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Araştırma Makalesi ● Research Article

İlköğretim Matematik Öğretmen Adaylarının Analiz-I Dersinden Aldıkları Puanların Güncellenen Programa Göre İncelenmesi: Türev Kavramı Örneklemesi

An Examination of Primary School Mathematics Pre-Service Teachers' Scores in Calculus-I Course According to the Updated Curriculum: The Case of Derivative Concept

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Öz: Bu araştırmanın amacı ilköğretim matematik öğretmenliği lisans programında yer alan Analiz-I dersi geçme puanlarının eski programda ve 2018 yılında güncellenen yeni programa göre değişiminin incelenmesidir. Araştırmada var olan farkların karşılaştırılması amaçlandığı için nicel araştırma desenlerinden nedensel karşılaştırma türünde bir araştırmadır. Araştırmanın çalışma grubunu Eğe bölgesindeki bir devlet üniversitesinde öğrenim görmekte olan 212 ilköğretim matematik öğretmenliği öğrencisi oluşturmaktadır. Araştırma kapsamındaki veriler eski programa göre (2016-2017 güz ve 2017-2018 güz) ve yeni programa göre (2018-2019 güz ve 2019-2020 güz) öğrenim gören öğrencilerin Analiz-I dersi vize ve final sınavlarından elde edilmiştir. Tüm dönemlerde dersler tek bir öğretim elemanı tarafından yürütülmüş olup, sorumlu öğretim elemanı ile ders hakkında görüşme yapılmıştır. Çalışmada üniversite yerleşme puanının etkisi sabit tutulduğunda, Analiz-I dersi geçme puanlarının eski ve yeni programa göre farklılaşıp farklılaşmadığı parametrik olmayan kovaryans analizi ile incelenmiştir. Çalışma sonucunda ilköğretim matematik öğretmen adaylarının yeni ve eski programa göre üniversite yerleşme puanlarının ortalamasının birbirine çok yakın olduğu, ancak Analiz-I dersini geçme puanlarının ortalamasının eski programda yeni programa göre istatistiksel olarak daha yüksek olduğu bulunmuştur. Bu durumun sebeplerinden birinin de yeni programda Analiz-I dersi ders saatinin azaltılması olduğu düşünülmektedir.

Anahtar Kelimeler: Analiz-I, İlköğretim Matematik Öğretmenliği Programı, Türev

Abstract: This study aims to examine the change in pre-service teachers' Calculus-I course passing scores in the undergraduate curriculum of primary school mathematics teaching program through comparing the previous curriculum and the new curriculum updated in 2018. This study is a causal comparison study, as it aims to compare the existing differences. The study group of the research consists of 212 pre-service teachers in primary school

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mathematics education department at a state university in the Aegean region, Turkey. The data within the scope of the research were obtained from the Calculus-I course midterm and final exams of the pre-service teachers in the previous curriculum (2016-2017 fall and 2017-2018 fall) and in the updated curriculum (2018-2019 fall and 2019-2020 fall). The courses were taught by a single instructor in all semesters, and an interview was conducted with the responsible instructor about the course. In the study, when the effect of the university placement score was held constant, whether the Calculus-I course passing scores differed according to the previous and updated curricula was examined by nonparametric covariance analysis. The study revealed that the average of the university placement scores of the pre-service teachers in the previous and updated curricula was very close to each other, but the average scores of passing the Calculus-I course were statistically higher in the previous curriculum than in the updated one. The main reason for this is thought to be the reduction of the Calculus-I course hours in the new curriculum.

Keywords: Calculus-I, Elementary School Mathematics Teacher Education Curriculum, Derivate

Introduction

"There is nothing more practical than a good theory," said Kurt Lewin, a well-known social scientist (Lewin, 1951, p.169). Based on his statement, we can argue that a good theory can shed light on some situations that could actually be complex (Bingölbali, Arslan & Zembat, 2016). However, according to Poincarê (1908), making a good theory practical is only possible by fully understanding the learners. That leads us to the fact that more qualitative facts about the subject under investigation can be reached in a study that is viewed with a strong theory and that seeks to understand learners.

One of the essential learning areas of mathematics in higher education is analysis. It is crucial to understand and interpret the changes in this learning area, and make predictions for the future (Çetinkaya, Erbaş & Alacacı, 2013). As a matter of fact, when the education process is taken into account, the science of analysis, which has an important place at every stage from secondary education to graduate school, includes high-level mathematical skills, and improves students' advanced mathematical thinking skills (Kuzu, 2021). In addition, the science of analysis includes advanced mathematical concepts such as limit, derivative, integral, and develops skills such as inquiry, reasoning and mathematical thinking in students (Ergene, 2019; Kuzu 2021; Konyalıoğlu, Tortumlu, Kaplan, Işık, & Hızarcı, 2011). This course of study which emerged as a monumental work by Leibniz and Newton is actually one of the most important discoveries of mathematics (Bingölbali, 2010). According to Tall (1993), analysis, or calculus courses in other words, may have different meanings, and even these meanings may differ from country to country. Regarding these changes, Tall (1993) pointed a shift from the informal calculus; informal ideas about the rate of change, taking differential, as integral, towards formal analysis; formally the idea of wholeness, the ε-δ definition of the limit, continuity, differential, Riemannian integration, mean value theorem, and so on. An examination of the related literature suggest that these subjects that require high-level knowledge and skills are a phenomenon that learners may have a hard time in learning and making sense of (Cornu,1981; Tall & Vinner,1981; Dreyfus & Eisenberg, 1982; Tall, 1993; White & Mitchelmore, 1996; Bukova, 2006; Grover, 2015; Turan, 2016; Doruk, Duran & Kaplan, 2017).

On the other hand, knowing the definitions of mathematical concepts, which are seen as the cornerstone of mathematical content knowledge, in a correct and meaningful way will affect the teaching service that teachers and pre-service teachers will offer to their students (Zazkis & Leikin, 2008). The way in which mathematical concept definitions are presented to students in the teaching process shapes the relationships between their concept images and concept definitions. Accordingly, they are important building blocks of the structure affecting students' thinking processes (Bingölbali & Monaghan, 2008; Tall & Vinner, 1981; Vinner 2002; Zazkis & Leikin, 2008).

In mathematical activities, concepts are used not only in formal descriptions of mathematics, but also in individual mental representations. In other words, these individual models are further detailed with the learned concept, which existed before the mathematical concept was learned, which took place in the experiences, and which occurred spontaneously (Cornu, 1981). However, even the correct concept definition can sometimes lead to cognitive conflicts in students (Tall, 1988). Mental conflicts recorded in studies in the related field can be summarized as; the representation and verbal expression of decimal numbers (Tall, 1977), definition and expression of functions (Vinner, 1983), difficulties in limit and continuity (Tall & Vinner, 1981), and limit of functions (Ervynck, 1983). Therefore, necessary and effective precautions for effective learning of mathematical concepts should be taken at the tertiary level before teachers start their teaching profession, which is possible by increasing the quality of teacher education programs (Öztoprakçı, 2014).

It is generally acknowledged that mathematics is one of the most difficult areas to understand, and this reveals that it is not sufficiently internalized by students. However, calculus has an important place in mathematics, which is one of the difficult fields. (Bresseoud, 2015; Yeşildere, 2007). The calculus examines infinite processes in mathematics. Ülger (1999) defines infinite processes as all concepts defined in the axis of the limit concept. Calculus focuses on calculatio. It contains many concepts and calculations in itself. In this respect, it is difficult for students to learn and comprehend the subject of calculus (Engin, 2016). Learning calculus, which is one of the sub-learning areas of mathematics, cannot be the same as learning arithmetic, algebra, and geometry (Thomas & Finley, 2001). Therefore, the Calculus course has an important place in mathematics. The importance of calculus is reflected in mathematics education, as it is the first step for mathematical subjects that require relationships with other mathematical concepts (algebra, geometry, trigonometry) in order to understand the concepts on the basis of the Calculus course. From this point of view, the calculus lesson is one of the basic lessons, particularly for mathematics education (Sağlam, 2011). Calculus courses can have visual features in terms of their subjects. When the concepts (limit, derivative and integral) within the scope of the Calculus course are examined, we see that graphs, diagrams, tables and so on are used as visual elements. Using visual elements is important in understanding the analysis concepts, and it is effective in solving several problems in calculus (Herman, 2002). As a matter of fact, the use of various types of representation in both concept teaching and problem solving process prepares the ground for the development of high-level thinking skills in terms of knowledge and cognition (Kuzu, 2020). However, it has been observed that most of the students taking the Calculus course at the university are reluctant to use visuals (Eisenberg & Dreyfus, 1991), instead, they generally prefer analytical solutions (Selden & Selden, 1993). Therefore, the concepts can be difficult to learn due to the intensive content of the Calculus course. However, with respect to modern mathematics, all mathematics branches are examined within the framework of calculus (Gözen, 2001). Hence, it may be a negative attitude for students to take only theoretical knowledge since the Calculus course includes deeper topics and has an abstract content (Engin, 2016). However, according to pre-service teachers, undergraduate mathematics teaching programs should focus on courses related to teaching mathematics, considering their teaching qualifications (Aksu 2016). On the other hand, it is an undeniable fact that mathematics field knowledge is important for mathematics teaching (Gök, 2016). In order to increase the qualifications of teachers in Turkey, various updates were made in the curricula of teaching programs in 1997, 2006, and 2009 by the Council of Higher Education. The last update in the curricula was made in 25 undergraduate teaching programs on 30 May 2018. In line with the former view, the course hours of the mathematics content knowledge courses were reduced, while the number of courses in the field education courses was increased in the updated primary school mathematics education teaching curriculum.

An examination of the related literature shows that, with the updated in the curricula of teaching programs in education faculties in 2018, the studies have been published on primary school mathematics teaching, preschool teaching, Turkish language teaching, biology teaching, and primary school teaching(Alver & Aydın, 2019; Bartan, 2019; Demir, Akbaş & Gök, 2021; Karakaya, Adıgüzel, Çimen & Yılmaz, 2020; Kılıç,Özmen, 2019). Demir, Akbaş and Gök (2021) included the views of the lecturers about the courses in the updated curriculum in their study. It can be said that no studies were conducted on the comparison of any courses in the curriculum implemented before 2018 and the curriculum updated in 2018.

The updated curricula were first put into practice in the 2018-2019 academic year, starting with first-year students who just started university. Students who started their education in the previous semesters continued their education according to the previous curriculum. With the aforementioned update, changes in many areas such as course hours, number of credits, European Credit Transfer System (ECTS) value, elective course types, etc., have been made. One of the updated curriculum in the teaching programs is undergraduate curriculum of mathematics teaching at primary school level program. Courses such as Physics-1 and Physics-2 were removed from the curriculum, and courses such as "Teaching Numbers", "Teaching Geometry and Measurement", "Teaching Algebra" and "Teaching Probability and Statistics", which are directly related to sub-education areas, were added. Table 1 shows the change in course hours and credits in the undergraduate curriculum of primary school mathematics teaching.

Table 1. Course Hours and Credits of Primary School Mathematics Teaching Undergraduate Curriculum Comparison

Program	Current Curriculum		Previous Curriculum		Difference	
Primary School Level Mathematics Education	*Credit*	*Course Hours*	*Credit*	*Course Hours*	*Credit*	*Course Hours*
	146	162	146	153	0	-9

When Table 1 is examined, it is seen that with the update made in the undergraduate curriculum of primary school mathematics teaching program, the number of existing credits was preserved, but the total course hours were reduced by 9 hours.

One of the lessons with decreasing number of hours is the Calculus-I course, which is offered in the first-year fall semester. With the updated curriculum, the total course hours of the Calculus-I course, which were 6 hours in total as 4 hours of theoretical and 2 hours of practice, have been updated to 2 hours theoretical in the current curriculum. That is to say, the lesson time of the relevant lesson was reduced by 4 hours, and the practice part of it was completely removed.

Similarly, in Calculus-I course, subjects such as *"The concept of limit in functions of one variable and its applications. Continuity and applications in functions of one variable, types of discontinuity. The concept of derivative and differentiation rules in functions of one variable. Derivatives of trigonometric, logarithmic, exponential, hyperbolic functions, and their inverse and implicit functions. Higher-order derivatives."* in the previous curriculum are preserved in the updated curriculum. On the other hand, in the updated curriculum, subjects such as *"To gain the ability to define the basic rules about the concept of limit in univariate functions and to make related applications, to express the concepts of continuity and discontinuity in univariate functions and to gain the ability to interpret them geometrically, to express the basic theorems related to derivative and derivative in univariate functions, polynomial, to gain the ability to calculate derivatives of trigonometric, logarithmic, exponential, resultant and inverse functions and to do related applications."* are added. When the contents of the course are examined, it can be said that the subjects covered are similar, and it mainly focuses of the subject of derivatives.

Giving only definitions of concepts that require high-level mathematics knowledge will not be sufficient for conceptual learning (Aksu 2016; Bingölbali & Monaghan, 2008; Engin, 2016; Gök, 2016; Tall & Vinner, 1981; Vinner, 1983). Creating a meaningful image of the concept of derivative in the minds of pre-service teachers in a more detailed way, which is considered as the building block of the Calculus course, is crucial (Engin, 2016; Herman, 2002; Gözen, 2001; Sağlam, 2011; Yeşildere, 2007).

The results of the change in the course hours of the Calculus-I course in the previous and current curriculum should be examined to see the effects of this curriculum development practice in primary school mathematics teaching program and how it is reflected in pre-service teachers' achievement. The use of the students' Calculus-I course data between 2016 and 2019 is important in terms of reflecting the change in student scores over time.

Purpose of the Research

This study aims to examine the change in the Pre-Service Mathematics Teachers' (PSMTs) passing scores of the Calculus-I course, which is related to the concept of derivative, by comparing the previous program with the new program updated in 2018.To this end, the current study sought to answer the research questions below.

1. What is the distribution of the PSMTs university placement scores and Calculus-I course passing scores in terms of curriculum type?
2. Do the PSMTs passing scores of the Calculus-I course differ in terms of the previous and current curriculum?
3. What is the passing status of the Calculus-I course and the letter grade distribution of the PSMTs in the previous and current curriculum?

Method

Research Design

This study is a causal comparison study, as it aimed to examine the difference between the Calculus-I course passing scores in the undergraduate curriculum of primary school mathematics teaching program in the previous curriculum and the current curriculum updated in 2018. Causal comparison studies are studies that aim to identify the causes and consequences of differences between groups of people without any intervention on participants (Fraenkel & Wallen, 2008). Causal studies are carried out to determine the relationships between variables determined before and after the situation (Cohen, Manion, & Morrison, 2017). It cannot provide the cause and effect relationship between the variables, but it can provide clues on this issue (Büyüköztürk, Çakmak, Akgün, Karadeniz & Demirel, 2012).

Study Group

Since the study is not intended for generalization, it was carried out on the research group. The participants of the study consist of a total of 212 pre-service teachers in the primary school mathematics teaching program, 171 (80.6%) female, and 41 (19.3%) male, studying at a state university in the Aegean region. While the first and second-year students took the calculus I course in the updated curriculum, the third and fourth-year students took the calculus I course in the previous curriculum. The distribution of the students in the research group according to the years they enrolled in the relevant program is given in Table 2.

Table 2. Distribution of Students According to the Period in Which They Were Registered

Curriculum Type	Period	*n*	%
Previous Curriculum	2016-2017 Fall	51	24.1
	2017-2018 Fall	50	23.6
Current Curriculum	2018-2019 Fall	59	27.8
	2019-2020 Fall	52	24.5
	Total	212	100

In table 2, the previous curriculum refers to the curriculum implemented in primary school mathematics teaching program before 2018 and the current curriculum refers to the curriculum that was updated in 2018 and it is currently implemented in the teaching program. Of the participants in the current study, 101 pre-service teachers were taught using the previous curriculum (47.7%) while 111 pre-service teachers were taught using the current curriculum (52.3%).

Data/Data Description

The data within the scope of the study were obtained from the Calculus-I course midterm and final exams of the students studying according to the previous curriculum (2016-2017 fall and 2017-2018 fall) and according to the current curriculum (2018-2019 fall and 2019-2020 fall). One midterm and one final exam were held for the relevant course. While the contribution of the midterm exam on the general success score was 40%, the contribution of the final exam was 60%.

The courses were conducted by a single instructor in all semesters, and an interview was conducted with the responsible instructor about the course. As a result of the interview, it was determined that the lecturer covered the same topics in both curricula, explained some subjects more superficially due to the decrease in the course hours, and solved fewer questions related to the subjects due to the removal of the practice time. Besides, the instructor stated that the midterm and final exams consisted of 5 open-ended questions with the same content and similar difficulty. In addition, expert opinion was obtained from two different subject-matter experts to determine whether the exam questions were of the same content and difficulty. The subject-matter experts also stated that the questions in the exams were of the same content and difficulty. In addition, it was determined that the answer key was used in the scoring of all questions, and they were scored with the same attitude. The data within the scope of the study were collected by obtaining the necessary permissions from the relevant instructor and the student affairs of the university. Descriptive statistics of the data used within the scope of the study are presented in Table 3.

Table 3. Descriptive Statistics of Students' University Placement Scores and Calculus-I Course Passing Scores According to the Terms

Year		*n*	Min.	Max.	$\bar{x}$	*ss*	Skewness		Kurtosis	
							Statistics	Std. Error	Statistics	Std. Error
2016	Placement Score	51	339.26	429.39	369.25	12.72	2.18	0.33	10.72	0.66
	Passing Score	51	0	88	61.76	16.12	-1.39	0.33	3.46	0.66
2017	Placement Score	50	312.10	380.57	351.25	10.97	-0.38	0.34	4.33	0.66
	Passing Score	50	38.	100	77.08	15.06	-0.46	0.34	-0.45	0.66
2018	Placement Score	59	298.32	412.44	347.33	16.86	0.86	0.31	5.35	0.61
	Passing Score	59	0	94	62.59	17.14	-0.85	0.31	2.10	0.61
2019	Placement Score	52	291.54	425.37	372.66	18.42	-2.58	0.33	13.09	0.65
	Passing Score	52	19	78	52.25	13.49	-0.38	0.33	-0.44	0.65

Data Analysis

First of all, during the preparation of the data to be used within the scope of the study, missing data, data accuracy, extreme values, and other necessary corrections have been made. Then, the assumptions of the statistical methods considered to be used within the scope of the study were examined.

The normality of the weighted scores (HBM) created by taking 40% of the students' placement scores and Calculus-I course midterm scores and 60% of the final scores were examined. Kolmogorov-Smirnov p values obtained from students' Placement Scores and HBM scores were 0.000 and 0.018, respectively; Shapiro-Wilk p values were 0.000 and 0.005, and it was determined that the scores were not normally distributed. Therefore, the use of nonparametric approaches was preferred in the analyzes performed within the scope of the study.

Within the scope of the study, it was investigated whether the placement scores and the Calculus-I course passing scores of the students differed according to the previous and current curriculum and whether the scores of the Calculus-I course differed when the effect of the placement score was held constant. In other words, in the study, the university placement scores of the students were included in the analysis as a covariate, and the average scores of the Calculus-I course, which were corrected according to the university placement scores of the students enrolled in the previous and updated curricula, were compared. The nonparametric covariance analysis method was preferred as the analysis method since the assumptions required for parametric covariance analysis were not met.

Nonparametric Covariance Analysis

Analysis of covariance (ANCOVA) is a statistical technique that combines regression analysis and analysis of variance (Pituch & Stevens, 2015). A nonparametric analysis strategy is generally recommended for evaluating studies with data that do not exhibit a normal distribution. When the conditional normal distribution assumption of the dependent variable is violated in the covariance analysis, several alternative ANCOVA methods independent of the distribution have been proposed. Some of these methods are (1) Quade (1967); (2) Puri and Sen (1969); (3) McSweeney and Porter (1971); (4) Burnett and Barr (1977); and (5) Shirley (1981).

Quade's Procedure

The Quade method was used within the scope of the study. The method was developed by Quade and is called by its own name. It is possible to summarize the Quade method in three steps (Olejnik & Algina, 1985; Quade, 1967):

i. Sort the dependent variable and covariant separately in all groups
ii. Compute the linear regression of the sorted covariant over the ordered dependent variable and the residuals for the model
iii. Estimate the regression model using the residuals calculated as the dependent measure, taking the grouping factor as an independent variable (estimate), and test whether the square of the multiple correlation coefficient is significant.

The Quade method is considered as Ranked ANCOVA approaches like other Puri & Sen (1969) and McSweeney & Porter (1971) methods. The main advantage of this approach is that it is easy to implement and more effective when data is outliers (Huitema, 2011).

Results

In this section, the findings and comments obtained through the data collected during the research process are included. Each sub-problem is discussed in turn.

What is the distribution of the pre-service teachers' university placement scores and Calculus-I course passing scores in terms of curriculum type?

Within the scope of the study, firstly, university placement scores and passing scores of Calculus-I course of the participants according to the current and previous curriculum were examined. Table 4 contains the descriptive statistics of the participants' university placement scores and Calculus-I passing scores according to the curriculum type.

Table 4. Descriptive Statistics of Students' Placement and Passing Scores by Curriculum Type

Curriculum		*n*	Min.	Max.	$\overline{x}$	*ss*	Skewness		Kurtosis	
							Statistics	Std. Error	Statistics	Std. Error
Current Curriculum	Placement Scores	111	291.54	425.37	359.20	21.64	-0.38	0.23	1.42	0.46
	Passing Scores	111	0	94	57.75	16.32	-0.42	0.23	0.76	0.46
Previous Curriculum	Placement Scores	101	312.10	429.39	360.34	14.88	0.76	0.24	4.87	0.48
	Passing Scores	101	0	100	69.35	17.33	-0.76	0.24	1.74	0.48

When Table 4 is examined, it is seen that the university placement scores of the participants vary between 291.54 and 425.37 according to the current curriculum and the average is 359.20. According to the previous curriculum, it is seen that it changes between 312.10 and 429.39, and the average is 360.34. It is seen that the participating pre-service teachers' passing scores in the Calculus-I course are between 0 and 94 for the students taking the current curriculum, and the average is 57.75, the scores of the students taking the previous curriculum vary between 0 and 100 and the average is 69.35. In addition, the graph of the university placement scores of (Previous / Current) students according to the curriculum type is shown in Figure 1.

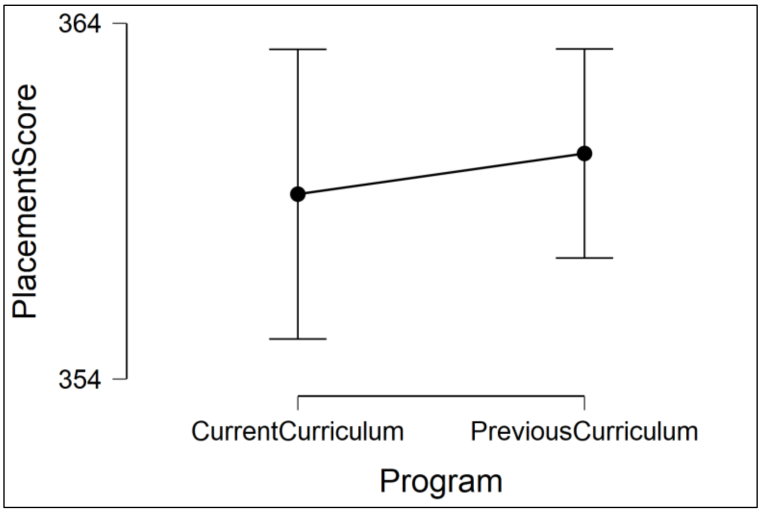

Figure1. University Placement Scores Of Students According To The Curriculum Type

When Figure 1 is examined, it is seen that the scores of the students who have been placed in the university compared to the previous curriculum are higher than the students who have been placed in the university compared to the current curriculum. For this reason, it was preferred to use nonparametric covariance analysis to keep the effect of university placement scores constant while examining students' Calculus-I passing scores according to curriculum type.

Do the pre-service teachers' passing scores of the Calculus-I course differ in terms of the previous and current curriculum? Within the scope of the study, when the effect of students' university placement scores was kept constant, whether the scores of passing the Calculus-I course differentiated according to the type of curriculum was examined with nonparametric ANCOVA. In Table 5, the nonparametric covariance analysis results of the Calculus-I course passing scores, which are corrected according to the university placement scores according to the curriculum type, are presented.

Table 5. Nonparametric ANCOVA Results of Calculus-I Course Passing Scores According to Curriculum Type

Variance Source	Sum of Squares	*df*	Mean Squares	*F*	*p*	Partial η^2
Adjusted Model	95536.66[a]	1	95536.66	29.74	.00*	.124
Constant	212.57	1	212.57	0.07	.80	.000
Group(curriculum)	95536.66	1	95536.66	29.74	.00*	.124
Error	674693.75	210	3212.83			
Sum	770230.42	212				
Adjusted Sum	770230.42	211				

*$p < .05$

When Table 5 is examined, it is found that there is a statistically significant difference between the average passing scores of the Calculus-I course, which are corrected according to the university placement scores according to the curriculum type.

Accordingly, the scores of the students who took the Calculus-I course for 6 hours compared to the previous curriculum differ significantly from the students who took the Calculus-I course for 2 hours compared to the current curriculum ($F_{(1, 210)}$=29.74, $p<.05$, *partial* η^2=.124)

It can be said that the passing scores of the students taking the previous curriculum (Average = 69.35) in the Calculus-I course are higher than the students taking the current curriculum (Average = 57.75). The graphic showing the relationship between the students' university placement scores and the Calculus-I course passing scores according to the curriculum type is shown in Figure 2.

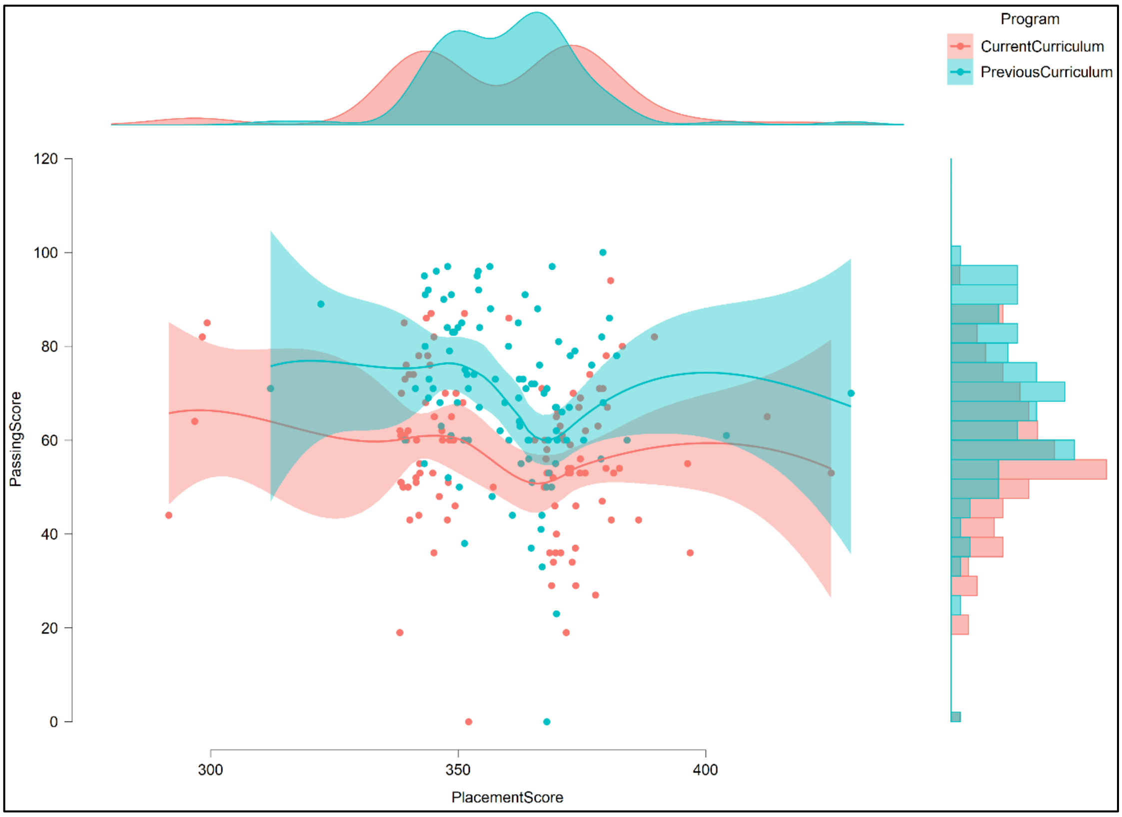

Figure 2. Relationship Between University Placement Score and Calculus-I Course Passing Score According to the Curriculum Type

When Figure 2 is examined, it is seen that the passing scores of the Calculus-I course of the students studying according to the previous curriculum are generally higher than the students studying according to the current curriculum. Therefore, it can be said that students taking the previous are more successful in derivatives, which are mainly studied in the content of the Calculus-I course. This difference in students' achievement may be related to the fact that the number of course hours in Calculus-I course in the previous was significantly reduced in the updated curriculum.

What is the passing status of the Calculus-I course and the letter grade distribution of the PSMTs in the previous and current curriculum?

In the scope of the study, it was also examined how the passing status and letter grades of the students change according to the curriculum type. Figure 3 shows the participants' passing status regarding the Calculus-I course according to the curriculum type.

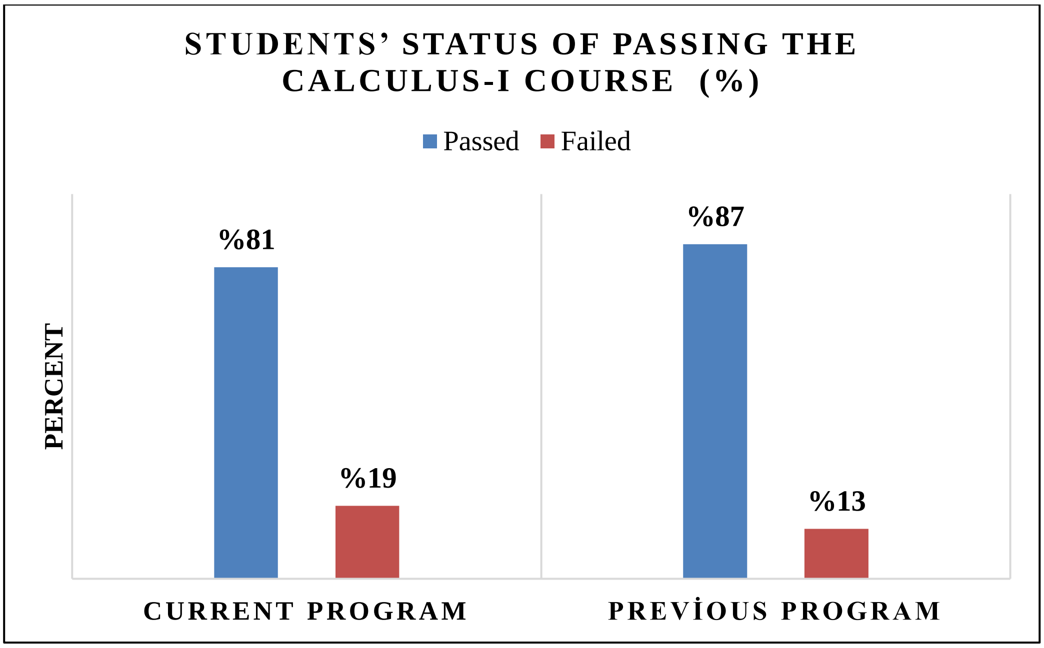

Figure 3. Students' Passing Status of the Calculus-I Course According to The Curriculum Type

When Figure 3 is examined, it is seen that percentage of the students who are successful in the Calculus-I course and passed it was 81% (n = 90) in the current curriculum and 87% (n = 88) in the previous curriculum. It is seen that the students who are unsuccessful in the Calculus-I course and failed it were 19% (n = 21) in the current curriculum and 13% (n = 13) in the previous curriculum. Therefore, the percentage of success of the participants in the Calculus-I course is lower in the current curriculum than in the previous curriculum. The distribution of the passing status of the students according to the letter grade is shown in Figure 4.

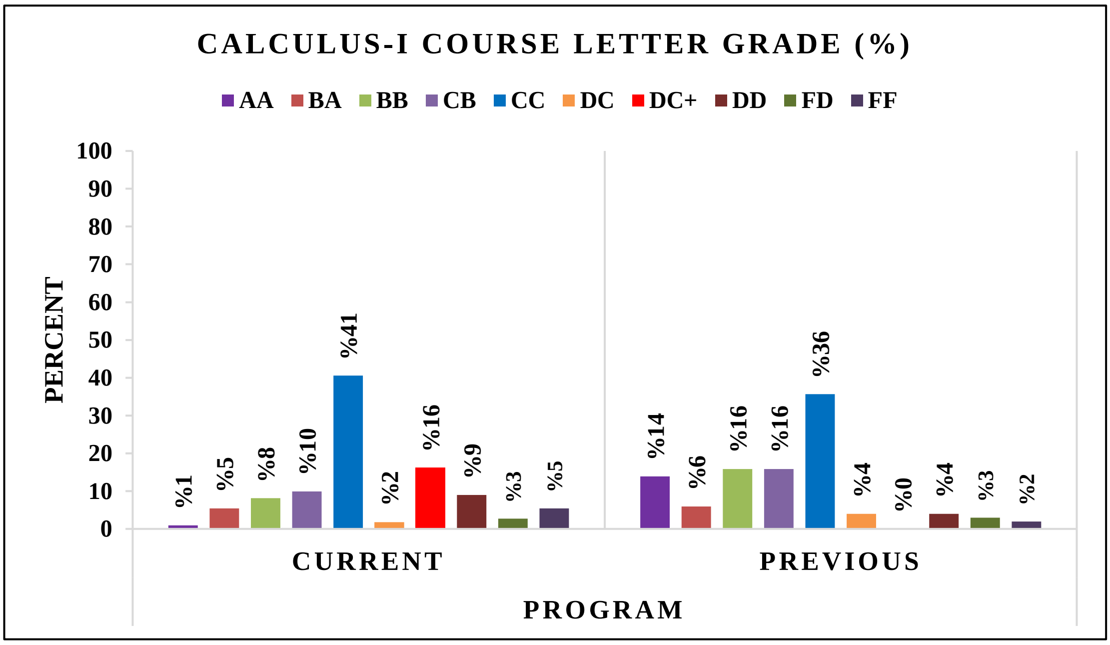

Figure 4. Distribution of Students' Calculus-I Course Letter Grade According to Curriculum Type

Figure 4 shows that the percentage of students who got "AA", "BA", "BB", "CB" and "DC" letter grades from the Calculus-I course is higher in the previous curriculum compared to the current curriculum. It is seen that the percentage of students who got the letter grades "CC", "DC +", "DD" and

"FF" from the Calculus-I course is lower in the previous curriculum compared to the current curriculum. The percentage of students who got the letter grade "FD" from the Calculus-I course is equal in the both curricula. In other words, the students taking the previous curriculum passed the Calculus-I course with a higher letter grade. While 52% of the students taking the previous curriculum succeeded in the Calculus-I course with "CB" and higher letter grade, this success of the students taking the current curriculum is 24%. Another remarkable point is that while 16% of the participants in the current curriculum have a letter grade of "DC" and fail the Calculus-I course, the "DC" letter grades in the Calculus-I course are "DC +" due to the weighted grade point average of 2.25 and above. It has been converted into a letter grade and deemed successful. In the previous curriculum, there were no students who passed the Calculus-I course with weighted grade points.

Discussion, Conclusion and Suggestions

This study was carried out to examine the change in the Calculus-I course passing scores in the undergraduate primary school mathematics teaching program with respect to and the previous curriculum and the current curriculum that was updated in 2018. In this study, we found that the average university placement score of pre-service teachers compared to the previous and current curricula was very close to each other, and the average score of passing the Calculus-I course was higher in the previous curriculum than in the current curriculum.

We can argue that students that are taught using the previous curriculum are more successful in derivatives, which are mainly studied in the content of the Calculus-I course. The main reason for this success is thought to be related to the decrease in the course hours of the Calculus-I course in the current curriculum compared to the previous program. In parallel with the findings of the study, it has been argued that practice in derivative learning positively affects academic achievement (Sağırlı, Kırmacı & Bulut, 2010). Besides, in the quasi-experimental study conducted by Çekmez and Baki (2019), the effect of dynamic software used for application in the learning of the geometric interpretation of the derivative was examined and it was concluded that the experimental group students who were subjected to the application had higher academic success. In this context, extra course hours may be needed for in-depth learning of concepts, especially for the calculus course. In addition to this, the instructors thought that the removal of general mathematics course in the updated curriculum of primary school mathematics teaching program could be an ecological problem (Demir, Akbaş and Gök, 2021). This situation may cause difficulties in learning the concept after the study results and the reduction of the course hours of the calculus I course in mathematics (Kuzu, 2017). We can argue that the pre-service teachers' readiness to learn the concepts are negatively affected both by abolishing the general mathematics course and decreasing the course hours of the analysis I course. In addition, when the Calculus-I course is examined in terms of credit/duration, it is thought that there may be difficulties for the instructors in terms of subject content (Demir, Akbaş & Gök, 2021). This argument is in parallel with the results of the study. Hence, it would be appropriate to increase the course hours of the calculus I course, both for theoretical and practical allocations. However, Kaymakçı, Keskin, and Çimen (2018) stated that mathematics teachers did not feel the need for the subject knowledge courses they took in their undergraduate studies in their professional lives. It can be said that this result contradicts the results of this study. However, Thomas and Finney (2001) emphasized the importance of the Calculus course from the field knowledge courses as follows: "Basically, you learn how to calculate with numbers, how to simplify algebraic expressions and calculate variables, and how to think about points, lines, and shapes on the plane. The analysis also includes these techniques and skills but also improves others on a more sensitive and deeper level. Analysis, in fact, defines so many new concepts and computational operations that you won't be able to learn everything you need in the classroom". Therefore, the calculus course is important and should not be limited to only 2 hours of theoretical course. Besides, in the study conducted by Erol (2013), it is emphasized that the content of mathematics content knowledge courses should be balanced in terms of theory and practice. Therefore, it can be said that the application course of the calculus I course is important and parallel to this study.

This study also examined the pre-service teachers' status of passing the Calculus-I course in terms of curriculum type, and we revealed that the percentage of students passing the Calculus-I course in the previous curriculum was higher than the current curriculum. The examination of letter grade distribution of the Calculus-I course in terms of curriculum type, demonstrated that more than half of the students in the previous curriculum were successful in the course with a letter grade of "CB" or higher, while this rate was less and about ¼ in the current curriculum. Therefore, we can conclude that the pre-service teachers taking the previous curriculum passed the Calculus-I course with a higher letter grade. In addition, Mertoğlu, Gürdal, and Akgül (2019) emphasized in their study that the situations regarding the constructivist education approach are not fully included in the curriculum. For this reason, considering the constructivist approach, it may be difficult to present concepts such as derivatives to pre-service teachers through only two hours of theoretical course. In the study conducted by Özgen and Alkan (2014), it was seen that the academic achievement of the learning activities of the pre-service teachers increased in the context of function and derivative concepts within the scope of the constructivist learning approach. In this context, it can be thought that Özgen and Alkan (2014) supported the results of the study that Mertoğlu, Gürdal, and Akgül (2019) conducted with their study, and that it is important to have practice hours in addition to the theoretical course hours in the previous.

In conclusion, based on the results of the current study, we recommend that pre-service teachers who are taking the current curriculum in primary school mathematics teaching program need to eliminate this lack of practice caused by the removal of the practice time with their own efforts. Also, it is recommended to carry out similar studies in the other courses in which the course hours are reduced in the current curriculum compared to the previous curriculum. In this way, it will be beneficial in revealing the difference between the both curricula.

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