



Developing a Scale for Both Students and Facilitators to Evaluate Problem Based Learning Efficiency

Öğrenci ve Öğretim Elamanları için Probleme Dayalı Öğrenim Etkinliğinin Değerlendirilmesi Ölçeğinin Geliştirilmesi

Evaluate Problem Based Learning Efficiency

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Özet

Amaç: Bu araştırmanın amacı, probleme dayalı öğrenmenin (PDÖ) etkinliğini değerlendirmeye yönelik öğrenci ile eğitim yönlendiricisi için geliştirilen bir ölçme aracının geçerlik ve güvenilirlik analizlerini yapmaktır. **Gereç ve Yöntem:** Literatürde PDÖ'nün klasik eğitime göre öğrenciyi daha fazla yarar sağladığı kabul edilen konular derlenerek öğrenciler için, üç alt boyutta (bilgi (5), beceri (7) ve tutum (7) olmak üzere) 19 madde, öğretim elemanları için ise tek alt boyutta ve 14 maddeden oluşan bir ölçme aracı geliştirilmiştir. Ölçekteki her bir madde için, 1 (kesinlikle katılmıyorum) ile 5 (tümüyle katılıyorum) arasında Likert tipi beş seçeneğin birisinin işaretlenmesi istenmiştir. Akdeniz Üniversitesi Tıp Fakültesi dönem I öğrencileri (n= 1265) ve PDÖ de eğitim yönlendiricisi olarak görev alan öğretim elemanlarından (n=392) oluşan iki farklı çalışma grubu araştırma grubunu oluşturmuştur. **Bulgular:** Bu ölçeğin yapı geçerliği incelenirken tüm alt boyutlarda Karşılaştırmalı Uyum İndeksi (CFI) > 0.9 Standardize Ortalama Hataların Karekökü (SRMR) 0.05 ve Yaklaşık Hataların Ortalama Karekökü (RMSEA) 0.07 olarak bulunmuştur. Cronbach Alfa değeri bilgi boyutunda 0.72, beceride 0.81, tutum boyutunda 0.73, ölçeğin tümü içinse 0.86 olarak hesaplanmış ve kabul edilebilir düzeyde bulunmuştur. Ölçeğin öğretim elemanı boyutunun yapı geçerliği incelenirken Karşılaştırmalı Uyum İndeksi (CFI) > 0.9 Standardize Ortalama Hataların Karekökü (SRMR) 0.04 ve Yaklaşık Hataların Ortalama Karekökü (RMSEA) 0.09 olarak bulunmuştur. Cronbach Alfa değeri 0.96 olarak hesaplanmış ve kabul edilebilir düzeyde bulunmuştur. **Tartışma:** Yapılan analizler sonucunda ölçeğin öğrenci boyutunun 16, öğretim elemanı boyutunun 14 madde üzerinden geçerli ve güvenilir bir ölçek olduğu saptanmıştır.

Anahtar Kelimeler

Tıp Eğitimi; Probleme Dayalı Öğrenim; Tıp Öğrencisi; Eğitim Yönlendiricisi

Abstract

Aim: The purpose of this study was to make validity and reliability analyses of a scale developed for both students and facilitators to evaluate PBL efficiency in medical education. **Material and Method:** A measuring tool was developed for the students and PBL facilitators by compiling evidence based facts in literature showing benefits of PBL against classical education. Scale for students (SS) composed of 19 items classified in 3 dimensions (knowledge (5), skill (7) and attitude (7)) while the scale for the facilitators (SF) had 14 items in one dimension. As an answer to the main question the participants were asked to give a score for each subject statement on a five item Likert-type scale between 1 and 5. First year medical students in Akdeniz University Faculty of Medicine (n=1265) and their facilitators in PBL sessions (n=392) composed of the study group. **Results:** Validity analysis results of the SS are as follows: Confirmatory Fit Index (CFI) >0.9, Standardized Root Mean Square Residual (SRMR)=0.05 and Root Mean Square Error of Approximation (RMSEA) = 0.07. Cronbach Alpha values for knowledge, skill and attitude dimensions were found 0.72, 0.81 and 0.73 respectively. Total reliability score of the SS was calculated 0.86. Validity analysis results of the SF are as follows: Confirmatory Fit Index (CFI) >0.9, Standardized Root Mean Square Residual (SRMR)=0.04 and Root Mean Square Error of Approximation (RMSEA) = 0.09. Cronbach Alpha value was found 0.96. **Discussion:** Consequently, the SS was determined to be valid and reliable for 16 items and the SF for 14 items.

Keywords

Medical Education; Problem Based Learning; Medical Students; Facilitator

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Introduction

Problem-Based Learning (PBL) is an education method being more widespread since 1969. One of the most important reasons for that is their benefit [1]. This education method gives the student skills of reasoning while solving problems, analyzing, and synthesizing, reaching information and commenting. Thus providing student with ability of developing knowledge and skill in the meantime, synthesizing and analyzing knowledge, and constant self-learning [2-5]. PBL, teaches the student to learn efficiently by being active, questioning, investigating, wondering, discussing with a little group instead of being a passive receiver. PBL teaches the student how and where to use the learned knowledge [6-10]. It helps student improve problem solving, make counter hypothesis, learning new knowledge to support this hypothesis skills. While doing this, it adds useful values for medical purposes to students such as scanning resources, using and evaluating them, group study and communication skills [11-14]. With the effect of these benefits, PBL is being used more in faculties of medicine each day.

One of the important components of education program is the evaluation. The reaction of the student for the applied methods, whether if it made a difference in student's knowledge, skill or attitude, whether if it reached the goals are main questions to be answered in evaluation [15]. It is also important to take note of comments of students, facilitators and executives which are part of the education programme. It is seen that PBL evaluation studies in litterateur mostly consists of questions about whether PBL is making a difference in contentment, knowledge and skill. Also the studies are either on students or on facilitators. In most of these researches, it is seen that researchers come to these conclusions from surveys or exam results. To our knowledge, there is no such a tool considering views of medical students and PBL facilitators together.

The purpose of this study was to make validity and reliability analyses of a measuring tool which has been used for program evaluation purposes since 2003 to determine opinions of students and facilitators on PBL.

Material and Method

Data Acquiring Tools

Scale to Evaluate Efficiency of PBL: When literature was examined it is noticed that different suggestions were made for evaluation. In this study, the stages suggested by, DeVelis (2003), Tavşancıl (2006), Tezbaşaran (1997) were followed [16-18]. In 2003, in direction of theoretical definition, present measuring tools in litterateur were examined and no record of a tool used to evaluate efficiency of PBL was found. In this case, acknowledged subjects in which PBL has more benefits than classic learning are taken into consideration and a measuring tool for students consisting of 19 items with 3 sub dimensions (Knowledge (5), skill (8), and attitude(6)) and for facilitators 14 items with one sub dimension was developed.

These written 3 items were prepared by taking opinions and suggestions of experts in field of medicine. Prepared items were then examined and edited by measuring and evaluating expert for comprehensibility and finally scale was prepared.

For each item in scale, 5 Likert type options were given between 1 (I totally do not agree) and 5 (I totally agree) and the person

answering the survey was asked to pick the most suitable answer for him/herself.

Study Group

For scale development operations, data was collected from 2 different study groups. First group was Akdeniz University Faculty of Medicine 1st semester students and second group was PBL directing facilitators in the same faculty. Data from 1161 people in first group and from 375 people in second group was acquired. First study group was used to determine psychometric features of the scale for students while second group was used to determine psychometric features of the scale for facilitators.

Acquiring Data

Taking legal consent, prepared scale was applied to 1st semester students at the end of the semester (May-June) since 2003. Also same scale was applied to facilitators working with PBL at the end of each semester since 2005 once in two years.

Items in each surveys, were asked as follows; "How did PBL help students in the following subjects?" for facilitators, and "How did PBL help you in the following subjects?" for students.

Analyzing Data

The statistical package for the Social Science (SPSS) was used. Group differences were analyzed using univariate analysis of variance (ANOVA). A principal component analysis was performed using Kaiser's criterion (Eigenvalue > 1), followed by an oblimin rotation. The internal consistency of the overall scale and subscales was measured by Cronbach's alpha coefficient. Confirmatory Factor Analysis (CFA) using LISREL [19].

The data showed univariate normal distribution, because the skewness and kurtosis values placed themselves within the range -1.0 and +1.0. The skewness values ranged from -.90 to +.11 while the kurtosis values ranged from -.97 to +.19. Also, correlation values were examined in order to state whether if there is a multiple connection problem or not. It is observed that values changed between .134 and .734. Since correlation value is below .90 there is no multiple connection problem [20].

As results of 3 items in survey for students are very low, they are subtracted from analysis and the statistical evaluation is made using 16 items.

Results

Exploratory Factor Analysis (Scale for students)

First of all, measures of sampling adequacy were conducted on the 17-item Scale for students (SS) to see whether it was suitable for factor analysis. Bartlett's test of sphericity indicated a chi square value of 4252,24, $p < 0.000$, while Kaiser-Meyer-Olkin measure of sampling adequacy indicates a value of 0.918. When a basic scree-test and eigenvalue at > 1.0 criteria were used, four factors were generated from the SS. The scree plot suggested that three factors should be extracted (Kline, 1994). These three factors, which were rotated through the varimax procedure, explained 55.04 percent of the variance (Table 2). Factor 1 (four items) accounted for 38.2 percent of the variance and measured interference with knowledge. Factor 2 (seven items) accounted for 13.0 percent of the variance and measured salience and skills. Factor 3 (five items) accounted

for 5.9 percent of the variance and measured overindulgence in attitude. The reliabilities of the MSLSS dimensions were assessed by Cronbach's a coefficient and each dimension's item-total correlations. Here acceptable criteria were $\geq .70$ for Cronbach's a coefficients [21]. (Table 1).

Table 1. Exploratory Factor Analysis (varimax rotation) of the Scale for students Items (N=1161).

No	Item	Factor 1 (Knowledge)	Factor 2 (Skill)	Factor 3 (Attitude)	Common Variance
1	I would learn subjects in PBL in shorter time with classic education	-.791			.656
2	I would learn subjects in PBL better with classic education	-.791			.653
3	I would have better grades in subjects I learned with PBL	.570			.599
4	PBL would affect my motivation better than classic education	.541			.536
5	PBL improves my communication skills		.678		.468
6	PBL improves my reason skills		.776		.669
7	PBL improves my problem solving skills		.799		.633
8	PBL improves my decision skills		.734		.470
9	PBL helps me approach the patient as bio psychosocial unity		.669		.289
10	PBL, helps me link basic sciences like anatomy, physiology with clinical sciences		.524		.572
11	PBL helps me tell my knowledge to other people		.521		.556
12	PBL helps me learn in life-time			.581	.497
13	PBL help me learn by myself by research			.602	.476
14	PBL helps me use library, internet more in order to reach knowledge			.703	.499
15	PBL helps me study more than usual			.682	.543
16	Group study used in PBL helps me learn			.566	.688
Cronbach Alpha		0.72	0.81	0.73	0.86

Confirmatory factor analysis of Scale for students

The evaluation of model fit was done by using confirmatory factor analysis (CFA). In order to perform the CFA, LISREL 8.7 was used and the model parameters were estimated by using

Table 2. Confirmatory Factor Analysis, ML: Method: Goog fit indexes

X ²	X ² /df	P-Value	NFI	TLI	CFI	GFI	AGFI	SRMR	RMSEA
189.14	189.14/71	0.0000	0.97	0.98	0.97	0.98	0.94	0.052	0.074

* p<0.01

maximum likelihood [20]. LISREL 8.5 provides a full range of goodness-of-fit measures. The three types of overall model fit measures useful in CFA can be represented by absolute, incremental and parsimonious fit.

In this study, in order to evaluate the absolute fit, X2 (X2: minimum fit function test), Root Mean Square Error of Approximation (RMSEA), goodness of fit index (GFI), and standardized root mean square residual (SRMR) were used. Adjusted goodness of fit index (AGFI), Normed fit index (NFI), Tucker-Lewis index (TLI), comparative fit index (CFI), were used as incremental fit measures. The results related to models were summarized in Table 2.

When table-2 was examined, the probability levels of all X2 statistics were less than 0.01, indicating a rather poor absolute fit [22]. X2 value usually gives significant value with large samples. For this reason, instead of using X2 value by itself, it is suggested to use calculated value to degree of freedom ratio. This ratio (X2/df) is wanted to be below 5. When Table 2 was examined, it is seen that X2 value (X2=189.14, sd=71, X2/df=2.66, p=.000) is significant. In fit indexes GFI, AGFI, NFI, TLI and CFI values above .90 means fine fit [23]. RMSEA and SRMR are wanted to be below <0.08. When calculated values are examined, it shows that there is an acceptable fit. The item-factor loading estimates, estimated error variances and t values in Table 3.

Convergent Validity Scale for students

Item reliability indicates the amount of variance in an item due to the underlying construct rather than to error. Either an item reliability of at least 0.50, or a significant t value, or both, observed for each item, is considered to be evidence of convergent validity [24]. As seen from Table. 3, all t-values of the items were significant and all item reliabilities were greater than 0.50, except one items.

The composite reliability of each construct is one of the principal measures used in assessing the measurement model and commonly used higher value for acceptable composite reliability is 0.70. [25] (Table 3).

Exploratory Factor Analysis (scale for the facilitators)

First of all, measures of sampling adequacy were conducted on the 14-item SF to see whether it was suitable for factor analysis. Bartlett's test of sphericity indicated a chi square value of 3806,54; p < 0.000, while Kaiser-Meyer-Olkin measure of sampling adequacy indicates a value of 0.937. When a basic scree-test and eigenvalue at > 1.0 criteria were used, four factors were generated from the SF. The scree plot suggested that three factors should be extracted. (Kline, 1994) These three factors, which were rotated through the varimax procedure, explained 58.22 percent of the variance (Table 4). Factor 1 (eight items) accounted for 58.22 percent of the variance and measured interference with. The reliabilities of the MSLSS dimensions were assessed by Cronbach's a coefficient and each dimension's item-total correlations. Here acceptable criteria were $\geq .70$ for Cronbach's a coefficients [21].

Confirmatory factor analysis of scale for the facilitators

The evaluation of model fit was done by using confirmatory factor analysis (CFA). In order to perform the CFA, LISREL

Table 3. Confirmatory Factor Analysis: Maximum likelihood estimates

No	No	factor loading estimates	t values	estimated error variances
1	I would learn subjects in PBL in shorter time with classic education	0.40	8.48	0.85
2	I would learn subjects in PBL better with classic education	0.54	11.98	0.70
3	I would have better grades in subjects I learned with PBL	-0.61	13.28	0.63
4	PBL would affect my motivation better than classic education	0.34	12.78	0.62
5	PBL,improves my communication skills	0.79	13.56	0.38
6	PBL improves my problem solving skills	0.63	16.49	0.60
7	PBL improves my decision skills	0.82	23.71	0.33
8	PBL helps me approach the patient as bio psychosocial unity	0.77	21.76	0.40
9	PBL,improves my communication skills	0.63	16.63	0.60
10	PBL, helps me link basic sciences like anatomy, physiology with clinical sciences	0.68	17.97	0.54
11	PBL helps me tell my knowledge to other people	0.29	6.25	0.92
12	PBL helps me learn in life-time	0.74	20.30	0.45
13	PBL helps me learn by myself by research	0.71	18.95	0.50
14	PBL helps me use library, internet more in order to reach knowledge	0.51	12.78	0.74
15	PBL helps me study more than usual	0.53	0.72	13.15
16	Group study used in PBL helps me learn	0.49	14.78	0.64

Table 4. Exploratory Factor Analysis (varimax rotation) of the scale for the facilitators' Items (n=375).

No	Item	Factor 1	Common Variance
1	PBL, improves learning motivation	,778	,394
2	PBL, improves reason skills	,805	,637
3	PBL improves problem solving skills	,834	,591
4	PBL improves decision skills	,812	,421
5	PBL helps me approach the patient as bio psychosocial unity	,765	,648
6	PBL improves communication skills	,755	,695
7	Improves integrate learned knowledge skills	,792	,628
8	PBL helps pass knowledge to other people	,769	,605
9	PBL helps life-time learning	,649	,569
10	PBL helps self-learning by research	,798	,644
11	Helps use library, internet more in order to reach knowledge	,722	,585
12	Helps filter desired knowledge from large subjects	,803	,521
13	Helps communications between people and group study	,744	,660
14	Prepares for Professional life better	,628	,553
Cronbach Alpha		,834	0.96

Table 5. Confirmatory Factor Analysis, ML: Method: Goog fit indexes

X ²	X ² /df	P-Value	NFI	TLI	CFI	GFI	AGFI	SRMR	RMSEA
299.65	299.65/70	0.0000	0.97	0.97	0.98	0.90	0.85	0.046	0.094

* p<0.01

8.7 was used and the model parameters were estimated by using maximum likelihood [20]. LISREL 8.5 provides a full range of goodness-of-fit measures. The three types of overall model fit measures useful in CFA can be represented by absolute, incremental and parsimonious fit.

In this study, in order to evaluate the absolute fit, X2 (X2: minimum fit function test), Root Mean Square Error of Approximation (RMSEA), goodness of fit index (GFI), and standardized root mean square residual (SRMR) were used. Adjusted goodness of fit index (AGFI), Normed fit index (NFI), Tucker-Lewis index (TLI), comparative fit index (CFI), were used as incremental fit measures. The results related to models were summarized in Table 5.

When Table 5 was examined, the probability levels of all X2 statistics were less than 0.01, indicating a rather poor absolute fit [22]. X2 value usually gives significant value with large samples. For this reason, instead of using X2 value by itself, it is suggested to use calculated value to degree of freedom ratio. This ratio (X2/df) is wanted to be below 5. When Table 2 was examined, it is seen that X2 value (X2=299.65, sd=70, X2/df=4.28, p=.000) is significant. In fit indexes GFI, AGFI, NFI, TLI and CFI values above .90 means fine fit [23]. RMSEA and SRMR are wanted to be below<0.08. When calculated values are examined, it shows that there is an acceptable fit. The item-factor loading estimates, estimated error variances and t values in Table 6.

Table 6: Confirmatory Factor Analysis: Maximum likelihood estimates

No	Item	Factor loading estimates	t values	Estimated error variances
1	PBL,improves learning motivation	0.77	17.20	0.41
2	PBL, improves reason skills	0.77	17.21	0.41
3	PBL improves problem solving skills	0.84	19.81	0.29
4	PBL improves decision skills	0.78	17.51	0.40
5	PBL helps me approach the patient as bio psychosocial unity	0.72	15.88	0.48
6	PBL improves communication skills	0.69	14.92	0.52
7	Improves integrate learned knowledge skills	0.78	17.62	0.39
8	PBL helps pass knowledge to other people	0.76		0.42
9	PBL helps life-time learning	0.59	12.09	0.66
10	PBL helps self-learning by research	0.78	17.55	0.40
11	Helps use library, internet more in order to reach knowledge	0.76	17.04	0.42
12	Helps filter desired knowledge from large subjects	0.69	17.72	0.53
13	Helps communications between people and group study	0.73	16.22	0.46
14	Prepares for Professional life better	0.56	11.38	0.69

Convergent Validity for scale for the facilitators

Item reliability indicates the amount of variance in an item due to the underlying construct rather than to error. Either an item reliability of at least 0.50, or a significant t value, or both, observed for each item, is considered to be evidence of convergent validity [24]. As seen from Table. 3, all t-values of the items were significant and all item reliabilities were greater than 0.50, except one items.

The composite reliability of each construct is one of the principal measures used in assessing the measurement model and commonly used higher value for acceptable composite reliability is 0.70 [25] (Table 6).

Discussion

As validity and reliability analyze results of scale which is developed to evaluate PBL events came out high, both scales are considered to be useful for evaluation. In student format of the scale, 3 items received low values in validity analyses and thus these items were subtracted for analyses. 3 subtracted items are; "I believe I will be more successful with my Professional life in subjects I learned with PBL", "PBL helps relations between people and group study", and "PBL helped me use internet to reach information".

Evaluation of Data Acquired from Scale:

Suggested method to evaluate the scale results; when comparing arithmetic averages in Likert-type survey items, interval coefficient of classification scale should be calculated using "row width/group number" formula. Classification scale was found 0.80 (5-1=4 and 4/5=0.80). Arithmetic average intervals which are taken primarily in evaluating findings are interpreted as follows; 1.00-1.80; "I totally do not agree", 1.81-2.60; "I do not agree", 2.61-3.40; "I partially agree", 3.41-4.20; "I agree", 4.21-5.00; "I totally agree".

Situations Where PBL Could be used

All the items in the scale are items in which PBL is specified to be more effective than classic learning. For this reason, it is thought to be helpful to evaluate the results of the scale whether if the results were the same with previous studies. The reasons for trying to show what is already shown before are the fact that different infrastructure for each school, different student, facilitator profiles, and different applications could give different results. Using the scale, there is a possibility to compare different faculties which are using PBL. It is known that PBL is becoming widespread in faculties of medicine. While some faculties have been using this method for a long time, some faculties are new to this subject. Also some faculties structured their education programme on PBL; some faculties are using hybrid programmes. Each faculty using PBL are expecting to benefit advantages and superiorities of this programme. So naturally, there is a question about the sufficiency of PBL. It is thought that the scale of which validity and reliability analysis were completed could be a solution to these questions.

In both scales, apart from the items which are analyzed, there are also suggestions like, "Are you content with PBL?" and "PBL is a helpful application for students in general" for facilitators. The answers for these suggestions should be expected to be "yes", "no", or "hesitant". These suggestions are not included in validity and reliability analysis. But as it is thought that these suggestions could help evaluate the results, they are added to the scale. Also some independent variables are added to facilitator scale such as, department of the facilitator (internal medicine, surgical etc.), title (prof. Associate prof. Expert etc.) how long and how many times the facilitator has been working with PBL. The results for these questions are added to instruc-

tion in order to be help for evaluation. Apart from this, other independent variables asked in a different survey could help evaluate the result. For example, for students sex, whether if they entered faculty of medicine voluntarily, success, and for facilitator, sex, age, working period in the faculty questions could be helpful for evaluation.

For a learning method being used more lately in faculties, being able to evaluate on a comparable scale in all faculties using the method, having both student and facilitator level is a strong side of this scale. Also in a large group, having high results in validation and reliability analysis is a positive side of this scale. Having both student and facilitator level is also a strong side of this scale.

Results

As a result, as validity and reliability analyze results of scale which is developed to evaluate PBL events came out high, both student and facilitator scales are considered to be useful in faculties which are using PBL for evaluation in acknowledged subjects in which PBL is more effective than classic learning.

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Competing interests

The authors declare that they have no competing interests.

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