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Investigation of The Efficiency of the In-Service Training Course Designed for Algebra Teaching: An Experimental Research

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Abstract

The study aimed to examine the effect of the in-service training course designed for teaching algebra on the awareness of mathematics teachers about the nature of the transition from arithmetic to algebra and their material design self-efficacy beliefs. Within the scope of the study, a 30-hour in-service training course was designed for mathematics teachers, and the study examined the effectiveness of this in-service training course. In this context, the study was carried out using the experimental research method. The participants consisted of 36 mathematics teachers who volunteered to work in public schools in aprovince in the northeast of Türkiye in the 2021-2022 academic years. The study's experimental group consisted of 16 mathematics teachers who attended the algebra teaching in-service training course. In comparison, the control group consisted of 20 mathematics teachers who received no intervention. "Awareness Scale for the Nature of Transition from Arithmetic to Algebra" and "Material Design Self-Efficacy Belief Scale "were used to collect the data for the study. Descriptive and predictive statistics were used in the analysis of the data. The results showed that the designed in-service training course did not create significant mean difference between the experimental and control groups.

Keywords: Arithmetic, Algebra, Algebraic thinking, Teaching material, Teacher training.

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Ethics Declaration:

This study followed all the rules stated to be followed within the "Higher Education Institutions Scientific Research and Publication Ethics Directive" scope. None of the actions specified under the title of "Actions Contrary to Scientific Research and Publication Ethics," which is the second part of the directive, were not carried out.

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Cebir Öğretimine Yönelik Düzenlenen Hizmet İçi Eğitim Kursunun Verimliliğinin İncelenmesi: Deneysel Bir Araştırma

Öz

Araştırmanın amacı cebir öğretimine yönelik düzenlenen hizmet içi eğitim kursunun matematik öğretmenlerinin aritmetikten cebire geçişin doğası hakkındaki farkındalıklarına ve materyal tasarımı öz-yeterlik inançlarına etkisini incelemektir. Çalışma kapsamında matematik öğretmenlerine yönelik 30 saatlik bir hizmet içi eğitim kursu tasarlanmış olup, çalışmada bu hizmet içi eğitim kursunun etkililiği incelenmiştir. Bu bağlamda çalışma deneysel araştırma yöntemi kullanılarak gerçekleştirilmiştir. Katılımcılar, 2021-2022 eğitim-öğretim yılında Türkiye'nin kuzeydoğusundaki bir ildeki devlet okullarında gönüllü olarak görev yapan 36 matematik öğretmeninden oluşmuştur. Araştırmanın deney grubunu cebir öğretimi hizmet içi eğitim kursuna katılan 16 matematik öğretmeni oluşturmuştur. Karşılaştırıldığında, kontrol grubu hiçbir müdahale almayan 20 matematik öğretmeninden oluşuyordu. Araştırmanın verilerinin toplanmasında "Aritmetikten Cebire Geçişin Doğasına İlişkin Farkındalık Ölçeği" ve "Materyal Tasarımı Öz-Yeterlik İnancı Ölçeği" kullanılmıştır. Verilerin analizinde tanımlayıcı ve yordayıcı istatistiklerden yararlanılmıştır. Sonuçlar, tasarlanan hizmet içi eğitim kursunun deney ve kontrol grupları arasında anlamlı bir ortalama fark yaratmadığını gösterdi.

Anahtar Kelimeler: Aritmetik, cebir, cebirsel düşünme, öğretim materyali, öğretmen eğitimi.

Introduction

Mathematics education is of great importance in raising students towards determined goals. Because mathematics is one of these sential tools developed for one's thinking and understanding and one of the critical building blocks of primary education (Koçlar, 2019). According to the research, students form their ideas about algebra by structuring their experiences with arithmetic (Akkan et al., 2017). For this reason, students should have a good knowledge of arithmetic in order to be able to learn algebra well. This reason strongly links algebra and arithmetic (Kieran, 1992; Akkan, 2011).

The first step of a person learning mathematics is to learn arithmetic. They then begin to learn advanced mathematics. Arithmetic takes its roots from numbers and deals with arithmetic numbers themselves. According to Akkan (2009), arithmetic, the largest and most well-known branch of mathematics, includes four basic operations with numbers, all calculations based on these four operations, finding the unknown from the known, and the relationships between numbers. In other words, the first step of learning mathematics starts with arithmetic because to learn mathematics, you need to know arithmetic.

While the formation of arithmetic came from numbers, the formation of algebra was from arithmetic. While arithmetic takes roots from number concepts, algebra takes roots from arithmetic. This situation shows a reciprocal and robust relationship between arithmetic and algebra (Koçlar, 2019), and arithmetic and algebra cannot be considered separately. Students from the foundations of algebra by making generalizations with the given concepts (Carpenter & Levi, 2000).

The abstraction of the arithmetic concept, which includes operations such as operations with numbers, comparison, and counting, has influenced the birth of algebra (Gürbüz & Toprak, 2014). Algebra has emerged as a branch of mathematics that generalizes the relationship or relationships between the data by examining the data at hand with numbers and symbols and transforming them into equations (Öztürk, 2021). Algebra has its own rules that form the main language of mathematics (Çelik, 2007). Algebra has formed an essential field of mathematics, and in order to do algebra, it is necessary to do abstraction first (Yenilmez & Teke, 2008). Baki (2008) explained algebra by classifying it as setting equations, solving equations, generalizing, and working with functions. Thorpe (1999), on the other hand, stated that teaching algebra should be planned in a way that makes students understand the concepts and encourages them to think. In addition, Thor Peex plained the general purposes of algebra teaching as follows:

1. Algebra develops students' equation-solving skills.
2. Algebra enables students to use symbol to resolve properly real-life problems.
3. Algebra prepares students to follow and gain insight into physics and engineering subjects.
4. It enables them to be sufficient about algebraic relations.

Algebra and algebra-related achievements, which have an important place in mathematics teaching, appear in every aspect of our daily life, making it necessary to use algebraic knowledge effectively (Konak, 2009). Algebraic thinking develops with the subject of algebra. In other words, all developments in the field of algebra also impress algebraic thinking.

First, students must understand what algebraic sentences mean, why algebraic transformations remade, and the structural features of the relationships between mathematical operations (Öner, 2009). Teachers should give importance to algebra teaching and give students algebraic relations, operations, and relations between concepts by giving meaning to them.

It is accepted that the development of algebraic thinking begins with arithmetic thinking in preschool and primary school years (National Council of Teachers of Mathematics [NCTM], 2000). However, from preschool to 5th grade, students only deal with arithmetic operations. In the 6th grade, the transition to algebra, including symbols, begins (The Ministry of National Education [MoNE], 2018). The learning area of algebra, which is one of the five essential learning are as in the middle school mathematics curriculum, is between 6th and8th grades. By finding the pattern rule in the classroom program, expressing it with letters, and associating it with equations with two unknowns, in which one variable change depending on another variable, with generalizations, concepts are learned in a more meaning full way (MoNE, 2018).

Algebraic thinking is necessary in every field, from solving problems in daily life to solving problems indifferent disciplines (Türkoğlu, 2017). According to Kriegler (2008), algebraic thinking is a structure consisting of algebraic ideas, mathematical thinking, and the generalizations of arithmetic as a tool of functions and mathematical models.

According to Çelik (2007), algebraic thinking skills are made up of a repetitive pattern of three actions by making generalizations with real life by making sense of algebraic expressions. These patterns are using algebra in relations and symbols, benefiting from multiple representations such as figures, tables, and graphics and expressing generalizations with formulas.

A project called "Concepts in Secondary Mathematics and Science" examined the students' understanding levels of algebraic expressions in four stages (Çağdaşer, 2008). These stages are given below in order.

1. Level 1: It is the level at which questions such as finding the value of a letter as a result of arithmetic operations, solving a problem by taking the letters as the name of an object, or concluding this operation without giving value to these letters although there are letters in them, can be solved.
2. Level 2: It is the same as the first level in terms of abstraction, and the questions are more complex at this level.
3. Level 3: Letters are used and interpreted as an unknown at this level.
4. Level 4: Unlike the third level, student's cans on clued these operations by making sense of more complex expressions at this stage.

Algebra education is critical to develop students' algebraic thinking and not to create misconceptions about algebra. For this reason, it will be challenging for students who have just moved from the substantial period to the abstract period to understand an abstract subject such as algebra without memorizing it. According to Ainsworth (2006), using different teaching techniques and strategies in teaching mathematical expression is necessary for teaching mathematical concepts and methods. This situation has led us to different teaching methods in the teaching of mathematics lessons and concrete materials in mathematics education. For students to achieve permanent learning, teachers should prepare environments where they can realize their learning by visualizing abstract topics to establish meaning full relationships between concepts and learn more information in less time (Şahin, 2012). Since concrete materials appeal to more than one sense of the student, they will affect the effective and meaningful learning of the students. In algebra teaching, materials, and virtual learning objects should increase active participation in the course and provide better learning (Karakaş & Bahadır, 2018). Studies have shown that concrete materials (Şahin, 2012; Turan, 2013) and virtual learning objects (Öztürk, et al., 2016) are successful in teaching mathematics in general and algebra in particular. Instead of pushing the students to memorize the information by giving them abstract algebra knowledge directly, teachers should give the information to students by understanding them with the help of concrete objects and virtual learning objects and even by allowing them to discover it themselves. For these reasons, teachers' use of materials is vital in teaching algebra. Akkan (2016) mentioned the necessity of using materials by stating that students would achieve better learning by appealing to various sensory organs with pictorial representations and concrete materials that would participate in algebra teaching.

It is essential to investigate the level of self-efficacy beliefs of teachers in preparing material and using the prepared material effectively. Bandura (1997) defines self-efficacy as an individual's belief in himself/herself that he/she can plan activities on any subject and conclude them successfully. In other words, it is the individual's thoughts about himself/herself. The higher the individual's self-efficacy belief regarding a subject, the higher the belief he/she has to overcome the difficulties he/she faces. The lower the individual's self-efficacy belief, the lower the belief he/she has to overcome the difficulties he/she faces (Avcı, 2019).

Self-efficacy belief has many effects on education (Ertekin & Dilmaç, 2021). One of them is teacher self-efficacy. Teacher self-efficacy is the teacher's belief in teaching the knowledge (Schunk, 2012). In other words, teacher self-efficacy is the belief in organizing and realizing educational activities that are effective and needed for successful teaching (Avcı,2019). Teachers' self-efficacy in teaching algebra can be explained as the teacher's self-belief in preparing concrete material on the subject of algebra and incorporating the concrete material he/she has prepared into teaching. The higher the teacher's self-efficacy in teaching algebra, the more successful he/she is expected to be in teaching algebra because the teacher's high self-efficacy in teaching algebra will contribute to the teacher's effort on not giving up easily and to produce alternative teaching methods, in this context, for students to be successful in algebra, their teachers should have high self-efficacy in algebra.

This research aims to provide an answer to the "Does the in-service training course designed for teaching algebra affect the awareness of mathematics teachers about the nature of the transition from arithmetic to algebra and their material design self-efficacy beliefs?" problem and the following questions:

1. Does the in-service training course designed for algebra teaching significantly affect mathematics teachers' perceptions of material design self-efficacy?
2. Does the in-service training course designed for teaching algebra significantly affect mathematics teachers' awareness of the nature of the transition from arithmetic to algebra?

Method

Research Model

An experimental research model, one of the quantitative research designs, was used in this study. Experimental research models are conducted to test the cause-effect relationship between variables (Büyüköztürk, 2018). This research design, after creating the experimental and control groups, including both groups in the research and processing the experimental group, is a method in which the two groups are compared again (Ekiz, 2015). This study's design was preferred since it aimed to compare the group that received and did not receive in-service training for teaching algebra.

Participants

The participants were formed according to purposive sampling method, which is one of the non-random sampling types. Mathematics teachers who volunteered to work in public schools in province in the northeast of Türkiye in the 2021-2022 academic year voluntarily participated in the study. The experimental group of the research consisted of 16 mathematics teachers who volunteered to participate in the in-service training course for teaching algebra, and the control group consisted of 20 mathematics teachers who could not attend the training.

Instruments

Quantitative data to be obtained within the scope of this study were collected with the "Personal Information Form," "Material Design Self-Efficacy Belief Scale," and "Awareness Scale for the Nature of Transition from Arithmetic to Algebra."

Personal Information Form

The researcher prepared this form. Information about the participants' gender, seniority, age, education level, region of employment, and whether they had participated in such a study before were collected.

Material Design Self-Efficacy Belief Scale

The material design self-efficacy belief scale developed by Bakaç and Özen (2015) for pre-service teachers was used to examine the material design self-efficacy perceptions of mathematics teachers. Scale consists of three sub-dimensions: "Preparing material on the computer", "Preparing three-dimensional material", and "Preparing a two-dimensional material.". The validity coefficient of all the items on the scale is. 814, which is greater than .6 and is significant. So it is valid for doing factor analysis. While the Cronbach Alpha internal consistency coefficient for the total scale was .92, Cronbach Alpha values for the sub-dimensions were calculated for material preparations .89, three-dimensional material preparations .82, and two-dimensional material preparations .79, respectively. A Cronbach Alpha value of .70 and above in scientific studies shows that the scale is reliable (Şencan, 2005). Accordingly, the results showed that the scale was reliable for the whole scale and its sub-dimensions.

Awareness Scale for The Nature of Transition from Arithmetic to Algebra

To determine the awareness of mathematics teachers about the nature of the transition from arithmetic to algebra, the "Awareness Scale for the Nature of Transition from Arithmetic to Algebra" developed by Polat et al. (2023) was used. Researchers determined that the scale consisted of eight items and two dimensions. The smallest item factor load value in the scale was calculated as .47. The first dimension of the scale is called the differences between arithmetic and algebra, and the second is the relationship between arithmetic and algebra. The total variance rate explained by the scale was determined as 50%. As result of the reliability analysis, the Cronbach Alpha internal consistency coefficient was calculated as .72. Two examples of items in the scale are as follows: "I see arithmetic as a subset of algebra." and "While arithmetic deals with numbers, algebra deals with unknowns."

Data Collection Process

To collect the data of the study before starting the study, the material design self-efficacy belief scale and the awareness scale about the nature of the transition from arithmetic to algebra were applied to the participating teachers before the in-service training course. Thus, pretest data were collected from the experimental and control groups. Then, the experimental process was started with in the scope of the in-service training program for the experimental group teachers. In this process, the mathematics teachers who participated in the study were taken to the in-service training course: "The effect of the in-service training course designed for teaching algebra on material design and the perception of the nature of the transition from arithmetic to algebra". The control group followed no treatment. Then, after this in-service training course was given to the experimental group, the data were collected applying the post-test data collection tools to the experimental and control groups again.

On the first day of the course, material preparation activities were held regarding the problems that may be encountered in daily life related to algebra. On the first day of the event, a six-hour program was organized. In the first of these programs, "Finding a result by choosing five random numbers and performing four operations with these numbers", "There is as pare storage in the shape of a cube inside a cube-shaped storage. What is the volume of the constantly used part of this warehouse?", " Complete the square by adding 1 $(x+1)^2$ to any length (x) and find its area" and "Subtract 1 $(x-1)^2$ from any length (x) and complete the square and find its area" activities were carried out.

A six-hour program was organized on the second day of the course. These programs were "regular four-sided, regular eight-sided, regular dodecahedron open and closed", "magic squares", "Getting a triangle with Pythagorean relation", "Prime numbers", and "Creating a pattern by painting visible faces of a given figure".

On the third day of the course, a six-hour program was organized. In these programs, the researchers explained how one should attend the "Research and Inquiry-Based Approach" modeling mathematics lessons. The researchers explained with examples of how the "Argumentation-Based Science Learning" approach should be included in algebra teaching. Moreover, the activity "Studies on real-life applications of algebra" washeld.

A six-hour program was organized on the fourth day of this course. This day included the following activities: "What is mathematical modeling and how is it done?" and "Five basic steps of mathematical modeling". Modeling activities were carried out in algebra teaching.

On the fifth day of this course, a six-hour program was organized. In the first program, the researchers analyzed the algebra topics in LGS. The researchers mentioned where the questions mostly came from, what level of questions came from, which process steps, and the students needed to be more successful. Furthermore, the researchers stated where students made misconceptions. In the study, in which more analyzes were made, in order to increase success, it was mentioned what teachers should pay attention to and how the objectives should be given. In the second program, the researchers taught the use of the "Geogebra" program, and the quadrilaterals were drawn by making equations to make drawings with the "Geogebra" program. In the third program, the researchers showed some daily life examples for the transition from arithmetic to algebra. In addition, a pattern-making activity was carried out by showing the towers of Hanoi.

Data Analysis

In the analysis of the data obtained in study, descriptive and predictive statistics were used to achieve the objectives. In order to achieve the objectives, descriptive statistics were first applied. Thus, the suitability of the data for analysis was evaluated and the researchers checked whether the data showed a normal distribution. The data showed normal distribution. With descriptive statistics, the awareness of mathematics teachers about material design and the nature of the transition from arithmetic to algebra was determined. Central tendency and distribution measures were used in descriptive statistics.

For predictive statistics, the pre-test scores of the groups were controlled, and their post-test scores were compared. For this, analysis of covariance (ANCOVA) was used. ANCOVA is used in cases where the number of variables in the study is high and is used to measure the changes in the dependent variable due to the interactions of the dependent Variations in the dependent variables due to the interaction of the dependent variables. Büyüköztürk (2018) stated that the reason for using this method was that it should be used to eliminate the effect of any variable in the study on the study and stated that it was used to measure the difference between the pre-test and post-tests of the experimental group and control group.

The Reliability Analysis for material design self-efficacy and awareness of the nature of the transition from arithmetic to algebra in the study is presented in Table 1.

Table 1.

Table of reliability analysis for material design self-efficacy and awareness of the nature of the transition from arithmetic to algebra

Experiment			Control	
	Pre-test	post-test	Pre-test	post-test
Material Design Self-Efficacy Perception	.846	.855	.962	.934
Awareness of the Nature of the Transition from Arithmetic to Algebra	.624	.641	.539	.694

When Table 1 is examined, there liability values of both material design self-efficacy scores and awareness scores about the nature of the transition from arithmetic to algebra were appropriate.

The histogram graph for normality values showed that the skewness in the ∓1 for the material design experimental group pre-test graph was 0.648, kurtosis was 0.464, meaning that the data showed normal distribution because it was in the range. The skewness (0.355) and kurtosis (-0.988) values were in the range of ∓1 for the post-test graph. For this reason, the post-test data of the experimental group collected for material design showed a normal distribution.

From the pre-test data of the control group collected for material design in the study, skewness (-0.838) and kurtosis (-0.444) were in the range of ∓1. For this reason, the pre-test data of the control group collected for material design showed normal distribution. When the normality analys is of the control group post-test data is examined, the skewness (-0.245) and kurtosis (-0.688) values were in the range of ∓1. Therefore, the control group post-test data collected for material design showed a normal distribution.

Data regarding the self-efficacy scores for material design met the normal distribution conditions. In the study, ANCOVA analysis was used to check whether there was a mean difference between the post-tests controlling the pre-tests.

First assumption of the covariance analysis is that the data should be normally distributed (Shavleson, 1988). The data met the normal distribution conditions. Another assumption for ANCOVA is the homogeneity of variances (Shavleson, 1988, p. 558). The homogeneity of the variances was tested, and it was determined that ($F1,34 = 3.976$, $p > .05$) the variances were homogeneously distributed. Another of the assumptions of ANCOVA is the homogeneity of their gression slopes (Shavleson, 1988, p. 559). The analysis found that the regression slopes were homogeneous ($F1,32= 2.166$, $p > .05$). Since all assumptions were met, ANCOVA was conducted to examine whether the intervention applied affected material design self-efficacy perception scores.

When the awareness scores for the transition from arithmetic to algebra are examined, all of the data met the normal distribution conditions. In the study, the covariance (ANCOVA) analysis was used to check whether there was a mean difference between the post-tests by controlling the pre-tests. The first of the assumptions of the covariance analysis is to provide the normality assumptions of the data (Shavleson, 1988, p. 558). The data meet the normal distribution conditions. Another assumption for ANCOVA is the homogeneity of variances (Shavleson, 1988). The homogeneity of the variances was tested, and it was determined that the variances were homogeneously distributed ($F1,34 = 0.140$, $p> .05$). Another assumption is the homogeneity of the regression slopes (Shavleson, 1988, p .559). In the analysis, the regression slopes were homogeneous ($F1{,}32 = 0.826$, $p > .05$). Since all assumptions were met, ANCOVA was conducted to examine whether the intervention applied had an effect on the awareness scores for the transition from arithmetic to algebra.

Results

Findings Regarding the Effect of In-Service Training Courses on Mathematics Teachers' Perceptions of Material Design Self-Efficacy

The findings regarding the ANCOVA analysis on whether the post-test scores differed when the pre-test scores were controlled are given in Table 2.

Table 2.
Findings of material design post-test analysis of covariance

	Experiment			Control		
	N	M	SE	N	M	SE
Pre-test	16	98.25	8.76	20	103.90	12.10
Adjusted Post-test	16	104.22	2.61	20	102.62	2.32

When Table 2 was examined, it was determined that the material design post-test scores did not differ significantly when the pre-tests were controlled ($F1{,}33$=.20, p>.05).

The in-service training course designed for algebra teaching did not significantly affect the mathematics teachers' material design self-efficacy perceptions.

Findings Regarding the Effect of In-Service Training Courses on Mathematics Teachers' Perceptions of Computer Material Design Self-Efficacy

The ANCOVA analysis findings on whether the post-test scores differed when the pre-test scores were controlled are presented in Table 3.

Table 3.
Findings of covariance analysis of self-efficacy in material design in computer

	Experiment			Control		
	N	M	SE	N	M	SE
Pre-test	16	45.06	1.04	20	46.88	1.82
Adjusted Post-test	16	45.41	1.27	20	46.92	1.13

When Table 3 was examined, it was determined that the material design post-test scores did not differ significantly when the pre-tests were controlled ($F1{,}33 = .77$, $p > .05$). In other words, when the material design self-efficacy perception on the computer material design pre-test scores of the experimental and control group were controlled, it was seen that the post-test scores of the material design self-efficacy perception on computer did not differ significantly.

Findings on the Effect of In-Service Training Course on Mathematics Teachers' Perceptions of Three-Dimensional Material Design Self-Efficacy

The ANCOVA analysis findings regarding whether the post-test scores differed when the pre-test scores were controlled are presented in Table 4.

Table 4.
Three-dimensional material design self-efficacy perception findings of covariance analysis

	Experiment			Control		
	N	M	SE	N	M	SE
Pre-test	16	24.63	.97	20	27.94	1.11
Adjusted Post-test	16	27.38	1.18	20	25.34	1.08

When Table 4 was examined, it was determined that the material design post-test scores did not differ significantly when the pre-tests were taken under control ($F1,33 = 1.523$, $p > .05$). In other words, when the three-dimensional material design self-efficacy perception pre-test scores of the experimental and control group were controlled, it was observed that the three-dimensional material design self-efficacy perception post-test scores did not differ significantly.

Findings Regarding the Effect of In-Service Training Course on Mathematics Teachers' Perceptions of Two-Dimensional Material Design Self-Efficacy

The ANCOVA analysis findings on whether the post-test scores differed when the pre-test scores were controlled are presented inTable5.

Table 5.
Findings of two-dimensional material design self-efficacy perception covariance analysis

	Experiment			Control		
	N	M	SE	N	M	SE
pre-test	16	24.50	.59	20	25.31	1.19
Adjusted Post-test	16	25.80	.66	20	24.81	.59

When Table 5 was examined, the material design post-test scores did not differ significantly when the pre-tests were taken under control ($F1,33 = 1.253$, $p > .05$). When the two-dimensional material design self-efficacy pre-test scores of the experimental and control group were controlled, it was seen that the two-dimensional material design self-efficacy perception post-test scores did not differ significantly.

The Effect of Awareness of the In-Service Training Course on the Transition of Mathematics Teachers from Arithmetic to Algebra

The ANCOVA analysis findings on whether the post-test scores differed or not when the pre-test scores were controlled are presented in Table 6.

Table 6.
Findings of awareness score covariance analysis for transition from arithmetic to algebra

	Experiment			Control		
	N	M	SE	N	M	SE
pre-test	16	30.13	1.12	20	32.63	.95
Adjusted Post-test	16	30.93	1.042	20	33.16	.93

When Table 6 was examined, the awareness post-test scores for the transition from arithmetic to algebra did not differ significantly when the pre-tests were controlled ($F1,33 = 2.466$, $p > .05$). In other words, the in-service training course designed for algebra teaching did not have a significant effect on the awareness of mathematics teachers about the nature of the transition from arithmetic to algebra.

The Effect of Awareness of the In-Service Training Course on the Relationship of Mathematics Teachers with Arithmetic and Algebra

The ANCOVA analysis findings on whether the post-test scores differed when the pre-test scores were controlled are presented in Table 7.

Table 7.
Findings of covariance analysis for arithmetic and algebra relationship

	Experiment			Control		
	N	M	SE	N	M	SE
pre-test	16	11.63	.56	20	12.71	.52
Adjusted Post-test	16	11.82	.62	20	11.99	.57

When Table 7 is examined, the awareness post-test scores for the relationship between arithmetic and algebra did not differ significantly when the pre-tests were taken under control (F1,33= .041, $p > .05$). In other words, when the awareness pre-test scores of the participants in the experimental and control groups regarding the relationship between arithmetic and algebra were checked, it was seen that the participants' post-test scores on awareness about the relationship between arithmetic and algebra did not differ significantly.

Findings on the Effect of In-Service Training Courses on Mathematics Teachers' Awareness of the Differences Between Arithmetic and Algebra

The ANCOVA analysis findings on whether the post-test scores differed when the pre-test scores were controlled represented in Table 8.

Table 8.
Findings of covariance analysis on the differences of arithmetic and algebra

	Experiment			Control		
	N	M	SE	N	M	SE
pre-test	16	18.50	.68	20	19.67	.63
Adjusted Post-test	16	19.29	.70	20	21.18	.64

When Table 8 is examined, the awareness post-test scores for the transition from arithmetic to algebra did not differ significantly when the pre-tests were taken under control (F1,33= 3.891, $p > .05$). In other words, when the awareness pre-test scores of the participants in the experimental and control groups about the nature of the transition from arithmetic to algebra were controlled, it was seen that the awareness post-test scores about the nature of the transition from arithmetic to algebra did not differ significantly.

Conclusion and Discussion

The study aimed to examine the effect of in-service training course on teaching algebra on the perception of material design and the nature of the transition from arithmetic to algebra. The most important result of the study was that the in-service training course designed for algebra teaching did not significantly affect the mathematics teachers' awareness about the transition from arithmetic to algebra and their perceptions of material design self-efficacy. This result constitutes one of the original results of the study. It coincides with the results of the study of Görgün and Eken (2020), in which the effect of Hands-on Activities on success was examined. Çelik (2007) examined the algebraic thinking skills of pre-service teachers and concluded that pre-service teachers' algebraic thinking skills were similar. This situation supports the absence of a significant difference in teachers' awareness of the transition from arithmetic to algebra in our study. The results of the study determined that there was a negative relationship between teacher candidates' self-efficacy against using materials and their use of materials. This situation is similar to the results of the study conducted by İskenderoğlu et al. (2016), in which their self-efficacy for recognizing and using concrete materials was examined. Bakaç and Özen (2015) stated in their study that they examined teachers' material design self-efficacy and that teachers' self-efficacy towards material design did not have significant effect. These results are in parallel with our results.

The results obtained in the study showed that when the pre-test scores of the experiment and control groups were controlled, there was no significant mean difference between the awareness scores of the nature of the transition from arithmetic to algebra. When the scores for the between arithmetic and algebra were examined, there was no significant mean difference relationship between the experiment and control groups. According to the results obtained by Çekirdekçi and Toptaş (2011) from the opinions of the classroom teachers about the rates of using materials in mathematics lessons, the rates of using materials did not differ according to the ages and seniority of the teachers. This situation appears to be similar to our results. Charitaki et al. (2022) stated, who looked at the impact of teachers' demographic characteristics on their opinions with the analysis carried out with parametric and non-parametric controls which were based on the age of the teachers, their field of expertise and whether there was a situation that would affect the environment, that there was no significant effect in the study. This situation appears to be parallel to our study.

According to the results obtained from the analysis made in this study, the in-service training course designed for teaching algebra did not have a good effect on the perception of mathematics teachers about the nature of the transition from arithmetic to algebra and on designing materials. As the reason for this, some planned events could not be held due to the pandemic. The teachers who would participate in the study due to the pandemic were also affected; therefore, the sample was affected. In addition, the change in the time of the in-service training course due to the pandemic and the official disruptions caused by this wholly affected both the teachers who would participate in the study, the teachers who would provide training, and the activities to be done. In addition, it is used as a reason why research conducted outside of these reasons does not yield the desired results. Vogiatzi et al. (2022) argued that teachers' competence and individual capacity to maintain motivation, as well as the teacher's feelings, attitudes and concerns, were also effective. In order to maintain motivation, it should be used in obtaining social support and developing teacher training programs (Vogiatzi et al., 2022).

Suggestions

The experimental research model, one of the quantitative research models, was used in the study, and only quantitative data were obtained. For this reason, the reasons why there was no significant mean difference between the teachers who participated in the in-service training course and the teachers who did not participate in the in-service training course could not be explained. Future researchers can make more in-depth evaluations of the in-service training course using mixed research methods to evaluate in-service training courses design for teaching algebra.

The results obtained in the research show that the designed in-service training course does not give effective results. There could be many reasons for this situation. In this context, organizing the in-service training course should be planned in line with the expectations and needs of teachers.

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Genişletilmiş Özet

Giriş

Öğretim materyallerinin öğrenci başarısına etkisi düşünülürse öğretmenlerin materyal hazırlama ve hazırlanan materyali etkili kullanma konusunda özyeterlik inançlarının ne düzeyde olduğunu araştırmak önemlidir. Bandura (1997) özyeterliği bireyin herhangi bir konuda etkinlikleri planlayarak başarılı bir şekilde sonuçlandırabilmesine yönelik kendine olan inancı şeklinde tanımlamıştır. Başka bir ifadeyle bireyin kendisi hakkındaki düşünceleridir. Bireyin bir konu ile ilgili olarak özyeterlik inancı ne kadar yüksek olursa, karşılaştığı zorlukları aşmak için sahip olduğu inancı da o derecede yüksek olur. Bireyin özyeterlik inancı ne kadar düşük olursa karşılaştığı zorlukları aşmak için sahip olduğu inancı da o derece düşük olur (Avcı, 2019).

Özyeterlik inancının eğitime bir çok etkisi vardır (Ertekin, & Dilmaç, 2021). Bunlardan birisi de öğretmen özyeterliğidir. Öğretmen özyeterliği, öğretmenin bir konuda sahip olduğu bilgileri öğretmeye yönelik inancıdır (Schunk, 2012). Başka bir deyişle öğretmen özyeterliği, başarılı bir öğretim için etkili olan ve ihtiyaç duyulan eğitim etkinliklerini organize ederek gerçekleştirmeye olan inancıdır (Avcı, 2019). Öğretmenlerin cebir öğretimi özyeterliği ise öğretmenin cebir konusuna ait somut materyal hazırlamada ve hazırladığı somut materyali öğretime katmada kendine olan inancı olarak açıklanabilir. Öğretmenin cebir öğretimi özyeterliği ne kadar yüksek olursa cebir öğretimide o denli başarılı olması beklenir. Çünkü öğretmenin cebir öğretimi özyeterliğinin yüksek olması öğretmenin kolay yılmamasını daha fazla çaba göstermesini ve öğretim için alternatif yöntemler üretilmesine katkı sağlayacaktır. Bu bağlamda öğrencilerin cebir konularında başarılı olması için öncelikle öğretmelerinince bir konusunda özyeterliklerinin yüksek olması gerektiği söylenebilir.

Bu araştırmada "Cebir öğretimine yönelik tasarlanan hizmetiçi eğitim kursunun, matematik öğretmenlerinin aritmetikten cebire geçişin doğasına yönelik farkındalıkları ve materiyal tasarımı özyeterlik inançlarına bir etkisi var mıdır?" problemine yanıt aranmıştır.

1. Cebir öğretimine yönelik tasarlanan hizmetiçi eğitim kursunun matematik öğretmenlerinin materyal tasarımı özyeterlik algıları üzerinde anlamlı etkisi var mıdır?
2. Cebir öğretimine yönelik tasarlanan hizmetiçi eğitim kursunun matematik öğretmenlerinin aritmetikten cebire geçişin doğasına yönelik farkındalıkları üzerinde anlamlı etkisi var mıdır?

Yöntem

Bu çalışmada nicel araştırma yöntemlerinden deneysel araştırma deseni kullanılmıştır. Yapılan çalışma deneysel araştırma türlerinden çok denekli desenler araştırmasıdır. Ve çok denekli deneysel araştırmalardan da gerçek deneysel desen araştırmasıdır. Gerçek deneysel araştırmalar içinden ise öntest-sontest kontrol gruplu seçkisiz desen çalışmasıdır. Yapılan deneysel çalışmanın yapılış süreci aşağıdaki şekil 1'de gösterilmiştir.

Araştırmanın çalışma grubu seçkisiz olmayan örnekleme çeşitlerinden amaçsal örnekleme yöntemine göre oluşturulmuştur. 2021-2022 eğitim öğretim döneminde Türkiye'nin kuzey doğusundaki bir ilde görev yapan gönüllü olarak çalışmaya katılan matematik öğretmenleri oluşturmuştur. Araştırmanın deney grubunu cebir öğretimine yönelik hizmetiçi eğitim kursuna katılmaya gönüllü olan 16 matematik öğretmeni ve kontrol grubunu ise eğitimlere katılamayan 20 matematik öğretmeni oluşturmuştur.

Bu çalışma kapsamında elde edilecek nicel veriler "Kişisel Bilgi Formu", "Materyal Tasarımı

Özyeterlik İnancı Ölçeği" ve "Aritmetikten Cebire Geçişin Doğasına Yönelik Farkındalık Ölçeği" ile toplanmıştır. Çalışmada elde edilen verilerin analizinde hedefleri gerçekleştirebilmek için betimsel ve kestirimsel istatistikten yararlanılmıştır. Hedefleri gerçekleştirmek için ilk olarak toplanan verilere betimsel istatistik yapılmıştır. Böylece verilerin analizi için uygunluğu değerlendirilmiş ve normal dağılım gösterip göstermediğine bakılmıştır. Yapılan analizler sonucunda elde edilen veriler normal dağılım gösterdiği görülmüştür. Betimsel istatistik ile matematik öğretmenlerinin materyal tasarımı ve aritmetikten cebire geçişin doğasına ilişkin farkındalıkları belirlenmiştir. Betimsel istatistikte merkezi eğilim ve dağılım ölçülerinden yararlanılmıştır. Kestirimsel istatistik için grupların öntest puanları kontrol altına alınarak sontest puanları karşılaştırılmıştır. Bunun için kovaryans analizi (ANCOVA) kullanılmıştır.

Sonuç ve Tartışma

Cebir öğretimine yönelik tasarlanan hizmetiçi eğitim kursunun, materyal tasarlamaya ve aritmetikten cebire geçişin doğasına yönelik algıya etkisini incelemek için yapılan çalışmada matematik öğretmenlerinin öntest–sontest sonuçlarına göre elde edilen sonuçlar bulgulara gore değerlendirilmiştir. Yapılan çalışmada ulaşılan en önemli sonucu cebir öğretimine yönelik tasarlanan hizmetiçi eğitim kursunun matematik öğretmenlerinin aritmetikten cebire geçişe yönelik farkındalıkları ve materyal tasarımı özyeterlik algıları üzerinde anlamlı etki oluşturmadığıdır.