

Investigating Pre-Service Elementary Mathematics Teachers' Perception of Integral*

İlköğretim Matematik Öğretmeni Adaylarının İntegrale Yönelik Algılarının İncelenmesi

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Abstract

The purpose of this research study is to examine the perceptions of the pre-service elementary maths teachers who attended a teaching application enriched with the modelling activities toward integral concept within the context of anxiety, attitude, and daily life usage awareness. While the quantitative data of the research were obtained from the Perception Scale for the Concept of Integral that was developed by the researchers and whose validity and reliability studies were conducted, the qualitative data of the research were gathered through the semi-structured interviews. At the end of the study, it has been seen that the teaching application enriched with the modelling activities decreased the anxiety levels of pre-service teachers toward the integral and increased their attitude and awareness levels regarding its usage in daily life.

Keywords: Teaching Application, Modelling Activities, Integral, Anxiety, Attitude, Daily Life Usage

Öz

Bu araştırmanın amacı modelleme etkinlikleri ile zenginleştirilmiş bir öğretim uygulamasına katılan ilköğretim matematik öğretmeni adaylarının integral kavramına yönelik kaygı, tutum

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ve integralin günlük hayatta kullanımına ilişkin farkındalık düzeylerinin incelenmesidir. Araştırmanın nicel verileri araştırmacılar tarafından geliştirilen geçerlik ve güvenilirlik çalışmaları yapılmış integrale yönelik algı ölçeği ile nitel verileri ise yarı yapılandırılmış görüşmeler ile toplanmıştır. Araştırmada, modelleme etkinlikleri ile zenginleştirilmiş öğretim uygulamasının öğretmen adaylarının integral kavramına yönelik kaygı düzeylerini düşürdüğü, tutum ve günlük hayat kullanımına ilişkin farkındalık düzeylerini ise yükselttiği sonucuna ulaşılmıştır.

Anahtar Kelimeler: Öğretim Uygulaması, Modelleme Etkinlikleri, İntegral, Kaygı, Tutum, Günlük Hayat Kullanımı

Geniş Özet

Giriş

İntegral kavramının anlamlandırılmasındaki güçlük birçok araştırmacı tarafından kabul edilmiştir (Ergene, 2014; Wagner, 2017; Rasslan & Tall, 2002; Orton, 1983). İntegral ve integral alan ilişkisine dair kavramsal anlayışın eksik olması (Ergene, 2019; Sevimli, 2013; Sealey, 2008), integralin kullanıldığı gerçek hayat problemlerinin uygulama süreçlerinde öğrencilere zorluk çıkaracağı aşikârdır. Bir matematik kavramına ilişkin yaşanan güçlüklerin öğrencinin kavrama karşı olan tutum, kaygı gibi algılarını da etkilemekte ve öğrencilerin matematik kavramından korkmasına, uzaklaşmasına, kaçmasına neden olmaktadır. Bu durum da öğrencilerin integral kavramına ilişkin yaşadığı güçlüklerin de integrale karşı olan algılarını değiştirebileceği düşünülebilir. Bu düşünce ışığında bu araştırmada, gerçek hayat problemlerinden oluşan modelleme etkinlikleri kullanılarak bir öğretim uygulaması ile öğretmen adayların integral kavramına yönelik algılarının incelenmesi amaçlanmıştır. Araştırma amacı doğrultusunda değişen/gelişen modelleme yaklaşımı (Emergent modelling) çerçevesinde hazırlanmış modelleme etkinlikleri ile zenginleştirilmiş bir öğretim uygulaması ile ilköğretim matematik öğretmeni (İMÖ) adaylarının integral kavramına yönelik algıları (kaygı, tutum ve günlük hayat kullanımına yönelik farkındalık bağlamında) araştırılmıştır.

Yöntem

Bu araştırmada nitel ve nicel veriler eş zamanlı olarak toplanmıştır. Araştırmanın nicel verileri tek gruplu ön test-son test deneysel çalışma esas alınarak, nitel verileri ise durum çalışması esas alınarak toplanmıştır. Araştırmanın çalışma grubunu Türkiye'de bir devlet üniversitesinin Eğitim Fakültesinin İlköğretim Matematik Öğretmenliği programına kayıtlı 28 tane dördüncü sınıf öğrencisi oluşturmaktadır.

Araştırmada nicel verilerin araştırmacılar tarafından geliştirilen geçerliği ve güvenilirliği test edilmiş İntegrale Yönelik Algı Ölçeği (İYAÖ) ile, nitel verileri ise yarı yapılandırılmış görüşmeler (YYG) aracılığı ile toplanmıştır. Araştırmada kullanılan öğretim uygulamasında 6 tane öğretici 2 tane de değerlendirici olmak üzere 8 tane modelleme etkinliğine yer verilmiştir.

Ayrıca 2 tane etkinlik de öğretmen adaylarına ödev olarak verilmiştir. Öğretim uygulamasında kullanılan modelleme etkinlikleri parçalama fikrinin gelişimi, Riemann toplamlarının kullanımı ve belirli integralin kullanımı üzerine temellendirilmiştir. Örneğin parçalama fikrinin gelişiminin incelenmesi amacıyla Thompson (1984, sf.133) çalışmasından faydalanarak Şehirlerarası Motorlu Kurye etkinliği hazırlanmıştır.

Araştırmada öncelikle uygulama öncesinde İYAÖ ve YYG ile ön test verileri toplanmıştır. Son test verileri için öğretim uygulamasının sonlandırılmasından itibaren (uygulama etkisinin daha net ortaya koyulabilmesi amacıyla) 5 haftalık sürenin geçmesi beklenmiştir. İYAÖ, Ergene ve Özdemir (2019, baskıda) tarafından integrale yönelik *kaygı, tutum ve integralin günlük hayatta kullanımına ilişkin farkındalık (kullanışlılık)* düzeylerinin belirlenebilmesi amacıyla geliştirilmiştir. Ayrıca YYG'de "İntegrale olan yaklaşımınızı anlatabilir misiniz?" sorusu ve "Bir integral problemi çözerken kendinizi nasıl hissediyorsunuz?", "İntegral kavramı düşündüğünüzde nasıl hissediyorsunuz?" ve "İntegralin günlük hayatta kullanımı hakkında ne düşünüyorsunuz?" alt soruları İMÖ adaylarına yöneltilmiştir. İYAÖ'den elde edilen verilerin normallik sayıltısını karşıladığı görülmüş ve verilerin analizi için ölçeğin bütünü ve alt boyutları (kaygı, tutum ve kullanışlılık) için t-testi analizi yapılmıştır. YYG'den elde edilen veriler ise betimsel analiz yoluyla analiz edilmiştir.

Bulgular ve Tartışma

İMÖ adaylarının İYAÖ ön test ve son test kaygı puanları arasında anlamlı bir fark olduğu ($p < .05$, $df=27$, $t=3,064$) sonucuna ulaşılmıştır. İMÖ adaylarının kaygı alt boyutunda aldıkları ortalama puan ön testte $\bar{X}= 26,856$ iken son testte $\bar{X}= 24,393$ olmuştur. Ön test ve son test puanları incelendiğinde kaygı alt boyutunda İMÖ adaylarının ortalama 2,463 daha az puan aldığı ve integrale yönelik kaygı düzeylerin azaldığı ve bu farkın $p= .05$ düzeyinde anlamlı olduğu görülmüştür.

İMÖ adaylarının İYAÖ ön test ve son test tutum puanları arasında anlamlı bir fark olduğu ($p < .05$, $df=27$, $t=-3,905$) sonucuna ulaşılmıştır. İMÖ adaylarının tutum alt boyutunda aldıkları ortalama puan ön testte $\bar{X}= 21,143$ iken son testte $\bar{X}= 23,929$ olmuştur. Ön test ve son test puanları incelendiğinde tutum alt boyutunda İMÖ adaylarının ortalama 2,786 daha fazla puan aldığı ve integrale yönelik tutum düzeylerin arttığı ve bu farkın $p= .05$ düzeyinde anlamlı olduğu görülmüştür.

İMÖ adaylarının İYAÖ ön test ve son test kullanışlılık puanları arasında anlamlı bir fark olduğu ($p < .05$, $df=27$, $t=-2,079$) sonucuna ulaşılmıştır. İMÖ adaylarının kullanışlılık alt boyutunda aldıkları ortalama puan ön testte $\bar{X}= 18,821$ iken son testte $\bar{X}= 20,286$ olmuştur. Ön test ve son test puanları incelendiğinde kullanışlılık alt boyutunda İMÖ adaylarının ortalama 1,465 daha fazla puan aldığı ve integralin günlük hayatta kullanımına ilişkin farkındalık düzeylerinin arttığı ve bu farkın $p= .05$ düzeyinde anlamlı olduğu görülmüştür.

İMÖ adaylarının İYAÖ ön test ve son test puanları arasında anlamlı bir fark olduğu ($p < .05$,

df=27, t=-2,079) sonucuna ulaşılmıştır. İMÖ adaylarının ölçeğin tamamından aldıkları ortalama puan ön testte $\bar{X}=66,820$ iken son testte $\bar{X}=68,608$ olmuştur. Ön test ve son test puanları incelendiğinde ölçeğin tamamında İMÖ adaylarının ortalama 1,788 daha fazla puan aldığı ve integrale yönelik algı düzeylerinin arttığı ve bu farkın $p=.05$ düzeyinde anlamlı olduğu görülmüştür.

Öğretmen adayları ile yapılan YYG'de verdikleri cevaplar kaygı, olumlu/olumsuz tutum kullanışlılık, yeterlilik ve diğer kategorilerinde incelenmiştir (Tablo 1).

Tablo 1:

YYG de elde edilen kategoriler ve açıklamaları

Kategori	Açıklama
Kaygı	İntegrale karşı korku, gerginlik, gibi duyguların hissedilmesi
Olumsuz Tutum	İntegrali sevmeme, integrali itici ya da sıkıcı vb. nitelendirme
Olumlu Tutum	İntegrali sevme, eğlenceli görme, integral çözerken mutlu hissetme vb.
Kullanışlılık	İntegralin günlük hayatta kullanımı hakkında fikir sahibi olma
Yeterlilik	İntegral problemi çözerken yeterli hissetme
Diğer	İntegrale ilişkin farklı görüşler

Öğretmen adaylarının büyük bir bölümü ön görüşmede integrale yönelik korku, gerginlik, tedirginlik gibi kaygı (n=24) hislerini ve sevmeme, problem çözmekten uzaklaşma, itici olması gibi olumsuz tutum (n=22) hislerini içeren düşüncelerini ifade etmişlerdir. Ön görüşmelerde ayrıca öğretmen adaylarının çok az bir bölümü olumlu tutum (n=3) ve integralin günlük hayat kullanımının farkındalığına (n=2) ilişkin düşüncelerde bulunmuşlardır. Son görüşmelerde ise öğretmen adaylarının integrale yönelik kaygı (n=4) ve olumsuz tutum (n=3) hakkındaki düşünceleri büyük ölçüde azalmıştır. Öğretmen adaylarının büyük bölümü son görüşmede integrale yönelik olumlu tutum (n=26) ve integralin günlük hayatta kullanımına ilişkin farkındalıklarını (n=26) içeren düşüncelerinden bahsetmişlerdir.

Tartışma

Modelleme etkinlikleri ile zenginleştirilmiş bir öğretim uygulaması ile öğretmen adaylarının integral kavramına yönelik algılarının kaygı, tutum ve günlük hayat kullanımına ilişkin farkındalık düzeyleri temelinde incelendiği bu çalışmada öğretim uygulamasının öğretmen adaylarının integrale yönelik algılarını değiştirdiği sonucuna ulaşılmıştır. Tutum, kaygı gibi psikolojik faktörlerin değişiminde yapılan müdahaleler, o anki yaşanmışlıklar, günlük hatta anlık ruh hali gibi etkenlerin rol oynayacağı bilinmektedir (Ryan, 1998). Bu çalışmada ise bu etkenler de düşünülerek, integral kavramına yönelik öğretmen adayları bir öğretim uygulamasının öncesinde ve sonrasında kavrama için geliştirilmiş algı ölçeği ve görüşme formu kullanılarak belirlenmeye çalışılmıştır.

Öğretmen adaylarının öğretim uygulamasının öncesinde integral kavramına yönelik kaygı düzeylerinin yüksek, tutumlarının ve günlük hayat kullanımlarına yönelik farkındalık düzeylerinin düşük olduğu görülmüştür. İntegral kavramı, alan yazında da belirtildiği üzere, öğrenciler tarafından zor olarak nitelendirilen (Ergene, 2014), öğrencilerin çözmekten korktuğu ve güçlük yaşadığı (Orton, 1983) bir matematiksel kavram olarak görülmektedir. Öğretmen adaylarının öğretim uygulamasının öncesinde integral kavramına yönelik sahip oldukları bu algı ayrıca çalışma grubunun da araştırma amacına uygun olarak seçildiğini ortaya koymaktadır.

Gerçek hayat problemleri ile zenginleştirilmiş öğretim uygulamasının sonrasında öğretmen adaylarının integral kavramına yönelik kaygı düzeylerinin azaldığı, tutum ve günlük hayat kullanımına ilişkin farkındalık düzeylerinin arttığı sonucuna ulaşılmıştır. Öğretmen adaylarının ayrıca “İntegrale karşı eskisi kadar ön yargılı değilim/ilgimin olduğunu fark ettim”, “İntegralden korkmuyorum artık.” İntegralin işime yarayacağını hissettim.” gibi olumlu tutum ve günlük hayat kullanımına ilişkin olumlu düşüncelerinin de arttığı görülmüştür. Öğretim uygulaması sonrasında yapılan görüşmelerde öğretmen adaylarının kaygı ve olumsuz tutum ifadelerinin azalması da yapılan uygulamanın etkisini ortaya koymaktadır. Araştırmada son test verilerinin, uygulamanın sonlandırılmasından 5 hafta gibi uzun bir süre sonra toplanması, özellikle deneysel müdahaleyi içeren çalışmalarda ölçme ve değerlendirme işleminin hemen yapılmasının ortaya çıkaracağı olumsuz sonuçlarını da engellediği düşünülmektedir.

Alan yazın incelendiğinde, bireylerin matematiğe karşı kaygı düzeylerinin azalması ya da tutum, günlük hayat kullanımına ilişkin farkındalık düzeylerinin artmasının başarıyı artırdığı görülmektedir (Vattanapath & Jaiprayoon, 1999; Ruffell, Mason & Barbara, 1998). Bu durum dikkate alındığında, zor olarak nitelendirilen ve anlamlandırılmasında güçlük yaşanan integral kavramının, modelleme etkinlikleri ile zenginleştirilmiş öğretim uygulaması ile aktarılmasının öğretim süreçlerine olumlu katkı yapacaktır. Sonuç olarak bu araştırmada, modelleme etkinlikleri ile zenginleştirilmiş öğretim uygulamasının, integrale yönelik kaygı düzeylerini düşüren, tutum ve günlük hayat kullanımına ilişkin farkındalık düzeylerini artıran bir uygulama olduğu görülmüştür.

Introduction

Integral concept, one of the basic topics of calculus, is followed with interest by mathematics education researchers due to the theoretical basis it holds, the reflection of its formula structures on the application process, and its relation to the real life. Many researches have revealed the difficulty in understanding the integral concept (Ergene, 2014; Wagner, 2017; Rasslan & Tall, 2002; Orton, 1983). In calculus courses, it was seen that although the students may be very good at applying symbolic integral techniques or calculating the area under a curve, they failed to have a satisfactory conceptual understanding of integral concept and the relationship between integral and area (Ergene, 2019, Sevimli, 2013; Sealey, 2008). It is obvious that the lack of conceptual understanding of integral and the relationship between integral and area cause difficulties for students in the application process of real-life problems where integral is used. The difficulties

faced by students regarding a mathematical concept affect their perceptions such as anxiety and attitude toward the concept. In this situation, it can be thought that the difficulties faced by the students regarding the integral concept may change their perceptions of integral.

Perception is about receiving, selecting, acquiring, transforming and organizing the information supplied through our senses. It is about sight, hearing, smell, taste, touch, and more (Barber & Legge, 2017). In the present study, perception toward the integral was considered as individual interpretation and feelings such as anxiety, fear, hate, desire, love and happiness that appear when the integral concept was thought or while solving a problem about the integral. In the study, perceptions toward the integral was determined by interpreting anxiety and attitude toward the integral and awareness levels regarding usage of integral in daily life together.

Mathematical concepts and construction of the conceptual structures in mind affect students' mathematics anxiety, their attitude toward mathematics and mathematical skills (MoNE, 2018). Affective factors have an important role in students' learning of concepts and retention of information (Özgen & Pesen, 2010). When the literature was reviewed, it was seen that students have negative feelings such as fear, hate, anxiety, reluctance and dislike toward mathematics lessons and mathematical concepts (Ma & Xu, 2004; Campbell & Evans, 1997; Tobias, 1990; Fennema & Sherman, 1976). Anxiety in mathematics lessons that contain the tension and fear of mathematics prevents students from understanding the concepts (Fulkerson, Galassi & Galassi, 1984). Research about mathematics learning revealed that mathematics anxiety leads to mathematics avoidance and low mathematics performance (Rounds & Hendel, 1980). Additionally, it is seen that the students having negative attitude toward mathematics have performance problems due to anxiety (Tapia, Martha, Marsh & George, 2004). Decrease in anxiety improves students' attitude toward mathematics learning in general and motivates them (Vattanapath & Jaiprayoon, 1999; Taylor & Walton, 1997; Carraway, 1987). Accordingly, it is quite likely that students develop positive or negative attitude toward mathematics under the influence of experiences in mathematics lessons. Researches have shown that when elementary and high school students' attitudes toward mathematics were measured by using mathematics attitude scales, meaningful differences were seen in their attitudes towards mathematics in terms of different variables (Capar & Tarım, 2015; Bandura, 1997; Roberts & Reese, 1987; Elmore & Vasu, 1980). Failure in understanding or explaining the importance of mathematics and the use of it in daily life constitutes problems while teaching mathematics in the lessons.

Although almost every part of our daily life includes a lot of things related to mathematics, mathematical concepts are regarded as abstract (Baki & Bell, 1997) and this situation indicates that it is impossible for a student to understand concepts on his/her own study. This situation leads to students' disbelief in learning mathematical concepts on their own or their belief in not having enough intelligence and capacity for understanding the concepts and hardness of these concepts.

When the literature related to mathematics education was reviewed, it was seen that using real life problems (Golding, Smith & Blaylock, 2018), modelling activities (Park, Park, Park,

Cho & Lee, 2013; Arzarello, Ferrara & Robutti, 2012) and technological software (Driver, 2012; Camacho, Depool & Santos-Trigo, 2009) lead to increase in academic achievement or positive improvement in conceptual understanding. Research have shown that in the teaching process of integral concept, software (Sevimli, 2013; Heid, 2003) such as Computer Algebra System and Geogebra, daily life problems and multiple representations (Sealey, 2008), and modelling activities were used. Since the fact that teaching process including mathematical modelling has a positive effect on attitude toward mathematics (Falsetti & Rodríguez, 2005) and in order to eliminate the thinking that integral concept is not used in daily life, in this research study, it was aimed to examine pre-service elementary mathematics teachers' perceptions toward the integral concept. The perceptions of pre-service teachers toward integral concept were investigated with a teaching application consists of modelling activities in which real-life problems were used in line with the aim of the study and within the context of anxiety, attitude, and daily life usage.

Methodology

Research Design

In this study, qualitative and quantitative data were collected simultaneously. While the quantitative data were collected through one group pre-test post-test experimental design, the qualitative data were collected through case study.

One group pre-test post-test design is the least used design among the experimental designs. The reasons of why this design is not preferred are that internal validity threats could not be controlled, and random assignment is not possible while forming the group. In this study, it was aimed to use different teaching method including modelling activities for the teaching process of definite integral and to test this teaching method on pre-service teachers who completed the courses involving definite integral successfully. The reason of testing on them is to overcome the widely observed deficiency. After the literature review and taking experts' opinions, it was seen that students who have completed the integral courses perceive integral as difficult and they have limited knowledge related to integral concept after a certain period. Thus, it can be said that deficiencies in the process of conceptual understanding of integral affect the perception toward integral. For this reason, in this study instead of selecting two groups as experimental and control, selecting one group and testing teaching method on this group was considered as more appropriate to the focus of the research.

Participants

The participants of the study consist of 28 pre-service teachers who were enrolled in Elementary Mathematics Education Program of Faculty of Education in one of the state universities in the Marmara Region of Turkey and who were taking the course Mathematics Problems in Constructivist Teaching at the time of the study. The reasons of selecting these pre-service elementary mathematics teachers [pre-service teachers] are that they passed the Calculus courses in which integral is taught successfully. Pre-service teachers will not teach integral at the

schools throughout their teaching careers since they will be middle school teachers and there is not integral concept in Turkish Middle Grades Mathematics Curriculum. For these reasons, there is not any situation affecting these pre-service teachers' perceptions toward the integral in a negative way such as fear of integral.

The Teaching Application Enriched with Modelling Activities

The reasons of difficulty in understanding integral concept are that integral is taught as the area staying the under curve and as a concept full of formulas and operations. This situation leads students to the opinion that integral is not used in real-life.

The usage of Riemann sums especially in the interpretation of definite integral has an importance in the conceptual understanding of definite integral. A teaching application enriched with modelling activities consisting of real-life problems was designed by using Riemann sums and definite integral. Modelling activities have been designed by using the theoretical framework of emergent modelling (Gravemeijer, 2007). In the teaching application process, after the literature review, 8 modelling activities were determined (see Figure 1). In addition, two homework activities were also used.

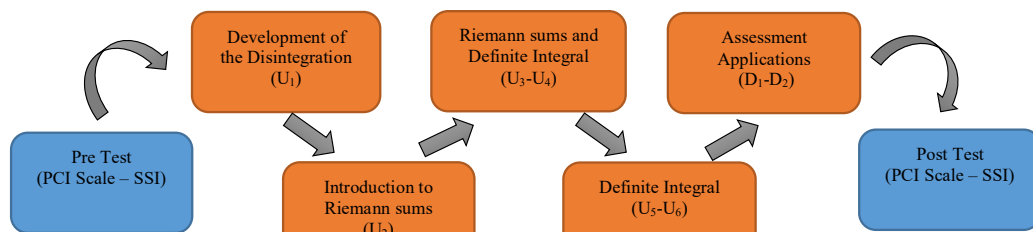


Figure 1: The Teaching Application Process

Modelling activities were designed as appropriate to the purpose of the study. For instance, U_1 , Motorized Courier was prepared by benefitting from Thompson's (1984) study to investigate the development of the disintegration idea. Thompson asked a student named as Sue, the following question:

“Imagine this. I’m driving my car at 50 mi/hr. I speed up smoothly to 60 mi/hr, and it takes me one hour to do it. About how far did I go in that hour?”

Sue stated that to find distance time can be divided into smaller intervals approximately. U_1 was designed to identify the relation between the road proceeded by the courier carrying cargo between two cities, and the time by using disintegration idea.

“A Motorized Courier who will carry a cargo from Sakarya University, Faculty of Education to Marmara University, Atatürk Faculty of Education sets off by motorcycle.

Right after the courier sets off, he realizes at 2 pm that his speed is 80 mi/hr and the speed increases to 90 mi/hr at 3 pm. Moreover, he does not face with situations that will delay traffic such as traffic lights and environmental conditions throughout the road. If the distance between the courier and the delivery address is 170 miles as in the map at 2 pm, how far may the courier need to go further at 3 pm?"

Other modelling activities were designed as similar to U1 and their validity and reliability issues were ensured. Enough time was given to the pre-service teachers for individual solution of activities, assessments were made at the end of the solution process, group work and GeoGebra and Excel as software were used, and the teaching process was directed with questioning and brainstorming methods.

Before the teaching application, Perception Scale for the Concept of Integral [PCI Scale] was administered to the pre-service teachers and Semi Structured Interviews [SSI] were conducted with them as pre-test. Teaching application has taken 5 weeks. Four weeks after the end of the teaching application, PCI Scale was implemented, and SSI were conducted as post-test. Post-test was not administered immediately at the end of the teaching application in order to determine the retention of the teaching application.

PCI Scale

PCI Scale was developed by Ergene and Özdemir (in press) with the aim to determine the anxiety level and attitude toward integral, and the awareness level regarding usage of integral in daily life. The PCI Scale has a three-factor structure consisting of three dimensions (Anxiety, Attitude, and Usefulness) and comprises 20 items that were finalized after the pilot study conducted with university students. Experts' opinions for content validity were taken and exploratory factor analysis and confirmatory factor analysis for factorial validity; discriminant and convergent validity analyses for construct validity; criterion validity, internal consistency and composite reliability procedures were conducted on the PCI Scale respectively. Also, t values regarding differences in item scores of bottom and top 27% groups were calculated in item analysis section of the scale.

The Cronbach's alpha coefficient calculated for the whole scale was .93. The coefficients for the factors were as follows: Anxiety: .92, Attitude: .87, Usefulness: .81 and all these values were equal or greater than .81. The CR alpha coefficient calculated for the whole scale was .96. The coefficients for the factors were as follows: Anxiety: .93, Attitude: .89, Usefulness: .85 and all these values were equal or greater than .85. Thus, it can be claimed that the instrument was reliable at an acceptable level (Nunnally & Berstein, 1994; Robinson, Shaver & Wrightsman, 1991). The scale provides adequate fit indices in confirmatory factor analysis and the scale can be used as a whole or just for the sub-scale. The higher the scores in sub-scales or in overall scale indicate the higher perception toward the integral.

Semi-Structured Interviews

SSI were conducted with pre-service teachers in order to determine their approaches toward integral before and after the application. During the interviews, following question and sub-questions were asked to the pre-service teachers by the interviewer:

- Can you tell us about your approach to integral concept?
- o How do you feel when you think integral concept?
- o How do you feel while solving an integral problem?
- o What do you think about the use of integral in daily life?

Data Analysis

After it was seen that data obtained from the PCI Scale consisting of sub-dimensions of anxiety, attitude, and usefulness, ensured the normality assumptions, t-test analysis of the whole scale and its sub-dimensions were conducted for data analysis. In addition, in order to analyse the data obtained from the interviews descriptive analysis was conducted.

Findings

Findings of the study were presented as findings of PCI Scale and findings of SSI in two sections.

Findings of PCI Scale

Before analysing the data obtained from the PCI Scale, the levels of the scale to meet the normality of both the whole scale and its sub-dimensions of anxiety, attitude, and usefulness were examined. Since the sample size was not very large, the Kolmogorov-Smirnov and Shapiro-Wilk tests were conducted, and the skewness and kurtosis values were also calculated to check the normality. The normality values of PCI Scale are given in Table 1.

Table 1:
Normality values of PCI Scale

	Skewness Values	Kurtosis Values	Kolmogorov-Smirnov			Shapiro-Wilk		
			Statistic	df	p	Statistic	df	p
Pretest Anxiety	,466	-,171	,158	28	,070	,944	28	,143
Posttest Anxiety	,134	-,776	,114	28	,200*	,958	28	,308
Pretest Attitude	,273	-,553	,121	28	,200*	,971	28	,608
Posttest Attitude	,485	1,308	,200	28	,096	,924	28	,080
Pretest Usefulness	-,448	,444	,204	28	,104	,946	28	,154
Posttest Usefulness	-,511	,418	,129	28	,200*	,939	28	,107
Pretest PCI	,164	-,276	,091	28	,200*	,984	28	,940
Posttest PCI	-,348	1,387	,144	28	,144	,959	28	,338

Result of the analysis of pre-test and post-test scores showed that, the skewness and kurtosis values for the anxiety, attitude, and usefulness sub-dimensions of the scale and the whole of the scale were found between -2 and $+2$. In consequence of the skewness and kurtosis values, it can be said that the data did not show an important deviation from the normal distribution (Kline, 2011).

When the Kolmogorov-Smirnov and Shapiro-Wilk tests results of the scores belonging to the anxiety, attitude, and usefulness sub-dimensions of the scale and the whole of it were examined, it is seen that the scores ensure the normality. When the results of analysis are examined, it can be interpreted that p values for the Kolmogorov-Smirnov and Shapiro-Wilk tests are greater than $\alpha = .05$ and the data show the normal distribution at the significance level of $\alpha = .05$ (Garson, 2012).

The skewness and kurtosis values of the data collected from the PCI Scale met the normality as a result of the Kolmogorov-Smirnov and Shapiro-Wilk tests. With the normality's being met, it was seen that the data complied with the t -test analysis. Table 2 shows the descriptive statistics of both pre-test and post-test scores of PCI Scale.

Table 2:

Descriptive Statistics of both pre-test and post-test scores of PCI Scale

	Pre-test		Post-test		
	Mean	SD	Mean	SD	
PCI Scale	Anxiety	26,856	5,445	24,393	5,197
	Attitude	21,143	4,266	23,929	4,768
	Usefulness	18,821	2,802	20,286	3,183
	Total	66,820	9,680	68,608	11,661

As seen from the Table 2, while there is an increase in pre-service teachers' mean score of attitude and usefulness sub-dimensions and total of PCI Scale, there is a decrease in the mean score of anxiety sub-dimension. Pre-service teachers' mean score in the whole scale is 66, 820 in pre-test and 68, 608 in post-test. It was seen that pre-service teachers' mean score in attitude sub-dimension is 21,143 in pre-test and 23,929 in post-test; their mean score in usefulness sub-dimension is 18,821 in pre-test and 20,286 in post-test; and pre-service teachers' mean score in anxiety sub-dimension is 26, 856 in pre-test and 24, 393 in post-test.

To investigate whether there is a significant mean difference between anxiety, attitude and usefulness sub-dimensions and the whole scale in terms of pre-test and post-test scores in PCI Scale, Paired Samples t -Test was conducted.

Paired samples t -test results of PCI for the sub-dimensions and the whole scale are given in Table 3.

Table 3:*Paired Samples t-test*

	\bar{X}	SD	t	df	p
Post-test Anxiety Pre-test Anxiety	-2.463	4.255	3.064	27	.005
Post-test Attitude Pre-test Attitude	2.786	3.774	-3.905	27	.001
Post-test Usefulness Pre-test Usefulness	1.465	3.727	-2.079	27	.047
Post-test PCI Scale Pre-test PCI Scale	1.788	9.196	-3.863	27	.001

When Table 3 was examined, it was seen that there was a statistically significant mean difference ($p < .05$, $df=27$, $t=3.064$) between pre-test and post-test scores of pre-service teachers in anxiety sub-dimension of PCI Scale. While the mean score of pre-service teachers in anxiety sub-dimension was 26.856 in pre-test, it was 24.393 in post-test. It can be said that their score was 2.463 less in post-test in terms of the anxiety sub-dimension, their anxiety levels for integral decreased, and this difference was significant at the level of $p = .05$.

In terms of attitude sub-dimension, it was seen that there was a statistically significant mean difference ($p < .05$, $df=27$, $t = -3.905$) between pre-test and post-test scores of pre-service teachers in attitude sub-dimension of PCI Scale. While the mean score of pre-service teachers in attitude sub-dimension was 21.143 in pre-test, it was 23.929 in post-test. When the pre-test and post-test scores were examined, it was seen that pre-service teachers scored averagely 2.786 more in attitude sub-dimension in post-test, their attitude levels for integral increased, and this difference was significant at the level of $p = .05$.

In terms of usefulness sub-dimension, it was seen that there was a statistically significant mean difference ($p < .05$, $df=27$, $t = -2.079$) between pre-test and post-test scores of pre-service teachers in usefulness sub-dimension of PCI Scale. While the mean score of pre-service teachers in usefulness sub-dimension was 18.821 in pre-test, it was 20.286 in post-test. When the pre-test and post-test scores were examined, it was seen that pre-service teachers scored averagely 1.465 more in usefulness sub-dimension in post-test, their awareness levels regarding the usage of integral in daily life increased, and this difference was significant at the level of $p = .05$.

In terms of the whole scale, it was seen that there was a statistically significant mean difference ($p < .05$, $df=27$, $t = -3.863$) between pre-test and post-test scores of pre-service teachers in whole of PCI Scale. While the mean score of pre-service teachers in the whole scale was 66.820 in pre-test, it was 68.608 in post-test. When the pre-test and post-test scores were examined, it was seen that pre-service teachers scored averagely 1.788 more in the whole scale, their perception levels for integral increased; and this difference was significant at the level of $p = .05$.

Findings of SSI

The responses given by the pre-service teachers during the semi-structured interviews were examined in terms of the anxiety, attitude (negative-positive) and usefulness dimensions, competence and others (Table 4).

Table 4:
Dimensions and Explanations for SSIs

Dimensions	Explanation
Anxiety	Feeling emotions such as apprehension, tension, and uneasy toward integral
Negative Attitude	Not liking integral, qualifying integral as unattractive, boring, etc.
Positive Attitude	Liking integral, finding it entertaining, feeling happy while solving integral, etc.
Usefulness	Having an idea about the usage of integral in daily life
Competence	Feeling adequate while solving integral problem
Others	Different opinions about integral

During the pre-interviews, pre-service teachers indicated integral as a difficult, complex and meaningless concept and they stated that they feel incompetent themselves in integral. In addition, according to them, integral is based on memorization and it requires using formulas. Following excerpt illustrates this situation:

Interviewer [I]: Could you explain your approach to integral?

Participant [P]: Integral, hmm... It is a difficult and complex concept, I have prejudice against integral. I feel anxious while studying and solving integral. I feel incompetent myself, actually there is a need to know formulas well.

I: What do you think about the use of integral in daily life?

P: We use integral in calculating volume. There are some formulas, we apply those formulas.

During the post-interviews, the opinions of pre-service teachers about the concept of integral changed. Almost all the pre-service teachers stated that they are not afraid of integral, they feel more moderate towards the integral, they are more confident in solving the integral problem and they no longer feel anxious about integral. In addition, negative attitudes of pre-service teachers towards the integral that they had in pre-interviews changed and turned into positive attitudes in post-interviews.

Pre-service teachers stated that they are not as prejudiced against the integral as they used to be and their approaches to integral changed positively. They also stated that they take pleasure in engaging in the integral. Following excerpt illustrates this situation:

I: Could you explain your approach to integral?

P: I thought it was a very difficult and complex issue. I learned how to do research and study and I realized that it was not difficult. I have investigated the reasons of what I have done so far by supporting with what I have learned researched in this course. In fact, I was very prejudiced against the integral. I felt incompetent myself and it was all about my study system based on memorization. After this lesson, I saw that it was actually enjoying. When I see integral, I am no longer stretched, and I feel confident. It can be used in every part of daily life. Integral can be used even when calculating a road in a traffic accident. I'm frankly very sorry about my previous times. I wish I could see it like this before.

Together with the themes created as a result of detailed analysis, pre-interview and post-interview codes were determined separately and PreIC was used for the pre-interview code and CPosI was used for the post-interview code. If a code created in the pre-interview was re-created in the post-interview, for this code PreICPosI was used as a demonstration. For example, "I don't like the integral" code was also used in the post-interview by the pre-service teachers and this opinion was coded as 6C6. As a result of the opinions of the pre-service teachers, 23 different codes were created in the pre-interviews and 24 codes in the post-interviews.

While pre-service teachers expressed opinions such as I am afraid of integral (n=8), and integral makes me nervous (n=6) during the pre-interviews, they stated that I am not afraid of integral (n=6) and I am not nervous any more while solving integral (n=8) during the post-interviews (Table 5a-5b).

Table 5a:
Codes for Anxiety

Theme	PreICode	Codes	CodePosI	Codes
Anxiety	1C	I am afraid of integral.	C1	I am not afraid of integral.
	2C	I feel nervous while solving an integral problem.	C2	I don't feel nervous while solving an integral problem anymore.
	3C	I feel uneasy.	C3	I am more comfortable while solving the integral problem right now.
	4C	Integral makes me angry.	C4	I feel more moderate towards integration.

Table 5b:
Participants for Anxiety

Theme	PreICode	Participants	f	CodePosI	Participants	f
Anxiety	1C	P3, P7, P18, P20, P21, P23, P25, P27	8	C1	P7, P18, P23, P25, P27, P28	6
	2C	P1, P6, P12, P15, P17, P19	6	C2	P1, P6, P8, P12, P15, P17, P19, P24	8
	3C	P2, P7, P10, P14, P24, P27, P28	7	C3	P2, P4, P10, P14, P18, P26, P27, P28	8
	4C	P1, P4, P8, P5, P16, P18, P26	7	C4	P1, P2, P5, P7, P16, P20	6

While pre-service teachers expressed opinions such as I don't like integral (n=8), and I don't want to study integral (n=6) during the pre-interviews, they stated that I realized that it is very funny (n=5) and I started to enjoy (n=8) during the post-interviews (Table 6a-6b).

Table 6a:
Codes for Attitude

Theme	Code _{PreI}	Codes	Code _{PostI}	Codes
Attitude	5C	I have a prejudice against integral.	C5	I am not prejudiced I used to be.
	6C	I don't like integral.	C6	Still I don't like it, but now my approach has changed.
	7C	The most unsympathetic thing I have ever seen is integral.	C7	I have seen that it is so funny.
	8C	I don't want to study integral.	C8	I started to enjoy studying integral.
	9C	Integral makes you feel bad.	C9	I realized that I am interested in integral.
	10C	Integral makes me feel good.		

Table 6b:
Participants for Attitude

Theme	Code _{PreI}	Participants	f	Code _{PostI}	Participants	f
Attitude	5C	P ₅ , P ₁₂ , P ₁₃ , P ₂₃ , P ₂₈	5	C5	P ₁₃ , P ₂₀ , P ₂₃ , P ₂₈	4
	6C	P ₁ , P ₂ , P ₁₃ , P ₁₈ , P ₂₀ , P ₂₅ , P ₂₇	7	C6	P ₅ , P ₁₃ , P ₁₈ , P ₂₀ , P ₂₅	5
	7C	P ₅ , P ₈ , P ₁₁ , P ₁₆ , P ₂₁	5	C7	P ₆ , P ₁₁ , P ₁₂ , P ₁₆ , P ₁₇ , P ₂₃ , P ₂₅ , P ₂₇	8
	8C	P ₃ , P ₁₀ , P ₆ , P ₁₃ , P ₂₂ , P ₂₄	6	C8	P ₁ , P ₅ , P ₁₄ , P ₁₉ , P ₂₁ , P ₂₄	6
	9C	P ₁₄ , P ₁₅ , P ₁₇ , P ₁₉ , P ₂₃	5	C9	P ₁ , P ₂ , P ₃ , P ₈ , P ₁₀ , P ₁₅ , P ₂₂	7
	10C	P ₁ , P ₄	2			

While pre-service teachers expressed opinions such as integral can be used in area problems (n=8), and it is not used in daily life (n=6) during the pre-interviews, they stated that I never thought that I could use integral in daily life problems (n=8), and it can be used beyond calculating area and volume (n=7) during the post-interviews (Table 7a-7b).

Table 7a:
Codes for Usefulness

Theme	PreI Code	Codes	Code _{PosI}	Codes
Usefulness	₁₁ C	It is used in area problems.	C ₁₀	I realized that integral will help me.
	₁₂ C	It is used to find volume.	C ₁₁	I have never thought that I can use integral in everyday life problems this much.
	₁₃ C	It is used for irregular shapes.	C ₁₂	It can be used in every part of daily life.
	₁₄ C	It is used where derivative and limit used.	C ₁₃	I see that there are situations where I can use the integral.
	₁₅ C	Not used in daily life.	C ₁₄	It can be used far beyond the opinions such as area-volume.
	₁₆ C	I don't think I will use.	C ₁₅	In fact, it is a concept that is always used in daily life.

Table 7b:
Participants for Usefulness

Theme	PreI Code	Participants	f	CodePosI	Participants	f
Usefulness	₁₁ C	P ₁ , P ₂ , P ₁₀ , P ₁₄ , P ₁₇ , P ₂₀ , P ₂₁ , P ₂₄	8	C ₁₀	P ₂ , P ₁₅ , P ₁₆ , P ₂₁ , P ₂₃	5
	₁₂ C	P ₁₂ , P ₂₂ , P ₅ , P ₁₀ , P ₁₂ , P ₁₇ , P ₂₄	7	C ₁₁	P ₁ , P ₆ , P ₇ , P ₁₀ , P ₁₂ , P ₁₈ , P ₂₃ , P ₂₅	8
	₁₃ C	P ₄ , P ₁₅ , P ₁₆ , P ₂₂ , P ₂₃ , P ₂₈	6	C ₁₂	P ₈ , P ₁₄ , P ₁₇ , P ₁₉ , P ₂₂ , P ₂₈	6
	₁₄ C	P ₂ , P ₄ , P ₅ , P ₇ , P ₁₁ , P ₁₉ , P ₂₆ , P ₂₇	8	C ₁₃	P ₃ , P ₄ , P ₁₃ , P ₁₆ , P ₂₁ , P ₂₆ , P ₂₇	7
	₁₅ C	P ₃ , P ₈ , P ₉ , P ₁₃ , P ₁₈ , P ₂₅	6	C ₁₄	P ₂ , P ₅ , P ₉ , P ₁₁ , P ₂₀ , P ₂₄	6
	₁₆ C	P ₆ , P ₂₃	2	C ₁₅	P ₁ , P ₃ , P ₄ , P ₁₃ , P ₁₈ , P ₂₃	6

In the post-interviews, it was observed that pre-service teachers' awareness about the use of integral in daily life in addition to use of integral for area-volume-irregular shapes increased. It was stated by pre-service teachers that use of integral is common in daily life beyond the area and volume calculations and that integral is a concept used in every part of daily life.

In the post-interviews, pre-service teachers stated that it is not difficult to integrate; thanks to the teaching application, now integral makes sense to them and they feel confident in integral. Furthermore, in the post-interviews, pre-service teachers also expressed their opinions about the teaching application enriched with modelling activities, for example, I felt sad when I realized that we did not learn integral in this way in the past and when I took this lesson I felt very sad

since I wasn't lectured on integral in this way in the past. Moreover, they indicated that after such a teaching application, integral is more meaningful.

While pre-service teachers expressed opinions such as I think that I could not do (n=9), and I feel incompetent myself in integral (n=6) during the pre-interviews, they stated that now integral makes sense and became meaningful (n=8) and I think that I can solve integral problems (n=7) during the post-interviews (Table 8a-8b).

Table 8a:
Codes for Competence

Theme	Code _{PreI}	Codes	Code _{PostI}	Codes
Competence	₁₇ C	It is a very difficult topic.	C ₁₆	I saw that it is not hard.
	₁₈ C	It is a very complex topic.	C ₁₇	I feel confident while solving integral problems.
	₁₉ C	I was feeling inadequate.	C ₁₈	I make sense of integral thanks to this course.
	₂₀ C	I think I can't solve integral problems.	C ₁₉	I think I can solve them.
	₂₁ C	Integral seems meaningless.		

Table 8b:
Participants for Competence

Theme	Code _{PreI}	Participants	f	Code _{PostI}	Participants	f
Competence	₁₇ C	P ₁ , P ₁₀ , P ₁₂ , P ₂₁ , P ₂₃	5	C ₁₆	P ₁ , P ₂ , P ₁₀ , P ₁₂ , P ₂₃	5
	₁₈ C	P ₅ , P ₁₀ , P ₁₂ , P ₁₇ , P ₂₆	5	C ₁₇	P ₅ , P ₁₁ , P ₂₀ , P ₂₁ , P ₂₆	5
	₁₉ C	P ₄ , P ₅ , P ₁₂ , P ₁₃ , P ₁₈ , P ₂₂ , P ₂₄	7	C ₁₈	P ₅ , P ₆ , P ₈ , P ₉ , P ₁₅ , P ₁₇ , P ₁₈ , P ₂₂ , P ₂₄ , P ₂₇ , P ₂₈	11
	₂₀ C	P ₂ , P ₃ , P ₆ , P ₇ , P ₁₁ , P ₁₄ , P ₁₆ , P ₂₀ , P ₂₈	9	C ₁₉	P ₃ , P ₄ , P ₆ , P ₇ , P ₁₃ , P ₁₄ , P ₁₆ , P ₂₀ , P ₂₈	9
	₂₁ C	P ₄ , P ₁₅ , P ₂₅ , P ₂₇ , P ₂₈	5			

Moreover, while pre-service teachers expressed opinions such as integral is based on memorization (n=8), and you need to know formulas to solve it (n=6) during the pre-interviews, they stated that I feel that I have an improvement in a positive way (n=6) and if I learned integral in this way before, it would make more sense (n=5) during the post-interviews (Table 9a-9b).

Table 9a:
Codes for Others

Theme	PreI Code	Codes	Code PosI	Codes
Others	₂₂ C	It is a memory-based subject.	C ₂₀	Frankly, I feel sad for previous time with integral.
	₂₃ C	If you know the formulas, then you can solve integral problems.	C ₂₁	I feel that I made positive progress.
			C ₂₂	If I learned integral in this way before, I could make sense of it.
			C ₂₃	If I learned integral in this way before, it would be more permanent.
			C ₂₄	The things that we learned in the course were very well. I wish we learned integral in this way in high school.

Table 9b:
Participants for Others

Theme	PreI Code	Participants	f	Code PosI	Participants	f
Others	₂₂ C	P ₂ , P ₈ , P ₁₁ , P ₁₂ , P ₁₈ , P ₂₀ , P ₂₃ , P ₂₅	8	C ₂₀	P ₁₂ , P ₁₂ , P ₁₉ , P ₂₄	4
	₂₃ C	P ₃ , P ₈ , P ₉ , P ₁₀ , P ₁₃ , P ₁₉	6	C ₂₁	P ₄ , P ₅ , P ₆ , P ₁₀ , P ₂₂ , P ₂₃	6
				C ₂₂	P ₂ , P ₁₁ , P ₂₀ , P ₂₃ , P ₂₅	5
				C ₂₃	P ₃ , P ₁₅ , P ₂₁ , P ₂₂	4
				C ₂₄	P ₂₈	1

Apart from the opinions given in tables, in the post-interviews some of the pre-service teachers repeated their opinions they expressed in the pre-interviews. In post-interviews, P₆ and P₉ received the code ₆C₆ by repeating the opinion that I don't like the integral, and P₆ and P₇ received the code ₁₄C₁₄ by repeating the opinion that integral is not used in daily life.

When pre-interviews and post-interviews were examined as a whole it was seen that in the pre-interviews, the majority of the pre-service teachers expressed their opinions about integral regarding negative attitude (n=22) such as feeling anxious (n=24) or feeling fear, tension, and uneasiness; distancing from solving the problems; and describing integral as an unappealing concept. In the pre-interviews, the minority of the pre-service teachers expressed their opinions regarding the positive attitude (n=2) and the awareness of the use of integral in daily life (n=2). On the other hand, in the post-interviews, the opinions of the pre-service teachers for integral about anxiety (n=2) and negative attitude (n=3) decreased substantially. In the post-interviews, the majority of the pre-service teachers expressed their opinions including the positive attitude (n=26) for integral and their awareness for the usage of integral in daily life (n=26).

Discussion, Conclusion and Suggestions

In this research, pre-service teachers' perceptions of integral concept were examined in the awareness levels regarding anxiety, attitude, and daily life usage through a teaching application where modelling activities are used. It has been concluded that the teaching application changed the perceptions of integral of the pre-service teachers. It is known that the factors like the interventions, the present experiences, and the daily or even instant mood plays a role in the changes of psychological factors such as attitude and anxiety (Ryan, 1998). As for this research, the perceptions of pre-service teachers of the integral concept were tried to be identified by considering also these factors and by using the scale and the interview form developed for the integral concept before and after the teaching application.

It was observed that while the pre-service teachers' anxiety levels for the integral concept were high, their attitudes and awareness levels regarding the usage of integral in daily life were low before the teaching application. The opinions of the pre-service teachers such as "I feel uneasy-anxious when I see an integral question." and "I am afraid of/don't like integral." before the teaching application show that they had anxiety and negative attitude toward integral. Accordingly, it was seen in the pre-interviews that the number of the pre-service teachers thinking like this was very high. Similar to the findings of Ergene (2014), in this research study, integral concept was described as "difficult" by the pre-service teachers. The pre-service teachers fear to solve integral problems and have difficulty in learning integral. This perception owned by the pre-service teachers in relation to the integral concept before the teaching application also reveals that the participants were chosen in accordance with the research's objective.

It has been concluded that the anxiety levels of the pre-service teachers toward the integral concept decreased and their attitude and awareness levels about its daily life usage increased after the teaching application enriched with modelling activities. It was also seen that the positive attitudes and the positive opinions about its daily life usage such as "I am not prejudiced against integral as much as I used to be." and "I am not afraid of integral anymore." belonging to the pre-service teachers increased. In the interviews made after the teaching application, decrease in the pre-service teachers' statements of anxiety and negative attitude reveals the effect of the application which was made. Collecting the post-test data after a long period of 5-weeks as of the termination of the application also avoided the negative results which can be resulted from immediate conduction of the measurement and assessment operation especially in the studies including applicational intervention. The pre-service teachers' opinions such as "I felt sad when I realized that we didn't learn it like this in the previous times." and "When I had this lesson I felt very sad since I wasn't learned integral in this way in the past." after the teaching application also puts forward that the teaching application has been effective.

When literature is reviewed, it is seen that decrease in individuals' anxiety levels toward integral or increase in their attitude and awareness levels for its daily life usage also increase the achievement (Vattanapath & Jaiprayoon, 1999; Ruffell, Mason & Barbara, 1998). When this situation is considered, the teaching application enriched with modelling activities will contribute

to the learning processes of integral positively. Consequently, in this research it has been seen that the teaching application enriched with the modelling activities is decreased the anxiety levels of pre-service teachers toward the integral and increased their attitude and awareness levels regarding its usage in daily life.

When the results of this research study are considered; a study including teaching application by adding control group can be conducted in order to examine the effect of different study groups on the perception of integral. In addition, similar teaching applications (consisting of modelling activities) in the teaching process of concepts such as series, limit and derivative can be designed. Thus, the effects of designed teaching applications on perceptions of various concepts can be examined.

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