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Changes in Prospective Primary School Mathematics Teachers' Conceptions of Teaching and Learning

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Abstract

Teaching-learning conception is related to preferences in teaching-learning. There are two major teaching-learning approaches in education, which are constructivist and traditional approaches. In parallel, education curricula are being developed in compliance with this understanding. It is also manifest in the current mathematics curricula. This study intends to reveal any changes, if any, in the teaching-learning conceptions of prospective teachers, who are the future teachers, from the beginning till the end of their university education, and to find out the reasons driving such change or lack of change. According to this study, the prospective primary school mathematics teachers adopt the constructivist teaching-learning approach regardless of their grade level. However, it is worth noting that the behavioral tendency of the 1st graders declines while their constructivist tendency increases by the time they reach the 4th grade. There is a transition from behavioral learning approach to constructivist learning approach in the learning-teaching understanding of 4th grade teacher candidates. This change is usually linked to Instruction-dominated courses. Depending on the results of the study, it is suggested that during teacher education, prospective teachers should be trained on teaching-learning conceptions and they should be given the chance to prepare and apply lesson plans in accordance with the conceptions.

Keywords: Constructivist approaches, traditional approaches, prospective primary school mathematics teachers

1. Introduction

Teaching-learning conception is related to preferences in teaching-learning paths (Chan & Elliot, 2004). There are two major teaching-learning approaches in education, which are constructivist and traditional approaches (Aypay, 2011; Bıkmaz, 2011; Chan & Elliot, 2004; Oğuz, 2011; Powell, Farrar & Cohen, 1985; Schunk, 2008; Şahin & Yılmaz, 2011; Thomas M. Sherman & Barbara L. Kurshan, 2005). The traditional approach basically supports a teacher-centered setting where students remain in the background and education is performed as a result-oriented activity rather than as a process. It concerns itself with whether learners think or not, instead of dealing with how they think

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(Özden, 2003). In learning environments reflecting this approach, the teacher is an authoritative actor, and the teaching-learning environments are managed by the teacher only. In these environments, memorization prevails rather than meaningful learning (Baş & Beyhan, 2013). According to the philosophy underlying this approach, knowledge already exists somewhere, and the duty of the individual is to access the knowledge. In order to achieve this, the individual needs to either find ready-made knowledge themselves or get it directly from someone else. In other words, the individual is not a producer, but they are responsible for obtaining the existing knowledge somehow (Baki, 2020). On the other hand, the constructivist approach promotes a student-centered setting where learners assume the leading role and education is carried out within a process-oriented framework (Biggs, 1996). In relevant learning environments, the teacher only undertakes the role of a guide, and meaningful learning is adopted (Miller, 1997). According to this approach, knowledge is not independent of the individual and cannot be directly transferred from one person to another. The individual themselves is the authority in constructing the knowledge. To put it in a different way, the individual takes an active part in the learning process and builds their new understanding on their previous knowledge. In short, the individual constructs their own knowledge through active interaction with their surrounding (Baki, 2020).

Looking at education process today, one can notice that education is evolving from the traditional understanding into the student-centered, constructivist one (Duffy & Roehler, 1986). In parallel, education curricula are being developed in compliance with this understanding (Erdem & Demirel, 2002). It is also manifest in the current mathematics curricula (MEB, 2018). The goal of the mathematics curricula is to help students learn mathematics, think about it, comprehend general problem-solving strategies, have a positive attitude towards mathematics and adopt it as an important tool in real life in addition to acquire the basic mathematical concepts and skills (Kalender, 2006).

The implementers of curricula are teachers (Fullan, 2007). Spillane (1999) argued that teachers' in-class practices are characterized by their own thoughts, and he named this role as teachers' zones of enactment. According to Macnab (2003), teachers' zones of enactment are formed around their knowledge, beliefs and philosophy. Therefore, the thoughts of teachers have an important place in educational activities, shape the educational opportunities of students and affect what is reflected in the classroom environment (Aksu, Demir & Sümer, 1998; Altınkurt, Yılmaz, & Oğuz, 2012; Ford, 1994; Thompson, 1992). Similarly, curricula for universities are built on the valid educational approaches (Yazçayır, 2016). In this way, it is expected to increase teacher candidates' awareness about learning and teaching process before starting the teaching profession.

In the known literature on teaching-learning approaches, the conceptions of teachers and teacher candidates (Aypay, 2011; Bıkmaz, 2011; Brousseau & Freeman, 1988; Chan, 2003; Chan & Elliot, 2004; Chai & Khine, 2008; Murray & McDonald, 1997; Oğuz, 2011;

Şahin & Yılmaz, 2011; Walker, Brownlee, Whiteford, Exely & Woods, 2012; Windschitl & Andre, 1998) were generally investigated in connection with various variables. In this study, it is aimed not only to reveal the change in the teaching-learning conceptions of teacher candidates, but also to examine the factors causing this change and the reasons for these factors in depth. In this direction, this study intends to reveal any changes, if any, in the teaching-learning conceptions of prospective teachers, who are the future teachers, from the beginning till the end of their university education, and to find out the reasons driving such change or lack of change. To this end, the following research questions were addressed in this study:

1. What are the teaching-learning conceptions of prospective teachers at different grade levels (1st and 4th year)?
2. What change, if any, has taken place in the teaching-learning conceptions of prospective teachers in their final (4th) year?
   a. What are the previous teaching-learning understandings of the 4th grade teacher candidates?
   b. What are the current teaching-learning understandings of 4th grade teacher candidates?
3. What are the factors causing the change in the teaching-learning conceptions of the prospective teachers in their final (4th) year?

2. Method

Mixed method was used in the study. Mixed method is obtained when the researcher uses qualitative and quantitative methods in a single study or successive studies (Creswell, 2003). In this study, quantitative method was used in order to identify the teaching-learning conceptions of prospective teachers with the help of a scale, while qualitative dimension was included to obtain in-depth information and explore the reasons for such conceptions.

2.1. Participant (subject) characteristics

The study was conducted with 135 teacher candidates studying Primary School Mathematics Teaching at a state university in the Eastern Black Sea Region of Turkey. The distribution of the participants by grade levels is as shown in Table 1 below.

Table 1. *Number of participants by grade level*

Grade Level	n	(%)
1st grade	54	40
4th grade	81	60

Total	135	100

2.2. Data *collection instruments*

In this study, there were two sources of data collection. For the quantitative aspect, Chan and Elliot's (2004) "Teaching-Learning Conceptions Scale" was used. The validity and reliability studies of the instrument in Turkish language were completed by Aypay (2011). This scale consisted of 30 items and 2 factors, which are "Constructivist Conception" and "Traditional Conception". There were 12 items under the factor of constructivist conception and 18 items under the other factor. A 5-point Likert-type rating was used in the scale. The overall Cronbach's Alpha internal reliability coefficient of the scale was found to be .71. Cronbach's Alpha reliability coefficient for the sub-scales were calculated as .88 and .83, respectively. The scale was applied to both sub-groups of participants, 1st graders and 4th graders. Secondly, an open-ended questionnaire was used to collect qualitative data. This instrument was applied to the participants at the 4th grade only (n=81) as this type of data was needed to unearth the reasons for the change or lack of change in the prospective teacher's understanding. The questionnaire was comprised of 6 open-ended items including the following: "How did you think you could teach mathematics before you started university?", "Do you think different now?", "If there has been a difference in your thoughts, what are the factors that caused this difference?" The items were drafted in connection with the research questions. Then, the items were reviewed and approved by experts, who teach at a state university and have at least 10-15 years of professional experience. In light of the experts' advice, some items were deleted as they were found to be repetitive or overlapping. Next, the questions were rewritten for improved intelligibility by taking the opinion of a Turkish language teacher. As the final measure to ensure clarity of the questions, the questionnaire was piloted with 4 prospective teachers, and it was seen to fit the purpose of getting in-depth information.

2.3. *Data analysis*

Since two different data collection instruments were used in the study, the analysis methods were also varied. To start with, statistical analyses were conducted on the closed-ended questionnaire forms using SPSS 21. Only the copies that were filled out appropriately were included in the study. Descriptive statistics and t-test were conducted. In order to decide whether the data met the assumptions of parametric tests, the Skewness and Kurtosis values and the Levene test results were checked. The data analysis was performed at the significance level of 0.05.

The other data analysis method was content analysis applied to the open-ended questionnaire forms. Thanks to content analysis, clearer results are reached by condensing related concepts under certain codes and themes (Çepni, 2018). During the content analysis in this study, the responses given to the same item by all participants were read at once. The operation was carried on in this way until all of the responses to

each question were analyzed. This stage of data analysis was assisted by another educational researcher. The whole text was read and codes were elicited by two researchers independently. Then, the codes were compared by the assessors. Miles and Huberman's formula (Reliability Coefficient = Number of Consensus/ (Number of Consensus + Number of Disagreements) (Baltacı, 2017). was applied to calculate the inter-coder consistency, and a high level of agreement at 0.98 was found between the coders.

3. Results

In this section, the findings are presented under the headings of "Prospective Teachers' Teaching-Learning Conceptions", "Changes in Prospective Teachers' Teaching-Learning Conceptions", and "Factors Causing the Change in Prospective Teachers' Teaching-Learning Conceptions" in the same order as the research problems.

3.1. Prospective teachers' teaching-learning conceptions

In Table 2, the constructivist teaching-learning conception levels are shown for the two sub-groups of participants.

Table 2. *Prospective teachers' conceptions of constructivist education*

	Group	N	$\bar{x}$	Ss	t	df	p
Constructivist	1st grade	54	4,33	0,38	-2,051	133	0,04
	4th grade	81	4,46	0,37			

As a result of the t-tests performed to find out the participants' constructivist education conception levels, it was found that the prospective teachers differed in terms of the dependent variable according to their grade level (t0,05;133=-2,051). More specifically, the respondents at the 4th grade exhibited higher levels of constructivist teaching and learning conception scores ($\bar{x}$=4,46) than their 1st grade fellows ($\bar{x}$=4,33) as can be seen in Table 2 above.

Table 3. *Prospective teachers' conceptions of behavioral education*

	Group	N	$\bar{x}$	Ss	t	df	p
Behavioral	1st grade	54	2,70	0,50	4,409	133	0,00
	4th grade	81	2,34	0,44			

According to Table 3, the t-tests again yielded different values for the 1st graders and 4th graders regarding the behavioral approach to teaching and learning (t0,05;133=4,409). It can be seen that the participants attending the 4th grade had lower levels of behavioral teaching and learning conceptions scores ($\bar{x}$=2,34) than those at the 1st grade.

3.2. Changes in prospective teachers' teaching-learning conceptions

The change in the teaching-learning concepts of the prospective teachers was examined as the previous teaching-learning conceptions and the current teaching-learning conceptions

Tablo 4 shows the participants' teaching-learning conceptions in the past.

Table 4. *Participants' teaching-learning conceptions in the past.*

	Previous Conceptions	Participants	f
Traditional approaches	Solving too many mathematical problems	P1,P2,P3,P4,P5,P6,P7,P8,P9,P10,P11,P12,P13,P14,P15,P16, P17,P18,P19,P20,P21,P22,P23,P24,P25,P26,P27,P28,P29,P30,P31,P32,P33,P34,P35,P36,P37,P38,P39,P40,P41,P42,P43,P44,P45,P46,P47,P48,P49,P50,P51,P52,P53,P54,P55,P56,P57, P58,P59,P60,P61,P62,P63,P64,P65,P66,P67,P68,P69,P70,P71,P72,P73,P74,P75,P76,P77,P78,P79,P80,P81	81
	Constantly revising the topics learnt	P6,P14,P22,P23,P24,P26,P27,P28,P29,P32,P33,P34,P38,P39, P43,P44,P45,P48,P49,P50,P56,P57,P60,P61,P62,P63,P65,P66,P68,P69,P70,P71,P72,P73,P75, P79	36
	Building the lesson on formulas and rules	P5,P10,P16,P17,P18,P19,P25,P29,P30,P31,P33,P35,P42,P44, P45,P49,P54,P55,P56,P57,P60,P61,P67,P68,P70,P75,P76,P77,P79,P80	30
	Teaching topics through lecturing	P1,P4,P6,P8,P10,P11,P12,P13,P26,P30,P31,P42,P50,P51,P58,P60,P80,P81	18
	Building the lesson on a book of multiple-choice questions	P3,P12,P16,P21,P23,P43,P44,P51,P52,P55	10
	Being able to learn mathematics by watching lecture videos	P7,P21,P27,P34	4
	Keeping the students active only in mathematical problem solving	P2,P12,P53	3
Constructivist approaches	Making the lesson fun	Ö23, Ö28, Ö31,Ö35	4
	Building the lesson on thinking and querying	Ö4,Ö68,Ö69	3
	Being well-rounded	Ö1,Ö55, Ö56	3

According to Table 4, the prospective teachers teaching-learning conceptions regarding the traditional approach respectively; solving too many mathematical problems (f=81), constantly revising the topics learnt (f=36), building the lesson on formulas and rules

(f=30), teaching topics through lecturing (f=18), building the lesson on a book of multiple-choice questions (f=10), being able to learn mathematics by watching lecture videos (f=4), and keeping the students active only in mathematical problem solving (f=3). The previous teaching-learning understandings of the prospective teachers regarding the constructivist learning approach are respectively to making the lesson fun (f=4), building the lesson on thinking (f=3) and querying and being well-rounded (f=3).

In relation with the most common previous conception, "solving too many mathematical problems", one participant had the following view:

"I used to have the idea of solving too many mathematical problems to be successful in maths class. I used to think that the more problems I solved, the better I would learn the topic. I also expected my teacher to solve too many mathematical problems in the lesson." (P2)

Under the second most common conception, "constantly revising the topics learnt", a participant's view was as following:

"Revision was very important. In order not to forget the topics (learnt). It was important not to forget the topics by revising and memorizing them." (P49)

Regarding "building the lesson on formulas and rules" as the third frequent previous conception, a participant said the following:

"I used to try to memorize all the formulas and rules. I used to think that the more formulas I knew, the more I could solve the (mathematical) problems." (P61)

As regards the next item, "teaching topics through lecturing", the view of a participant was as follows:

"Narrating the topics plainly. The teacher lectures, and the student listens. This is the way we were accustomed to." (P80)

Under "being able to learn mathematics by watching lecture videos", one respondent said the following:

"Actually, there are very well-made lesson videos. I used to think that one doesn't even need a teacher. Everything was clear and comprehensible in those videos. Of course, now I realized that there was always a tendency towards rote learning." (P27)

The next conception, "building the lesson on a book of multiple-choice questions", was implied by one of the participants as following:

"There is everything in books of multiple-choice questions. Synopsis of the topics. The bullet points. Formulas, rules… We used to learn the lessons from books of multiple-choice questions. The lectures in the form of synopsis highlight the critical points." (P51)

The least frequently mentioned conception was "keeping the students active only in mathematical problem solving", and it was exemplified by a respondent below:

"The teacher lectures in the lesson. And the student solves problems. I used to think that the student would come to the board only when it was time to solve a problem." (P12)'

Table 5 shows the participants' current teaching-learning conceptions.

Table 5. Participants' current teaching-learning conceptions

	Current Conceptions	Participants	f
Traditional approaches	Solving too many mathematical problems	Ö5,Ö6,Ö7, Ö38, Ö60	5
	Teaching topics through lecturing	Ö1,Ö35,Ö42, Ö43	4
Constructivist approaches	Giving communication an important place in lessons	P2,P3,P8,P15,P16,P18,P19,P23,P24,P27,P28,P34,P35,P36, P38,P39,P41,P44,P45,P47,P48,P49,P50,P52,P54,P55,P56, P57,P58,P60,P61,P62,P64,P65,P67,P68,P69,P71,P72,P77 P80,P81	42
	Making the lesson fun	P1,P2,P8,P9,P10,P11,P12,P13,P14,P15,P17,P22,P23,P25, P28,P29,P30,P31,P32,P33,P40,P41,P42,P47,P48,P50,P68, P70,P73,P80,P81	31
	Ensuring conceptual learning	P1,P2,P6,P8,P16,P20,P25,P29,P30,P32,P34,P35,P36,P39, P40,P41,P48,P53,P57,P61,P66,P67,P72,P76,P78,P80	26
	Helping students enjoy mathematics	P5,P11,P13,P20,P22,P23,P28,P33,P34,P35,P37,P38,P50,P 52,P56,P58,P61,P64,P67,P68,P74, P79,P81	23
	Being well-rounded	P1,P16,P17,P18,P21,P23,P32,P33,P34,P35, P44,P45,P51,P53,P55,P56,P60,P64,P66,P72,P76,P81	22
	Integrating technology and up-to-date information into lessons	P2,P7,P10,P12,P15,P16,P24,P27,P31,P39,P51,P57,P58, P59,P60,P62,P63,P64,P77,P80,P81	21
	Building the lesson on thinking and querying	P4,P5,P8,P14,P26,P31,P39,P40,P43,P44,P46,P49,P65,P68, P69,P73	16
	Giving students prominence in lessons	P2,P4,P6,P10,P11,P12,P14,P17,P22,P27,P31,P46,P68,P78	14
	Making connections with everyday life	P4,P10,P15,P16,P18,P19,P22,P26,P56,P57,P67,P70,P71	13
	Building the lesson on discovery	P7,P8,P18,P22,P28,P30,P50,P58,P59,P67,P79	12
	Using materials	P7,P9,P11,P12,P13,P39,P40,P43,P50,P55,P57,P71	12
	Considering individual differences	P9,P14,P20,P57,P63,P66,P67,P75	8
	Using the mathematical language effectively	P16,P18,P34,P54	4
	Arousing curiosity	P4,P5,P40,P73	4
	Using a simple and intelligible language	P6,P16,P75	3
	Making interdisciplinary connections	P29,P34	2
	Being knowledgeable about the curriculum	P1, P15	2

According to Table 5, the prospective teachers now possess a number of different conceptions of teaching and learning. They are listed below in a descending order of frequency: giving communication an important place in lessons (f=42), making the lesson

fun (f=31), ensuring conceptual learning (f=26), helping students enjoy mathematics (f=23), being well-rounded (f=22), integrating technology and up-to-date information into lessons (f=21), building the lesson on thinking and querying (f=16), giving students prominence in lessons (f=14), making connections with everyday life (f=13), building the lesson on discovery (f=12), using materials (f=12), considering individual differences (f=8), using the mathematical language effectively (f=4), arousing curiosity (f=4), using a simple and intelligible language (f=3), being knowledgeable about the curriculum (f=2), and making interdisciplinary connections (f=2). The prospective teachers teaching-learning conceptions regarding the traditional approach respectively; Solving too many mathematical problems (f=5), Teaching topics through lecturing (f=4).

Under the most frequent current conception, "giving communication an important place in lessons", one of the participants said the following:

"I think it is necessary to be a teacher who cares about student-related situations as much as lessons so that there will be success. In learning-teaching environments, the teacher should be a person who is open to new ideas, has no one right, and respects different views so that the student can relax." (P3)

Secondly, "making the lesson fun" was exemplified by one participant as following:

"The student should not be afraid of maths and should find it fun so that he has no prejudices. First of all, the lesson should be made fun." (P12)

Regarding the third common current conception, "ensuring conceptual learning", one participant said the following:

"It is very important to establish a good cause-effect relationship in the lessons. A student should induce. Many conclusions can be induced from the definition. Then why should we give the results right away?" (P34)

Concerning the conception of "helping students enjoy mathematics", a participant stated the following view:

"In order for teaching-learning to be complete, I think it should be first emphasized that maths is not a feared subject. Students should think that maths is not a feared lesson, but a loved one." (P23)

Concerning the conception of "being well-rounded", one participant stated the following thought:

"The teacher should trust himself. He should be an expert in his field, well-educated and transfer this mastery to students. I mean, having good subject knowledge is necessary for success above all." (P64)

Under the next item, "integrating technology and up-to-date information into lesson", a participant made the following remarks:

"The time must be kept up with. Being aware of up-to-date information and the development of technology, these situations should be integrated into the course. Technology is a very beautiful thing. We should not skip this." (P27)

Under "building the lesson on thinking and querying", one of the participants stated the following:

"We need to activate thinking and querying so that the knowledge is lasting. Transfer information straight ahead without query, then comes zero success. Being able to think is a skill and this skill should be transferred to students." (P49)

Concerning "giving students prominence in lessons", a participant had the following view:

"There should be a student-centered environment. In the foreground is the student, and the teacher is the one who sets the environment. The teacher is the guide." (P78)

For the next item, "making connections with everyday life", the following view was expressed by a participant:

"Instead of an environment that depicts and makes the maths lesson all based on numbers and formulas, there should be an environment that gives examples from maths in nature and is associated with daily life." (P22)

In relation with the conception of "building the lesson on discovery", one of the participants said:

"There shouldn't be memorization, neither should rote teaching or rote learning. Things should be discovered by students so that they can be lasting." (P59)

Regarding the conception of "using materials", a respondent stated:

"I learned how big the impact of using materials is. Why aren't they used? An abstract subject like maths is made concrete." (P11)

Another conception, "considering individual differences", was implied by a respondent as following:

"There are learning techniques. Differing from person to person. Not everyone learns in the same way. Some learn better by hearing, some by saying, some by doing. I think individual differences are very important in these teaching-learning matters. It should be taken into account." (P75)

About "using the mathematical language effectively", one of the respondents stated:

"Mathematical language is very important in teaching, I believe. Appropriate use of this language increases intelligibility. Therefore, it must be efficient and effective." (P18)

About the conception of "arousing curiosity", a participant said:

"The teacher should encourage students to think. He shouldn't think book knowledge is enough, he should make maths wondered about as a science. He should arouse curiosity." (P5)

As another conception, "using a simple and intelligible language" was referred to by a respondent as following:

"The language is very important. Okay, you're telling something, but can they be understood by the other side? We must track this. If the speech is not understood, if what you are saying is not resolved by the other side, then it is very difficult to teach and learn." (P6)

As one of the least frequent conceptions, "being knowledgeable about the curriculum" was referred to by a participant as following:

"There should be a learning environment that has full command of the curriculum, knows all of the topics in the best way, and presents these topics to the other side permanently." (P1)

The last conception mentioned by the participants, "making interdisciplinary connections", was implied by a respondent as follows:

"Maths is in every branch of science. Therefore, if maths is taught by establishing a relationship, learning becomes easier, do does teaching." (P34)

3.3. Factors causing the change in prospective teachers' teaching-learning conceptions

Table 6 shows the possible reasons for the change in the prospective teachers' teaching-learning conceptions.

Table 6. Change in the prospective teachers' teaching-learning conceptions.

Conceptions.	Participants	f
Instruction-dominated courses	P1,P2,P5,P6,P7,P8,P9,P10,P11,P12,P13,P14,P15,P16,P17,P18,P19,P20,P21,P22,P23,P24,P25,P26,P27,P28,P29,P30,P31,P32,P33,P34,P35,P39,P40,P41,P42,P43,P44,P45,P46,P47,P48,P49,P50,P53,P54,P55,P56,P57,P58,P59,P60,P61,P62,P63,P64,P65,P66,P67,P68,P69,P70,P71,P72,P73,P74,P75,P76,P79,P80,P81	72
Practicum	P1,P2,P3,P4,P5,P6,P7,P8,P9,P10,P11,P12,P13,P14,P15,P16,P17,P23,P25,P26,P27,P28,P30,P31,P32,P33,P34,P35,P36,P37,P38,P40,P41,P42,P43,P44,P46,P47,P48,P50,P51,P52,P53,P54,P55,P56,P57,P58,P59,P60,P62,P63,P64,P65,P66,P67,P68,P69,P70,P72,P73,P74,P75,P77,P78,P79,P80,P81	68
Instructors' teaching-learning understanding	P1,P4,P7,P8,P9,P10,P11,P12,P13,P14,P15,P16,P17,P21,P24,P27,P28,P29,P30,P32,P33,P37,P38,P40,P45,P46,P57,P59,P60,P71,P79	31
Technology-aided lessons	P7,P8,P16,P25,P60,P62,P63,P64,P77,P80,P81	11
Philosophy-integrated lessons	P3,P6,P20,P40	4

As it can be seen in Table 6, the prospective teachers explained the change that took place in their teaching-learning conceptions with instruction-dominated courses (f=72), practicum (f=68), instructors' teaching-learning understanding (f=31), technology-aided lessons (f=11), and philosophy-integrated lessons (f=4), respectively.

In relation with the most frequently mentioned factor, "instruction-dominated courses", a participant said:

"Instruction-oriented courses (teaching algebra, teaching probability, teaching geometry, teaching numbers) in our field broadened my horizons. I learned how to teach effectively, how to learn most effectively, thanks to the courses I took during university. In this way, I could learn the activity-intensive lectures in which the students are active." (P79)

The second prominent factor, "practicum", was referred to by one of the participants as following:

"During the practicum, we have seen how the courses we took at the university can be applied. We attended different classes. We took this course for two semesters. My practicum teacher at the school I attended in the first semester was a traditionalist. The one in the second semester was a constructivist. I was able to observe the difference clearly there." (P41)

As regards the next probable factor, "instructors' teaching-learning understanding", a respondent noted the following:

"Now we are studying at the university. Role models are very important. The models ahead also affect us. How the teacher introduces the lesson, how he winds it up. These are the points we follow as examples." (P57)

Under "technology-aided lessons", a respondent expressed their view as following:

"I figured out at the university that maths can be learned through technology. It's a super thing. How come this can't be used while teaching? During my education life, I have never seen a course benefiting from technology in high school." (P16)

The last item on the list, "philosophy-integrated lessons", was implied by a participant as follows:

"What is your perspective on maths in the first place? This question was shaped in my philosophy classes. Knowing the existing views and evaluating oneself greatly influenced my understanding." (P27)

4. Discussion and Suggestions

In this study, it was attempted to describe the teaching-learning conceptions of prospective primary school mathematics teachers at the 1st and 4th grades of undergraduate study, the changes in the conceptions of the 4th graders, and the probable reasons for such change.

According to this study, the prospective primary school mathematics teachers adopt the constructivist teaching-learning approach regardless of their grade level. However, it is worth noting that the behavioral tendency of the 1st graders declines while their constructivist tendency increases by the time they reach the 4th grade. Similarly, past research on teaching-learning conceptions reveals that the constructivist learning approach is dominant among teachers and prospective teachers (Aypay, 2011; Chai & Khine, 2008; Aydoğdu & Selanik-Ay, 2016; Aykan, 2014; Işıkoğlu, Baştürk & Karaca, 2009; Cheng, Chan, Tang & Cheng, 2009; Çiftçi, Sünbül, & Köksal, 2013; Saşıcı, 2013; Şahin & Yılmaz, 2011; Yanpar-Yelken, Üredi, Tanrıseven & Kılıç, 2010; Yalçınoğlu & Ersoy, 2012). Nevertheless, Baş and Beyhan (2013) found out that neither constructivist nor behavioral understanding of learning is prominent in the teacher candidates' mind. In a study conducted in China, Chan and Elliot (2004) also found that the teacher candidates do not particularly adopt either of the traditional or constructivist approach.

It is obvious that the traditional education conception of prospective teachers has been replaced by the constructivist conception in four years' time. As another remarkable result of this study, the 4th grade prospective teachers used to perceive teaching and learning as activities like solving too many mathematical problems, building the lesson on formulas and rules, constantly revising the topics learnt, teaching topics through lecturing, keeping the students active only in mathematical problem solving, and building the lesson on a book of multiple-choice questions, whereas they now have teaching and learning conceptions such as being well-rounded, being knowledgeable about the curriculum, ensuring conceptual learning, making the lesson fun, integrating technology and up-to-date information into lessons, giving communication an important place in lessons, giving students prominence in lessons, building the lesson on thinking and querying, arousing curiosity, making connections with everyday life, helping students enjoy mathematics, using a simple and intelligible language, building the lesson on discovery, using materials, considering individual differences, using the mathematical language effectively, and making interdisciplinary connections. To make it clearer, while the prospective teachers used to believe that teaching-learning can be done individually and is mostly based on memorization, they have gradually realized that conceptual learning should take place and that students should be active in the construction of knowledge under guidance. Also, the teacher candidates make a point of affective activities such as helping students enjoy mathematics, giving communication an important place in lessons, arousing curiosity, and making the lesson fun besides cognitive aspects of teaching and learning. It is an interesting result because affective factors matter considerably in learning (Koçkar, Kılıç, & Şener, 2002). Since students in education faculties are exposed to the behavioral learning approach before higher education, it looks inevitable for them to experience a change in their teaching-learning understanding once they start the university. In a similar vein, Aypay (2011) reported a

positive change in the teaching-learning conception of teacher candidates depending on the variable of grade level.

In this study, the participants at the 4th grade mostly attribute the change in their teaching-learning conception to the undergraduate courses they have taken. At university, each learning area is offered with specific courses on how to teach that learning area. In these courses, usually discussions are held on how to teach the topics, consensus is reached, and learning and teaching activities are carried out accordingly. It is seen that another strong factor affecting the prospective teachers' teaching-learning conception is the practicum they fulfill at primary schools. Practicum offers students of education faculties a formal opportunity to put their theoretical knowledge into practice, and the practicum is largely influenced by the leader teacher at the practicum school. Moreover, prospective teachers spend the most of their final year at practicum schools. In that setting, as put forward by the participants, prospective teachers are affected by the teaching-learning understanding of the instructors supervising their practicum. Spillane (1999) stated that the core of teachers' in-class practices is decided by their own thoughts and this effect is called teachers' zones of enactment. The knowledge, beliefs and philosophy of teachers shape their in-class practices and constitute the zones of enactment (Macnab, 2003). Another probable reason for the changing conception was reported to be the philosophy-integrated lessons by the participants. Likewise, in the study conducted by Baş (2015), there was a significant positive relationship between teachers' educational philosophy and their teaching-learning conception. Furthermore, it was acknowledged that educational philosophy is a significant predictor of teaching-learning conception. Modern educational principles suggest that even if teachers are willing to reconstruct themselves, their previous beliefs about the nature of knowledge, teaching and learning inevitably prevent them from employing new learning practices (Pecore, 2013). Lastly, according to the prospective teachers, technology-aided lessons account for their changing teaching-learning conception among other factors. A consistent conclusion was reached in the study conducted by Bağcı (2019) on prospective teachers. It is a known fact that the constructivist approach is embodied more easily in technology-supported learning environments (Özmen, 2004).

Undoubtedly, teaching is a specialist profession that requires continuous professional development. In other words, it is beyond question that all teachers need to constantly renew themselves. Therefore, teachers should attend professional meetings, seminars, courses, workshops, and similar organizations with the purpose of reconstructing themselves in teaching and learning approaches and also catching up with the new changes brought by the age. In addition to this, during teacher education, prospective teachers should be trained on teaching-learning conceptions and they should be given the chance to prepare and apply lesson plans in accordance with the conceptions. These lesson plans, which they apply especially in teaching practice courses, can be reviewed and their deficiencies can be completed. In addition, since it is effective in affective

factors and teaching-learning conceptions, activities can be organized to increase motivation for teachers from time to time. In this whole process, teachers and teacher candidates should not be left alone and should be supported by school administrations.

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