

Determining Cutoff Points of Factors Affecting Scores of Private Skill Tests: ROC Curve Approach

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Suggested Citation:

Zırhlioğlu, G. (2013). Determining cutoff points of factors affecting scores of private skill tests: ROC curve approach. *Eğitim Araştırmaları-Eurasian Journal of Educational Research*, 53/A, 119-130.

Abstract

Problem Statement: Evaluation is carried out by a variety of factors when choosing the student to physical education and sport science departments. These factors are skill tests, University Student Selection Exam (OSS) and students' academic success in their secondary school (AOBP). Various research have indicated that these tests scores are effective in determining academic success. Students who get a high score may be also successful in skill tests, and the grade of OSS may be effective in order to select accurate student. Problem statement of this study can be expressed as "What are cutoff points and distinctiveness level of exams those are applied for entrance to Department of Physical Education and Sports Teacher of Yuzuncu Yil University?"

Purpose of study: The aim of the study is to use the University Student Selection Exam, students' academic success in their secondary school, shuttle running and coordination test scores instead of the average academic achievement in order to distinguish successful and unsuccessful students through ROC (Receiver Operating Characteritic) analysis method.

Methods: The data used in this study were taken from the students' office and the record of the physical education and sport science department. These data were obtained from 25 male and 15 female students in the first semester of the 2007-2008 academic year. Data included student selection exam, students' academic success in their high school, and special skill test scores (i.e., including shuttle running tests and coordination test).

ROC curves were used to evaluate the effect of OSS, AOBP and special skill test scores on the academic achievement score and to determine to the

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cut-off points of these variables. In this study, academic achievement scores of the students were used as gold standard score. This score is 60 points. Students who have 60 or more are viewed successful.

Findings and Results: ROC analysis revealed that Maximum sensitivity+specificity value were found 234.601 for OSS score. If this value is selected as the cut-off point, 91.7% of students who are successful according to academic success average estimated true. This variable is significant ($p<0.05$). Maximum sensitivity+specificity value was found as 78.346 for AOBP score. If this value is selected as the cut-off point, 75% of students who successful according to academic success average estimated true. This variable is significant ($p<0.05$). Maximum sensitivity+specificity value was found 139 for shuttle runs score. If this value is selected as the cut-off point, 41.7% of students who are successful according to academic success average estimated true. This variable is not significant ($p>0.05$). Maximum sensitivity+specificity value was as found 29.45 for coordination score. If this value is selected as the cut-off point, 25% of students who are successful according to academic success average estimated true. This variable is not significant ($p>0.05$).

Keywords: Cutoff points, ROC curve, private skill tests, gold standart point

The main purpose of special skill tests, held for taking students for departments such as physical education, art and music, is to choose "talented" students among prospective candidates who may be successful in the academic sense after entering the department (Peker, 2003). Content of the academic program of departments of physical education does not include only practical courses. As well as practice courses, nature of theoretical courses is included in curricula of these departments. So, making students equipped with theoretical aspects of the sport and raising educators that demonstrate good model with practices is one of one of the goals of these departments. Therefore, when students are placed in physical education departments, Undergraduate Placement Exam (LYS) score and weighted high school grade scores (AOBP) are taken into account as well as capability tests (Erten and Tiryaki, 1999).

There are several factors that may interfere with a reliable and valid measure of actual levels about measured features of selection and placement tests. Impact of these factors and determination of predictive variables of these exams been investigated in various studies. (Dođan and Őahin, 2009). It is expressed in conducted researches that when students are placed in physical education students, scores obtained from skill tests should be taken into account with OSS scores, test scores are especially effective in predicting success in the first classes and OSS scores even may be more effective in the selection of appropriate student. In addition, it is stated that AOBP first predicts general academic achievements of the students studying in this department and there is a negative correlation between achievements of students and scores obtained from skill tests. (Saracođlu et al., 1998; Őamlıyer et al., 1999; Yalĉiner et al., 2001; Gelbal and Demirhan, 2002; Peker, 2003; Author, 2011).

In statistical analysis, taking into account the characteristics of individuals, differences or relationships between the variables are investigated. Depending on the reason so many events occurring in everyday life, they may show a complex structure. (Dirican, 2001). Sometimes, for standard test or a more practical test, determination of cutoff points may be needed for least erroneous or correct classification. ROC (Receiver Operating Characteristic) curve is one of the methods used for finding cutoff point. (Alpar, 2010).

ROC curve method, developed for removal of radio signals from noise during the Second World War, is based on statistical decision theory. The method, which is used to demonstrate the effectiveness of classification of the good and bad cells of Pap Semar test, was used in experimental psychology in the mid 1960s. In recent years, this method is used frequently on diagnostic radiological studies (Zweig and Campbell, 1993; Elmalı, 2009).

In order to evaluate a test with ROC curve method, gold standard that spells out the exact status of the data and sequential or continuous test results showing binormal distribution are needed. With reference to the gold standard, performance of the test is graphically evaluated (Elmalı, 2009). The maximum value of the area under the ROC curve can take is one. When value of area closes to 1, distinctiveness of the test increases, when closes to 0.50, distinctiveness reduces, when it is equal to 0.50, it indicates that new test has no distinctiveness (Alpar, 2011). If the area under the ROC curve is 0.975 or above, or between 0.9-1.0 is excellent, between 0.8-0.9 is very good, between 0.7-0.8 good, between 0.6-0.7 is medium and between 0.5-0.6 can be described as weak (Dirican, 2001; Demir and İntepeler, 2012).

In this paper, the primary concern is determination of the variables which can be used instead of the gold standard. ROC curve method provides useful information to compare the results of the different diagnostic tests. This method also provides determination of the distinctiveness power of the test and appropriate cut-off points of the success. Hence, this paper, with reference to gold standard, aims to examine OSS, AOBP, shuttle run and degree of coordination scores in order to determine of the academic success of students.

The objective of this study is to investigate distinctiveness properties of OSS, AOBP, shuttle run and the degree of coordination, which are used in entrance exams of Department of Physical Education and Sports Teacher of Yuzuncu Yil University, on students' academic achievement by using ROC curve method.

In this context, problem statement of the study can be expressed as "What are cutoff points and distinctiveness level of exams those are applied for entrance to Department of Physical Education and Sports Teacher of Yuzuncu Yil University?"

Method

Research Design

In this research, general scanning model was used. This model is an approach that aims to describe exactly the current state of the past and present. There is no attempt to change and affect to the status of the research topic (Karasar, 2010).

Research Sample

The data used in this study belongs to students studying in Department of Physical Education and Sports Teacher of Yuzuncu Yil University. Information about total of 40 students, including 25 (62.5%) men and 15 (37.5%) women were used.

Research Instrument and Procedure

The data used in this study consists of scores obtained from skill tests (degree of coordination and track shuttle), Student Selection Examination (OSS), weighted high school grade point average (AOBP) and academic grade point average of the first semester.

Data Analysis

ROC curve was used to determine cutoff points and evaluation of performances of OSS score, AOBP, coordination trail and shuttle run variables on average academic achievement. ROC curve is often used when two groups independently of each other are distinguished with the aid of a test obtained from numeric data. In order to establish the ROC curve, the actual status of the individuals involved in the study must be determined precisely with the aid of a test called gold standard. Therefore, success (+) and failure (-) values in the data set of individuals are arranged in order of magnitude and then number of successful and unsuccessful individuals is shown on 2x2 sized cross-table indicated in Table 1.

Table 1.

Relationship Between Gold Standard and Test Results

Test Result	Gold Standard		Total
	Successful (+)	Unsuccessful (-)	
Successful (+)	A(RS)	B(FP)	A+B
Unsuccessful (-)	C(FN)	D(RU)	C+D
Total	A+C	B+D	N

Note. A(RS)=real successful. C(FN)=false-negative. B(FP)=false-positive. D(RU)=real unsuccessful

When expressions given in Table 1 are analyzed, A compartment represents number of real successful individuals who are successful as a result of the test and indicated as real successful (RS). B compartment represents number of unsuccessful

individuals mistakenly considered as successful in result of the test and indicated as false-positive (FP). C compartment represents number of successful individuals according to gold standard but those failed in the test and they are indicated as false negative (FN). D compartment represents number of real unsuccessful individuals who failed as a result of the test and indicated as real unsuccessful (RU). Taking into account the frequency values given in Table 1, the following ratios can be calculated for the performance of the test (Dirican, 2001; Alpar, 2010; Akçay and Demirel, 2011; Demir and İntepeler, 2012).

Sensitivity: It indicates how sensitive the test is successful at eliciting individuals.

$$\text{Sensitivity} = \frac{A}{A + C} = \frac{GB}{GB + YN}$$

Selectivity: It indicates percent of real unsuccessful individuals distinguished as failure as a result of developed test.

$$\text{Selectivity} = \frac{D}{B + D} = \frac{GBZ}{YP + GBZ}$$

False negative rate. It is rate of individuals mistakenly considered as failure as result of developed test although they are successful.

$$\text{False Negative Rate} = \frac{C}{A + C} = \frac{YN}{GB + YN}$$

False positive rate. It is rate of individuals mistakenly considered as successful although they failed in result of developed test.

$$\text{False Positive Rate} = \frac{B}{B + D} = \frac{YP}{YP + GBZ}$$

In determining the validity of a test used instead of the gold standard, sensitivity and specificity values are of great importance, in a good test these values are desired to be 1 or close to 1 (Alpar, 2010).

In this study, academic achievement of students at the end of year is handled as gold standard, students who have 60 points and over are referred as successful, students fail to score on this scale has been described as unsuccessful. Success state is encoded with "1" while failure status is encoded with "0". All values in data set are taken as cutoff points and for each cutoff point, sensitivity and specificity values are calculated. "Sensitivity" values are located in Vertical axis of the curve while "1-specificity" values are in horizontal axis. In order to determine the best cutoff point value, point where sensitivity + specificity value is greatest, is taken as cutoff point or the point where the curve closest to the upper left corner of the graph is taken as cutoff point (Dirican, 2001; Tomak and Bek, 2010).

Results

To draw the ROC curve of the data included in the study, and hence, to evaluate students as success or failure by looking at OSS, AOBP, shuttle and coordination degree, sensitivity and specificity values were calculated for each individual based on these values as cutoff points. The information obtained for OSS, AOBP, shuttle run score and degree of coordination are as shown in Table 2.

Table 2.

ROC Analysis Results According to Variables

<i>Variables</i>	<i>Cutoff point values</i>	<i>Sensitivity</i>	<i>1-Selectivity</i>	<i>Selectivity</i>	<i>Sensitivity + Selectivity</i>
OSS	234.601	0.917	0.250	0.750	1.667
AOBP	78.346	0.917	0.429	0.571	1.488
Shuttle run	139	0.417	0.179	0.821	1.238
Coordination	29.45	0.250	0.143	0.857	1.107

Note. OSS = university student selection exam. AOBP = students' academic success in their secondary school.

As shown in Table 2, 234.601 points was found to be the best cutoff point for evaluating students as success or failure according to OSS scores. The largest sensitivity + specificity value has been reached when this point value is selected as cutoff point. When 234.604 points is selected as cutoff point to determine the status of academic achievement, 91.7% of real successful individuals were found as successful. 78.346 points is the best cutoff point according to AOBP values of students. According to this point value, 91.7% of real successful individuals were found as successful. When shuttle run values are examined, the highest sensitivity + specificity value is obtained from 139 shuttle run degree cutoff point. But, probability of distinguishing real successful individuals is very low (%41.7). This situation can be considered as an indication that sensitivity of shuttle run test is insufficient. The same situation applies to the degree of coordination test. The best cutoff point value for this test was obtained as 29.45 sec. This cutoff point value distinguishes only 25% of real successful students as successful. ROC curves obtained for OSS, AOBP, shuttle run and coordination tests are as shown in Figure 1.

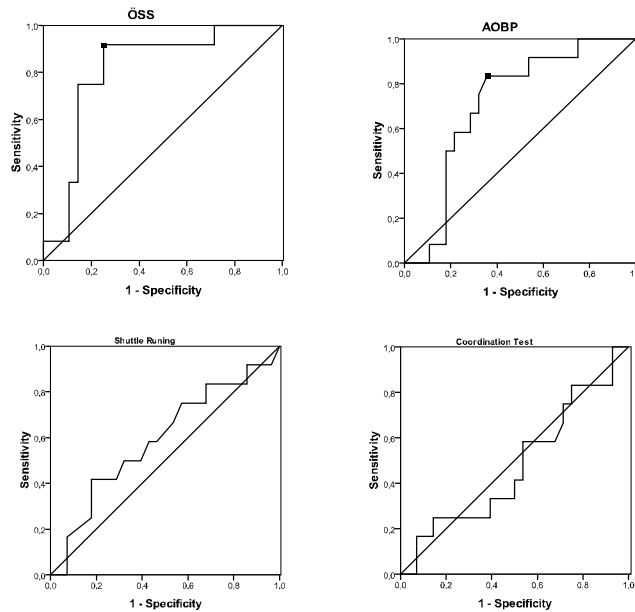


Figure 1. ROC Curve created for selected variables

When curve charts in Figure 1 are analyzed, the place where ROC curve, generated by the students' 1-specificity values, is closest to the upper left corner of the graph is shown on the graph. As a result of the analysis, value of the area under the ROC curve for OSS scores variable is obtained as 0.812. Value of the area under the ROC curve is found as 0.713 for AOBP variable. For OSS score and AOBP variables, these values are above the acceptable level. For Shuttle run variable, value of the area under the ROC curve is calculated as 0.591 whereas value of this field for coordination degree is 0.478. These results can be expressed as variables have a very weak level of distinguish power.

Z statistic was used for importance control of distinctness from 0.5 of the areas under the curve. The areas under the ROC curve and importance controls for OSS, AOBP, shuttle and coordination track values are obtained as noted in Table 3.

Table 3.

The Areas Under the ROC Curve for OSS, AOBP, Shuttle and Coordination Track Values and Importance Controls

Variables	AUC	SE	Z	p	%95 confidence interval of AUC	
					Min	Max
ÖSS	0.812	0.074	4.16**	0.002	0.668	0.957
AOBP	0.713	0.038	2.82*	0.030	0.554	0.872
Shuttle Run	0.591	0.101	0.87	0.368	0.392	0.789
Coordination	0.478	0.102	-0.21	0.825	0.278	0.677

AUC: Area Under the Curve. * $p < .05$. ** $p < .01$

In Table 3, remaining areas under the ROC curve of variables and importance controls of distinctness of these areas from 0.5 are shown. When obtained information is evaluated, it has been detected that OSS score and AOBP significantly differ from ROC curve reference point 0.5 and may be an important factor in distinguishing successful students.

Discussion and Conclusion

Departments of physical education and sports teacher that receive students with special skill exams, as well as ability tests OSS and AOBP can have serious effects. With this study, determining cutoff points and evaluation of performance of these variables on academic achievement were aimed.

In a study conducted in 2002 by Gelbal and Demirhan, it is expressed that the best predictors of academic success in first grade is OSS score. In this study, it has been detected that the area under the ROC curve is significant and have a significant influence on distinguishing students with high academic achievement. When 234,601 points is selected as the best cutoff point to qualify students as success or failure according to OSS score, 91.7% of real successful individuals were correctly found as successful and 75% of real unsuccessful individuals were correctly found as unsuccessful. As the gold standard score is considered as passing grade (60 points), it has been observed that academic achievement of individuals with 234,601 OSS score are distinguished accurately.

AOBP or weighted high school gpa is a important predictor for many examination, especially for college entrance exams (Erten and Tiryaki, 1999; Çakan and Kaplan, 2007; Author, 2011). The area under the ROC curve, created for AOBP, is significant that this variable has an indication of the high power of distinguishing. According to this variable, when 78 346 points is selected as the best cutoff point to qualify students as success or failure, 91.7% of real successful individuals were correctly found as successful and 57.1% of real unsuccessful individuals were correctly

found as unsuccessful. This situation shows that academic achievement of 92% of individuals with 78,346 AOBP points or higher has been estimated correctly.

The best cutoff point was determined as the 139 degree shuttle run to qualify students as success or failure according to 60 academic achievement scores. In other words, when 139 degree shuttle run is selected as cutoff point for 60 points, 41.7% real successful individuals were correctly found as successful and 82.1% real unsuccessful individuals were correctly found as unsuccessful. This indicates that shuttle run variable as low sensitivity.

When 29.45 sec is selected as the best cutoff point to qualify students as success or failure according to coordination degree, %25 of real successful individuals was correctly found as successful and %85.7 of real unsuccessful individuals was correctly found as unsuccessful, accordingly, sensitivity is determined to be low.

The area under the ROC curve can take values between 0.50 and 1.00 depending on the level of activity. Diagnostic test is carried out for the successful and unsuccessful students may have stronger ability to distinguish depending on bigness of the area (Dirican, 2001; Demir and İntepeler, 2012). In this study, the area under the ROC curve for OSS variable was obtained as 0.812. Therefore, as the area under the ROC curve that belongs to OSS variable is between 0.8-0.9, it can be expressed that the variable has very good level of distinction. Likewise, the area under the ROC curve which is calculated as 0.713 for AOBP variable shows that the variable has a good level of ability to distinguish. The area under the ROC curve which is calculated as 0.591 for shuttle variable and 0.478 for coordination variable shows that these variables have a poor level of ability to distinguish (Demir and İntepeler, 2012).

Diagnostic tests used in distinguishing between successful and unsuccessful individuals have been widely used in many fields. Early and accurate diagnosis and determining status successfully provides taking necessary measures in the educational process (Dirican, 2001). Most appropriate threshold for positivity should be selected for using diagnostic method successfully. In other words, purpose is to find cutoff point values that provide least erroneous or error-free classification. Taking the point where sensitivity selectivity value is greatest as cutoff point is one of the methods used to determine the best cutoff point value (Alpar, 2010; Akçay and Demirel, 2011).

In conclusion, in this study, it has been observed that by taking the point where sensitivity selectivity value is greatest as cutoff point, especially OSS and AOBP variables may be used as a method of diagnosis help to distinguish students' academic achievement in the first semester. As it is simple and easy for visually monitoring, ROC curve calculation techniques has a structure that can be used easily in all aspects of education in order to distinguish successful and unsuccessful students terms of variety of variables.

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Özel Yetenek Sınav Puanlarını Etkileyen Faktörlerin Kesim Noktalarının Belirlenmesi: ROC Eğrisi Yaklaşımı

Atf:

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Özet

Problem Durumu: Özel yetenek sınavları ile öğrenci alan bölümlerdeki eğitim-öğretim programının içeriği sadece uygulamalı derslerden oluşmamaktadır. Uygulama derslerinin yanı sıra kuramsal nitelikteki dersler de bu bölümlerin müfredat programları içerisinde yer almaktadır. Beden eğitimi bölümlerine öğrenci yerleştirilirken uygulanan beceri testlerinin yanı sıra Öğrenci Seçme Sınavı (ÖSS) puanı ve ağırlıklı ortaöğretim başarı puanları da (AOBP) dikkate alınarak değerlendirme yapılmaktadır. Yapılan ölçme işlemlerinin geçerli ve güvenilir bir şekilde uygulanmasına engel olabilecek çeşitli faktörler söz konusudur. Çeşitli araştırmalarda, beden eğitimi bölümlerine öğrenci yerleştirilirken öğrencilerin yetenek testlerinden elde etmiş oldukları puanlar ile birlikte ÖSS puanlarının da dikkate alınması gerektiği, özellikle sınav puanlarının ilk sınıflardaki başarıyı belirlemede etkili olduğu, ÖSS’de yüksek puan alan öğrencilerin yetenek testlerinde de başarılı olabildikleri hatta ÖSS puanlarının isabetli öğrenci seçiminde daha etkili olabileceği ifade edilmektedir. Belirtilen bu durumlar dikkate alındığında yapılan çalışmaya ilişkin problem durumu “Yüzüncü Yıl Üniversitesi Beden Eğitimi ve Spor Öğretmenliği Bölümü’ne girişte uygulanan sınavların (tanı testlerinin) ve puanların kesim noktaları ve ayırt edicilik düzeyi nedir?” biçiminde ifade edilebilir.

Çalışmanın Amacı: Yapılan bu çalışmanın amacı, Yüzüncü Yıl Üniversitesi Beden Eğitimi ve Spor Öğretmenliği Bölümü giriş sınavlarında yerleştirme puanının belirlenmesinde kullanılan ÖSS, AOBP, mekik koşusu ve koordinasyon derecelerinin, ROC eğrisi yöntemi kullanılarak, öğrencilerin akademik başarı durumları üzerindeki ayırt edicilik özelliklerinin araştırılmasıdır.

Araştırmanın Yöntemi: Yapılan çalışmada kullanılan veriler Yüzüncü Yıl Üniversitesi Beden Eğitimi ve Spor Öğretmenliği bölümünde okuyan öğrencilerin özel yetenek sınavından elde etmiş oldukları mekik ve koordinasyon parkur dereceleri ile öğrenci seçme sınavı (ÖSS), ağırlıklı orta öğretim başarı puanı (AOBP) ve birinci yarıyıl akademi başarı ortalamalarına ait verilerdir. Çalışmada 25 erkek ve 15 bayan olmak üzere toplam 40 öğrenciye ait bilgiler kullanılmıştır.

Araştırmanın Bulguları: ÖSS puanlarına göre en büyük duyarlılık+seçicilik değerine kesim noktası olarak 234.601 puan seçildiğinde ulaşılmıştır. ÖSS puanı için ROC eğrisi altında kalan alanın değeri 0.812 olarak elde edilmiştir. AOBP’na göre en büyük duyarlılık+seçicilik değerine kesim noktası olarak 78.346 puan seçildiğinde ulaşılmıştır. Öğrencileri başarılı ya da başarısız olarak nitelemek için en iyi kesim noktası 78.346 puan olarak belirlenmiştir. AOBP değişkeni için ROC eğrisinin altında kalan alanın değeri 0.713 olarak elde edilmiştir. Öğrencileri başarılı ya da başarısız olarak

nitelemek için en iyi kesim noktasının 139 mekik derecesi olduğu sonucu elde edilmiştir. Mekik koşusu derecesi değişkeni için ROC eğrisinin altında kalan alanın değeri 0.591 olarak elde edilmiştir. Koordinasyon parkuru derecelerine göre en büyük duyarlılık+seçicilik değerine kesim noktası olarak 29.45 sn koordinasyon parkuru derecesi seçildiğinde ulaşılmıştır. Koordinasyon parkuru derecesi değişkeni için ROC eğrisinin altında kalan alanın değeri 0.478 olarak elde edilmiştir. Değişkenlerin ROC eğrisi altında kalan alanları ile bu alanların 0.5'ten farklılığının önem kontrolleri için yapılan testlerden elde edilen bilgiler değerlendirildiğinde ÖSS puanının ve AOBP'nun ROC eğrisinin referans noktası olan 0.5'ten anlamlı olarak farklılık gösterdiği ve başarılı öğrencileri ayırmada önemli etken olabilecekleri belirlenmiştir.

Araştırmanın Sonuçları ve Öneriler: Bu çalışmada, ÖSS puanının akademik başarısı yüksek olan öğrencileri ayırmada önemli güce sahip olduğu belirlenmiştir. ÖSS puanına göre öğrencileri başarılı ya da başarısız olarak nitelendirmek için en iyi kesim noktası 234.601 puan olarak seçildiğinde, gerçekte başarılı olan bireylerin %91.7'sinin doğru olarak başarılı ve gerçekte başarısız olan bireylerin de %75'inin doğru olarak başarısız bulunduğu sonucu elde edilmiştir. Bu durumda altın standart puanı olarak geçme notu olan 60 puan düşünüldüğünde OSS puanı 234.601 ve üzerinde olan bireylerin yaklaşık %92'sinin akademik başarı durumunun doğru tahmin edildiği belirlenmiştir. Ağırlıklı ortaöğretim başarı puanı 78.346 ve üzerinde olan bireylerin yaklaşık %92'sinin akademik başarı durumunun doğru tahmin edildiği belirlenmiştir. Yapılan çalışmada ÖSS değişkeni için ROC eğrisi altında kalan alan 0.812 olarak elde edilmiştir. Dolayısıyla ÖSS değişkenine ait ROC eğrisi altında kalan alan 0.8-0.9 arasında olduğu için bu değişkenin çok iyi derecede ayırım yeteneğine sahip olduğu belirlenmiştir. Aynı şekilde AOBP değişkeni için 0.713 olarak hesaplanan ROC eğrisi altında kalan alan bu değişkenin ayırım yeteneğinin iyi düzeyde olduğunu göstermektedir. Mekik koşusu için ROC eğrisi altında kalan alanın 0.591 ve koordinasyon değişkeni için ise ROC eğrisi altında kalan alanın 0.478 olarak elde edilmesi bu değişkenlerin ayırım yeteneklerinin zayıf olduğunu belirtmektedir.

Başarılı ve başarısız bireyleri ayırt etmede kullanılacak olan tanı testleri modern teknolojinin kullanıldığı pek çok alanda yaygın olarak kullanılmaktadır. Bir tanı yöntemini başarılı bir şekilde kullanabilmek için en uygun pozitiflik eşiği seçilmelidir. Diğer bir ifade ile amaç; en az hatalı ya da hatasız sınıflamanın yapılmasına olanak sağlayacak kesim noktasının bulunmasıdır. Duyarlılık+seçicilik değerinin en büyük olduğu noktanın kesim noktası olarak alınması en iyi kesim noktasının belirlenmesi için kullanılan yöntemlerden biridir. Yapılan çalışmada, duyarlılık+seçicilik değerinin en büyük olduğu nokta kesim noktası olarak alınarak özellikle ÖSS ve AOBP değişkenlerinin öğrencilerin birinci yarıyıl akademik başarılarını ayırt etmede yardımcı tanı yöntemi olarak kullanılabilirlikleri sonucuna ulaşılmıştır. ROC eğrisi hesaplama teknikleri basit ve görsel açıdan izlenmesi kolay olan bir yöntem olduğundan dolayı eğitimin her alanında başarılı ve başarısız öğrencileri çeşitli değişkenler bakımından ayırt etmek amacı ile rahatlıkla kullanılabilir bir yapıya sahiptir.

Anahtar Sözcükler: Kesim noktası, ROC eğrisi, özel yetenek testleri, altın standart puan