

WCES 2010

Reliability and validity study of the achievement scale of electromechanic systems course

Özgür Yılmaz^a *, Koray Tunçalp^a, Ahmet Arslan^a

^aMarmara University, Göztepe Kampüsü, 34722, Istanbul, Turkey

Received October 22, 2009; revised December 31, 2009; accepted January 12, 2010

Abstract

The purpose of the study of Achievement Scale of Electromechanic Systems (ASES) is to introduce the achievements of the students studying this course, in their learning-teaching processes, and to contribute to evaluation and assessment of the acquisitions in this field. At the beginning of the reliability and validity study of the achievement scale, a question pool consisting of 100 questions was formed, by considering the subjects stated in the course program of the Electromechanic Systems Course as well as the target behaviors. In line with the opinions of the academicians and evaluation and assessment experts active in the field of Electromechanic Systems, some (60) of these questions were selected and used in the study. The study was carried out in two stages. In the first stage, a group consisting of 95 students studying this course in Marmara University Technical Education Faculty was subjected to achievement test and validity analysis. In consequence of this validity analysis, the items (20), validity levels of which were low and item difficulties of which remained out of the scientific criteria, were eliminated and the achievement test was applied again to the same group (95 students). Acceptable state (40) and correlation (r) of the achievement test of these two applications were considered. High-level positive relation was observed between the two tests ($r = 0.881$). The 20 questions over the significance level of 0.05 in all the item-total, item-remainder and item-distinctiveness relations were eliminated and the number of questions was reduced to 40. Cronbach alpha coefficient was found 0.802, calculated statistically as based on the variance of each question. In the second stage, the valid and reliable achievement test was applied to the same group consisting of 95 students 8 weeks later. High-level positive relation was observed between the two measurements of the valid and reliable achievement tests repeated 8 weeks later ($r=0.881$, $p<0.001$).

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Keywords: Achievement scale; electromechanic systems course; mechatronics education.

1. Introduction

Mechatronics technology covers knowledge and technology background mainly in three subjects as well as integrated practice of these subjects. These subjects are sensor technology, actuator technology and cognition

* Özgür Yılmaz. Tel.: + 90 (216) 336 57 70 / 656; fax: + 90 (216) 337 89 87
E-mail address: oyilmaz@marmara.edu.tr

technology (Erden, 2005). Although these subjects had been developed separately and they are different disciplines individually, integrating these subjects in a product and turning them into a usable product require special approaches and a special education.

Within the historical process, mechanization was provided first of all, as a consequence of the development of mechanical technology. However, the developing electronic technology was utilized and electromechanic systems were formed due to that the developing technological requirements could not be realized by only mechanization. Nevertheless, new supplemental technologies were looked for and the developing data processing technology was rapidly applied to electromechanic systems, due to that the advanced technology level and economical conditions were not sufficient (Erden, 2005). Electromechanic systems are important due to the fact that they constitute the final step before the Mechatronics Systems, which are the final point in the historical process of the Mechatronics Systems; and that they contain the first practice in the field of designing semi-smart devices by combining different disciplines in the education process. Additionally, containing four different disciplines, and the requirement of these disciplines to be composed within a design axis, render Mechatronics education difficult and different from the other single disciplines. The importance of Electromechanic Systems education in this difficult structure of Mechatronics education is that a model and basis are constituted by combining two different discipline design axis.

University period is the foundation stone of mechatronics education. When assessed from its aspect, enabling the students to be successful during their university period is very important. The change being experienced in the educational technologies surely affected the educational environments; and due to that effect, continuous adjustment of the educational environments in the light of new developments and its enrichment by new applications have become a requirement for enhancing the student success (Yılmaz, 2009).

The purpose of this study is to reveal the success of the students in their learning-teaching process, with intent to examine the effect of the “Web Supported Mixed Instruction Model” developed by combining the web supported teaching, one of the computer supported education methodologies, with the other teaching methods in accordance with the expectations of mechatronics education on student success; and to develop the Achievement Scale of Electromechanic Systems (ASES) in order to contribute to the evaluation and assessment of the acquisitions in this field.

2. Method

2.1. Development of Achievement Scale of Electromechanic Systems

The following processes have been followed for the development of the achievement scale.

2.1.1. Preparation of the Items

A question bank consisting of 100 questions was formed, by considering the subjects stated in the course program of the Electromechanic Systems Course as well as the target behaviors. In terms of the subject and contents of the course, those 100 items have been examined by 2 experts serving in the field of Electromechanic Systems. Additionally, the items have also been examined by 2 experts serving in the field of evaluation and assessment, in terms of form and definition, and then the required corrections have been made. At the end of the examinations and corrections carried out by the Subject and evaluation and assessment experts, some (60) of these items were selected and used in the study.

2.1.2. Study Group

In the development process of this scale, data of the 95 students, who had previously received Electromechanic Systems course that had been given in the department of Mechatronics Education, have been used. Classrooms of the department of Mechatronics Education consist of 32 students and the department has graduated 30 students yet. Consequently, the study group has been constituted with totally 95 students, 65 of whom were 3rd and 4th grade students in their education periods and 30 of whom were graduated students. Since there were no student, who has not pricked out any group of items on the scale systematically, data of any student has not been cancelled and consequently the analyses have been carried out over 95 people.

3. Analyses of the Data

The study has been carried out in two stages. In the first stage, a group consisting of 95 students was subjected to achievement test and validity analysis. In consequence of this validity analysis, the 20 items over the significance level of 0.05 in all the item-total, item-remainder and item-distinctiveness relations were eliminated and the achievement test, number of questions of which was reduced to 40, was applied again to the same group (95 students). Valid state (40) and correlation (r) of the achievement test of these two applications were considered. In the second stage, the valid and reliable achievement test was applied to the same group consisting of 95 students 8 weeks later. The test was checked to see whether it has pre-test/post-test reliability.

3.1. Item Analysis

Item Analysis is carried out with intent to calculate the item statistics, to select the items that can be included in the test, to determine the items that can be included in the test by being subjected to correction, and to sort out the items that cannot be included in the test (Baykul, 2000). In this study, item-total, item-reminder and item-distinctiveness relations were calculated separately.

In consequence of the item analysis processes of the Achievement Test of the Electromechanic Systems, the 20 items over the significance level of 0.05 in all the item-total, item-remainder and item-distinctiveness relations were eliminated and the number of questions was reduced to 40. The item analysis results received after the validity and reliability analyses of the achievement test are given in the Table 1

Table 1. The item analysis results received after the validity and reliability analyses of the achievement test

Item	N	Item Remainder r	p	Item Total r	p	Item Distinctiveness t	p
S1	95	0.254	0.018	0.298	0.003	-2.013	0.049
S2	95	0.226	0.027	0.299	0.003	-3.125	0.003
S3	95	0.224	0.029	0.293	0.004	-2.118	0.039
S4	95	0.288	0.004	0.368	0.000	-4.087	0.000
S5	95	0.335	0.001	0.394	0.000	-3.693	0.001
S6	95	0.200	0.055	0.273	0.007	-2.611	0.012
S7	95	0.233	0.019	0.315	0.002	-3.379	0.001
S8	95	0.216	0.035	0.292	0.004	-1.726	0.090
S9	95	0.231	0.022	0.294	0.004	-2.165	0.035
S10	95	0.256	0.014	0.325	0.001	-4.087	0.000
S11	95	0.368	0.000	0.443	0.000	-4.596	0.000
S12	95	0.185	0.076	0.246	0.016	-2.313	0.025
S13	95	0.376	0.000	0.443	0.000	-3.379	0.001
S14	95	0.211	0.026	0.302	0.003	-2.357	0.022
S15	95	0.189	0.062	0.262	0.010	-2.724	0.009
S16	95	0.174	0.108	0.237	0.021	-1.536	0.131
S17	95	0.432	0.000	0.497	0.000	-4.087	0.000
S18	95	0.266	0.009	0.341	0.001	-3.810	0.000

Table 1. The item analysis results received after the validity and reliability analyses of the achievement test (Cont.)

Item	N	Item Remainder r	p	Item Total r	p	Item Distinctiveness t	p
S19	95	0.262	0.010	0.326	0.001	-2.923	0.005
S20	95	0.316	0.002	0.364	0.000	-3.083	0.003
S21	95	0.213	0.168	0.213	0.038	-2.200	0.032
S22	95	0.313	0.001	0.390	0.000	-3.959	0.000
S23	95	0.181	0.080	0.251	0.014	-2.059	0.045
S24	95	0.231	0.032	0.296	0.004	-2.611	0.012
S25	95	0.211	0.048	0.273	0.007	-2.059	0.045
S26	95	0.205	0.048	0.272	0.008	-2.807	0.007
S27	95	0.172	0.107	0.241	0.019	-2.059	0.045
S28	95	0.244	0.022	0.302	0.003	-3.241	0.002
S29	95	0.266	0.008	0.341	0.001	-4.119	0.000
S30	95	0.277	0.005	0.360	0.000	-3.573	0.001
S31	95	0.268	0.008	0.344	0.001	-2.357	0.022
S32	95	0.385	0.000	0.450	0.000	-4.087	0.000
S33	95	0.478	0.000	0.521	0.000	-5.000	0.000
S34	95	0.328	0.001	0.397	0.000	-3.379	0.001
S35	95	0.335	0.001	0.400	0.000	-4.537	0.000
S36	95	0.190	0.064	0.265	0.009	-1.991	0.052
S37	95	0.340	0.001	0.396	0.000	-4.295	0.000
S38	95	0.393	0.000	0.454	0.000	-5.139	0.000
S39	95	0.451	0.000	0.513	0.000	-7.582	0.000
S40	95	0.159	0.132	0.233	0.023	-2.724	0.009

Item-distinctiveness is the comparison of the point averages given by the end groups (upper group and lower group, when the group is ordered from the highest point to the lowest according to the total points received from the scale) for each item. Lower and Upper groups constitute the 27% of the number of the students. The difference between the item averages of these lower and upper groups, constituted according to the total point of the test, is compared by independent group t-test (Büyüköztürk, 2002; Tavşancıl, 2002; Ergin, 1995).

At the first stage, where the data of totally 95 students were evaluated, the students were put in order according to the points received from the test. An independent group t-test was applied between the data of the 26 students included in the part constituting the 27% remained at the lowermost level according to that ordering and the data of the 26 students included in the part constituting the 27% remained at the uppermost. The results of that application are given in the Table 2 below.

Table 2. Results of the independent group t-test carried out on the data of the 26 students included in the part constituting the 27% remained at the lowermost level and the data of the 26 students included in the part constituting the 27% remained at the uppermost.

Achievement Test	N	Mean	ss	Sd	t	p
Lowermost %27	26	10.3077	4.1547			
Uppermost %27	26	25.5385	2.40384	50	-16.180	0.000

Table 2, distinctiveness of the achievement test for the successful and unsuccessful students is high.

Table 3. Internal consistency coefficients regarding the achievement test

	r	p
Cronbach Alfa	0.802	p<0.05
Spearman-Brown	0.757	p<0.05
Guttman	0.756	p<0.05

Internal consistency coefficients of the Achievement Test of the Electromechanic Systems are given in the Table 3 Cronbach Alpha coefficient calculated statistically as based on the variance of each question is 0.802. Kuder Richardson (KR20) reliability coefficient could be used at that stage as well. Cronbach Alfa coefficient can be used whenever Kuder Richardson (KR20) reliability coefficient can be used. However, the reciprocal of this is not possible. In other words, (KR20) reliability coefficient can be used only when the point scoring is on a two-option basis. As it is understood, Alfa coefficient is the generalized form of the KR20 reliability coefficient (Tan, 2008). Guttman and Spearman-Brown coefficients obtained with intent to separate the test into two halves equal to each other are 0.756 and 0.757 respectively. The highest value regarding the reliability of the test was founded 0.802 by use of Cronbach Alfa coefficient, whereas the minimum reliability value was founded 0.756 and 0.757 respectively, by use of Guttman and Spearman-Brown coefficients. These findings show that the Scientific Achievement Test prepared is reliable.

3.2. Consistency of Pre-Test/Post-Test

After all these processes, the valid and reliable achievement test was repeated 8 weeks later to the same group, from which the data of the validity and reliability studies were obtained. By the pre-test/post-test method, our test was checked to see whether it gives the same results in repeated measurements. The correlation analysis showing the relation of the data with one another, which were obtained from the application of our valid and reliable achievement test at 8-weeks intervals, is shown in the Table 4.

Table 4. Correlation of the repeated measurement of the achievement test

		First Measurement	Second Measurement
First Measurement	Pearson Correlation	1	0.881
	P		0.000
	N	29	29
Second Measurement	Pearson Correlation	0.881	1
	P	0.000	
	N	29	29

As seen in the table above, high-level positive relation was observed between the two measurements of the valid and reliable achievement tests repeated 8 weeks later ($r=0.881$, $p<0.001$). This data shows us the fact that our test gives the same result in repeated measurements as well.

4. Conclusion and Recommendation

The Cronbach alpha coefficient calculated statistically as based on the variance of each question is 0.802. Guttman and Spearman-Brown coefficients obtained with intent to separate the test into two halves equal to each

other are 0.756 and 0.757 respectively. The highest value regarding the reliability of the test was founded 0.802 by use of Cronbach Alfa coefficient, whereas the minimum reliability value was founded 0.756 and 0.757 respectively, by use of Guttman and Spearman-Brown coefficients. These findings show that the Scientific Achievement Test prepared is reliable. At the first stage, where the data of totally 95 students were evaluated, the students were put in order according to the points received from the test. An independent group t-test was applied between the data of the 26 students included in the part constituting the 27% remained at the lowermost level according to that ordering and the data of the 26 students included in the part constituting the 27% remained at the uppermost; and according to the data obtained, distinctiveness of the achievement test for the successful and unsuccessful students was found high.

Valid and reliable tests used for measuring the success are desirable for all the educators. Otherwise, the results obtained from the tests, which are not able to realize the purpose intended for measurement, would be misleading. By means of learning these methods, the academicians and teachers serving in the field of Mechatronics Education may develop acceptable and reliable achievement tests regarding nearly all the subjects; or they may examine the validity and reliability of the standard tests. By this means, they would have the opportunity of making test in a more reliable way to see whether the students have reached the desired targets or not. In consequence of the study carried out, it is ascertained that the scale called Achievement Scale of Electromechanic Systems (ASES) is a valid and reliable instrument that can be used in the field of education. This achievement test developed in the field of Electromechanic Systems has a structure able to be a model for the acceptable and reliable tests that will be prepared regarding this subject.

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