented by the

researcher to teacher candidates in the sample group in January 2020.

2.4 Analysis of Data

All items of the scale prepared by Sanalan et al. (2013) in 5-point Likert type have the options of “totally disagree”, “disagree”, “undecided”, “agree” and “totally agree”. 11 out of 25 items in scale, represent the absolutist perspective, 14 items, on the other hand, represent the quasi-experimentalist perspective. The scoring of the items representing the quasi-experimentalist point of view ranges from 1 point to 5 points from “totally disagree” option to “totally agree” option; The scoring of the items representing the absolutist point of view was made from 5 points to 1 point from the option “totally disagree” to “totally agree”. The lowest score that the participants can get from the scale is 25 and the highest score, on the other hand, is 125.

3. Results

The scales from which the data were obtained, were checked before starting the analysis process. After the control, scales with incorrect or incomplete filling were not included in the evaluation and 141 participants' data were enumerated. After enumeration, the data were entered into the SPSS (IBM SPSS Statistics 22) program. Three groups were formed by the scores the participants got from the scale. Percentage, frequency, and arithmetic mean analyzes of the data entered into the SPSS program were made according to the absolutist, mixed and semi-experimentalist groups. In the study, at the beginning of the statistical analysis, the appropriate analysis type needs to be determined. Since the sample size is larger than 30, it has been predicted to use parametric methods for this study. The prerequisite for using parametric tests is to determine whether each factor has a normal distribution. The normal distribution of the data was determined using the single sample Kolmogorov Smirnov Test. Since the data were found not to be distributed normally as a result of the analysis, Mann Whitney U test and Kruskal Wallis calculations were made.

Table 1. Distribution of preschool teacher candidates according to groups determined as absolutist, mixed and semi-experimentalist.

| Names of the Group | N | % | \bar{x} | SD | Mark Range |
|--------------------------|-----|------|-----------|--------|------------|
| Absolutist Group | 74 | 52.5 | 66.32 | 8.088 | 25-75 |
| Mixed Group | 64 | 45.4 | 80.88 | 3.885 | 76-94 |
| Quasi-Experimental Group | 3 | 2.1 | 97.65 | 3.055 | 95-125 |
| Total | 141 | 100 | 73.59 | 10.277 | |

According to Table 1, individuals scoring between 25–75 points on the scale are in the absolutist group, those scoring in the range of 76–94 points are in the mixed group, and those scoring in the range of 95–125 are in the quasi-experimentalist group. When the percentage distributions of the groups are examined, it can be seen that the teacher candidates are mostly included in the Absolutist group (52.5%) and minimum in the Quasi-Experimentalist Group (2.1%).

Table 2. Normality test results of pre-school teacher candidates' scores

| | N | \bar{x} | Skewness | Kurtosis | Kolmogorov-Smirnov Test |
|-------|-----|-----------|----------|----------|-------------------------|
| Total | 141 | 73.59 | -0.480 | 0.359 | 0.00 |

According to Table 2, it can be seen that the normal distribution is not provided due to the Kolmogorov-Smirnov test results of the participants being $p < 0.05$. The Mann-Whitney U test results on whether there is a significant difference by the gender variable between the views of the teacher candidates on the nature of maths are presented in Table 3.

Table 3. Mann-Whitney U test results towards the gender variable of preschool teacher candidates' views on the nature of maths.

| Gender | N | Mean Rank | Sum of the Ranks | U | p |
|--------|-----|-----------|------------------|------|-------|
| Female | 120 | 70.58 | 8469 | 1209 | 0.768 |
| Male | 21 | 73.43 | 1542 | | |

According to Table 3, there are no significant differences in the views of pre-school teacher candidates by the gender variable $U = 1209$, $p > 0.05$. Considering the mean rank, it is understood that the views of male teacher candidates on the nature of maths are higher than the average scores of the female teacher candidates. Although the average scores of female and male teacher candidates differ, this difference is very low. According to the results, the views of male and female teacher candidates support each other.

Descriptive statistics regarding the grade levels in which the teacher candidates are educated are presented in Table 4, and the results of Kruskal Wallis regarding whether there is a significant difference between their views regarding the grade level variable they study in are presented in Table 5.

Table 4. Descriptive statistical analysis results related to the variable of the grade level of teacher candidates.

| Grade Level | N | \bar{x} | SD |
|-------------|-----|-----------|----------|
| 1st grade | 35 | 67.29 | 11.38516 |
| 2nd grade | 42 | 75.55 | 7.84982 |
| 3rd grade | 39 | 75.59 | 9.43040 |
| 4th grade | 25 | 76.04 | 10.44222 |
| Total | 141 | 73.59 | 10.27756 |

According to Table 4, the average scores of teacher candidates studying in the first grade are 67.29, of the second grades are 75.55, of the 3rd grades are 75.59 and of the 4th grades are 76.04. Although there are differences between the average scores between the groups, it can be seen that these differences are small.

Table 5. Kruskal Wallis analysis results of teacher candidates' views by the variable of grade levels of education

| Grade Level | n | Mean Rank | df | χ^2 | p | Significant Difference |
|-------------|----|-----------|----|----------|-------|------------------------|
| 1 | 35 | 48.91 | 3 | 13.64 | .003* | 1-2, 1-3, 1-4 |
| 2 | 42 | 78.50 | | | | |
| 3 | 39 | 78.35 | | | | |
| 4 | 25 | 77.86 | | | | |

According to Table 5, the views of the teacher candidates about philosophical thoughts on the nature of maths by the grade level variable they study in have been determined to be $p < 0.5$. The Dunnett C test was applied to determine the source of the Kruskal Wallis difference. As a result of the Dunnett C test, it was found that the difference between 1st and 2nd graders was significant in favor of the 2nd grade, the difference between 1st and 3rd grade was in favor of 3rd grade and the difference between 1st and 4th grade was in favor of 4th grade. In the Results section, summarize the collected data and the analysis performed on those data relevant to the discourse that is to follow. Report the data in sufficient detail to justify your conclusions. Mention all relevant results, including those that run counter to expectation; be sure to include small effect sizes (or statistically nonsignificant findings) when theory predicts large (or statistically significant) ones. Do not hide uncomfortable results by omission. Do not include individual scores or raw data with the exception, for example, of single-case designs or illustrative examples. In the spirit of data sharing (encouraged by APA and other professional associations and sometimes required by funding agencies), raw data, including study characteristics and individual effect sizes used in a meta-analysis, can be made available on supplemental online archives.

4. Discussion

Since it has been considered that teacher candidates' beliefs in the nature of maths will affect their maths teaching in future, it should be tried to get the teacher candidates the desired beliefs. Thus, a positive contribution will be made to achieving the goals targeted in maths education (Baydar & Bulut, 2002). In this study, it is aimed to examine the philosophical views of pre-school teacher candidates on the nature of maths. As the first sub-problem in the study, the philosophical views of teacher candidates on the nature of maths were discussed in terms of gender and grade level variables. Although gender is a variable that affects beliefs in maths, by Li (1999), it has been concluded that the participants' philosophical thoughts about the nature of maths do not differ by the gender variable. This result is in parallel with the results of the studies conducted by Akman (2019), Baş et al. (2015), Budak (2011), and Baydar (2000).

The average score that teacher candidates got from the scale used is 73.59. It has been concluded that teacher candidates generally adopt the mixed view being closer to the absolutist point of view. Most of the teacher

candidates having an absolutist point of view have been studying in the first grade. It has been considered that the reason for this may be that the teacher candidates studying in the first grade do not take “the Early Childhood Maths” course. It has been concluded that the rates of teacher candidates adopting the mixed perspective and quasi-experimentalist perspective in the 2nd, 3rd and 4th grades are very close to each other. However, it has been concluded that teacher candidates studying in the 4th grade have a quasi-experimentalist perspective. It has been considered that this may be due to the fact that teacher candidates studying in the 4th grade are placed in the department with equal weight points in the university exam.

In the second sub-problem in which the philosophical views of teacher candidates about the nature of maths were examined, although their score ranges are very close, they can be seen to be included mostly in the Absolutist group, then in the Mixed Group and on the other hand minimum in the Semi-Experimental Group. These results are similar to the results of the study conducted by Paksu (2008), Amiralı and Halai (2010), and Grossman and Stodolsky (1995). In the study in which Amiralı and Halai (2010) examined the views of maths teachers about the nature of maths, it has been found that teachers accept mathematical information without questioning, thinking that mathematical rules could never be wrong. Paksu (2008), in the study comparing teachers’ beliefs in maths with various variables, has found that the maths teachers participating in the study consider maths as the discipline that the rules and procedures used to solve problems should be memorized. In the study by Grossman and Stodolsky Nin (1995), maths teachers consider maths as highly sequential and static compared to teachers of other subjects. These results do not correspond with the results of the studies conducted by Akman (2019), Bař et al. (2015), Kayan, Haser and Bostan (2013) and Zakaria and Musiran (2010). Akman (2019) has concluded that more than half of the teacher candidates (53%) adopt a quasi-experimentalist perspective in the study, which examined the philosophical views of teacher candidates about the nature of maths. In the studies to determine maths teacher candidates’ beliefs in the nature of mathematics, mathematics teaching, and learning. It has been found that 69% of them have constructive beliefs by Bař et al. (2015), however, the vast majority of them have constructive beliefs by Kayan et al. (2013). In the study carried out by Zakaria and Musiran (2010), teacher candidates have stated that there are multiple methods to solve mathematical problems and it has been found that they have a positive attitude towards the constructivist approach. The reason for the difference in these results may be that the researchers did it with maths teachers and teacher candidates. While maths teacher candidates are placed in the department with a numerical score in the university exam, pre-school teacher candidates are placed in the department with verbal scores except for 4th grade.

The average score that teacher candidates got from the scale used is 73.59. It has been concluded that the teacher candidates generally adopt the mixed view closer to the absolutist point of view. Most of the teacher candidates having an absolutist point of view are studying in the first grade. It has been considered that the reason for this may be that the teacher candidates studying in the first grade do not take Maths in Early Childhood lessons. It has been concluded that the rates of teacher candidates adopting the mixed perspective and quasi-experimentalist perspective in the 2nd-, 3rd- and 4th-grade levels of education are very close to each other. However, it has been concluded that teacher candidates studying in the 4th grade have a quasi-experimentalist perspective. It has been considered that this may be due to the fact that teacher candidates studying in the 4th grade are placed in the department with equal weight points in the university exam.

5. Suggestions

As a result of the findings obtained from the research, suggestions for the researchers are given below:

- 1) The factors that affect having an absolutist view can be investigated.
- 2) Philosophy of Maths course can be included in the pre-school education undergraduate program.
- 3) The relationship between the philosophical views of preschool teachers on the nature of maths and the maths achievement of children can be examined.
- 4) The study can be applied to a larger sample group.

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