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Contribution of Video Analysis of Elevator Experiments to Physics Achievement

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Abstract

The purpose of the study is to examine contribution of the experimental course materials and course activities produced from video records of physics experiments carried out in an elevator cab on learning efficiency in physics course. Quantitative research methods comprise the study pattern. The study was carried out in two different schools. Experimental group consists of 27 students, while control group consists of 46 students. In the study, data was collected by applying "Demographic Questionnaire, Virtual Experimental Questioning, Motion Experiments and Activities in Elevator and Diagnostic Concept Test in Elevator (DCTE). The obtained data were interpreted after making reliability & effect size analyses and t-test & one way ANOVA statistics. Learning efficiency of the course was interpreted by calculating according to Hake's definition of learning gain. Reliability value of data obtained from DCTE is in 0.76; and significant differences were found in control and experimental groups. It is understood that the method applied to experimental group made significant and positive contribution to academic achievement of physics courses and learning efficiency in comparison to control group. Depending on study findings, *"*Using Experimental Video Course Materials in Elevator*"* can make positive contributions to secondary education physics curriculum.

Key words: Course Efficiency; Diagnostic Concept Test in Elevator (DCTE); Everyday Physics; Video Course Materials of Elevator Experiments

Introduction

One of the more efficient studies in terms of course efficiency when compared with conventional methods is "Interactive Education (IE) Method" (Hake, 2000). In this method, prepared guidance materials and teacher's course management as a guide gain importance. Basic qualities of this method are (Hake, 2007), receiving feedbacks instantly from student groups via discussions, and supporting conceptual learning by means of mental activities, continuously supported by experimental activities and students experienced by students. Thus, it is important to attract students' attention and making continuous questioning in order to make students do something or make them think. IE is defined as a method in which students have interactions with each other, teachers are as guides and guiding course materials are

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prepared as video documents (SERCH, 2003). In order to measure efficiency of the method applied, Hake's normalized gain formula was used (Hake, 2007). According to this formula, course efficiency is calculated as follows.

$$< g> = [(\% \text{ post-test}) – (\% \text{ pre-test})] / [(\%\text{Maximum Score} – \% \text{ pre-test})]$$

In order to find out the effect of applied methods, "effect size analysis" is also used. *Effect Size (ES)* concept defines the level of efficiency of an instructional application. Different from significance t-test, these sets of data are independent from sampling size. Effect size measurements can be assessed as an upper-analysis carried out in addition to analysis such as t-test summarizing findings of a study belonging to a specific field (Becker, 2000). The effect of course method is calculated from pre-test and post-test data obtained by means of a "*effect size calculator"* program (Wilson, 2010).

Physics experiments in elevator were developed in order to be applied to physics teacher candidates for their professional developing stage. However, in this study they were applied to secondary school students. Different motion types of elevator are videotaped by variable masses on a precision kitchen scale. These data are presented to students as physics course-experiment materials to contribute their better understanding of Newton's Laws of Motion. The instructor's role is crucial at this point Çorlu (1989, p:16) states that rather than being a transmitter of knowledge, the instructor needs to approach as a guide to student and arrange interesting video materials with students' activities (İrven, 2010; Hake, 2000). With the method used here, students were provided with the opportunity to examine and evaluate physics laws in daily life (İrven, 2010).

Method

Quasi experimental research design was preferred to examine the contribution of teaching method to students' success in a physics course in a secondary school (Black, 2005; Gay, 1996).

Teaching materials such as video recorded elevator experiments were used in the experimental group and traditional lecturing was used in the control group. All the precautions are taken to reduce the effect of confounding variables on the course performance.

Population of the Study and Sampling

Population of the study consists of students totally 73 students going to Anatolian High School (AHS) (N = 27) and Anatolian Teacher High School (ATHS) (N = 46) in Muradiye District of Van Province in spring semester of 2009-10 academic year. Sampling of the study consisted of 10th grade student receiving education in science classes of Muradiye Anatolian High School as experimental group and Alpaslan Anatolian Teacher High School as control group. Experimental group consists of N = 27 students from Muradiye Anatolian High School and control group consists of N = 46 students from Alpaslan Anatolian Teacher High School. Gender of students' population was (% 93) male and (% 7) female.

Data Collection

In this study, data was obtained with an instrument called "DTCE" (Diagnosted Concept Test for Elevator Experiments) developed by Corlu which consist of video recorded experimental activities (Irven, 2010; Coşkun, 2010). DCTE is a measuring instrument for diagnosing of Newtonian Concepts for elevator experiments (ibid.). It was found out that the data taken from this test comprising of 38 items and four sub-dimensions. Cronbach's Alpha

reliability coefficient was calculated as 0.86 in Coşkun's study (Coşkun, 2010). It provides opportunity to examine concepts under four sub-dimensions. These sub-dimensions consist of questions including fields of "motion concepts, force concept, inertial force concept and applying on bascule". DCTE has five point scale for each of first 32 questions which have the choices of "absolutely agree, agree, uncertain, disagree, absolutely disagree", while last six questions have the choices of such as "greater than (>), equal to (=) and less than (<).

Data Analysis and Methodology

The data were interpreted by using t-tests, effect sizes and one way ANOVAs. Learning efficiency of the courses was interpreted by calculating according to Hake's definition of learning gain (Hake, 2007). In this study, Cronbach Alpha reliability coeffficient obtained from DCTE data was 0,76 level. Effect sizes of applied methods were interpreted based on Cohen's d calculations of t-test values (Becker, 2000; Wilson, 2010). Generally course methods' effect sizes can be interpreted in literature as low ($d \leq 0,2$), medium ($0,2 \leq d \leq 0,8$) and high ($d \geq 0,8$) value intervals (Coşkun, 2010; Becker, 2000; Wilson, 2010).

Findings

DCTE and Findings of Course Efficiency

Data analyses of course methods applied to experimental and control groups depending on points obtained from DCTE in general are presented in Table 1. Depending on sub-dimensions of DCTE, analyses related to "motion concepts, force concept and applications on bascule are given in Table 2.

Table 1. DCTE Efficiency analysis data of experimental and control groups.

Group	N	pre-test average	post-test average	<%g>
Experimental Group	27	59.27	68.73	23.22
Control Group	46	67.62	72.36	14.64

Depending on data given in Table 1, it is seen that effect of course method applied to experimental group (<g>=0.23) is higher than effect of conventional course method applied to control group (<g>=0.14). However, it is observed that effects of both applications are low depending on normalized effect size values stated by Hake (1998). In spite of this, it can be expressed that course method supported by experimental video recorded materials used in elevator, which provides opportunity for students to learn actively, is more successful in contribution to physics achievement than conventional course method.

Table 2. DCTE analysis of data for experimental and control groups.

	Experimental Group N=27			Control Group N=46		
Sub-Concepts	Pre-test Average	Post-test Average	Gain <%g>	Pre-test Average	Post-test Average	Gain <%g>
Motion Concepts	63.39	69.19	15	70.91	74.2	11
Net Force	64.22	65.03	2	69.91	70.43	1
Bascule Application	47.77	74.9	51	64.02	69.57	15

Depending on data given in Table 2, effect size results of provided from sub-dimensions of the test is presented according to pre-test and post-test points of physics concepts identification test. According to DCTE results, in experimental group, learning gain for motion concepts is <%g=15>, while learning gain for net force is <%g=2>; and learning gain for bascule application is <%g=51>. In control group, however, learning gain for motion concepts is <%g=11>; learning gain for net force is <%g=1> and learning gain for application on bascule is <%g=15>. Questioning of inertial force for DCTE was omitted from this study.

Depending on data obtained, it is seen that effect sizes taken from the bascule application questions of experimental group is in medium level (Hake, 1998). In analysis carried out according to DCTE sub-dimensions, it can be suggested that course method applied to the experimental group has a higher effect than conventional course method applied to the control group.

The Effect of the Method

In order to examine the effect of course methods applied both to experimental and control groups, points taken in test was used as the measure (Doran and et al, 2002;). Data gathered from physics concepts identification test in elevator is presented in Table-3 and effect of course methods was examined based on the data presented.

Table 3. Pre- and Post-test mean values obtained from DTCE, t-test results and effect size scores as "Cohen's -d" for each group.

Application Groups	**N**	$\bar{X}$	**sd**	**df**	**t**	**p**	**Cohen's-d**
Experimental Group(A.H.S)							
Pre-test	27	112.62	12.41	26	6.87	0.000	1.565
Post-test		130.59	11.57				
Control Group(A.T.H.S)							
Pre-test	46	128.59	17.15	45	2.67	0.010	0.500
Post-test		137.50	19.90				

In p: 0.05 level

As a result of data presented in Table 3 by Effect Size Calculator program (Wilson, 2010) , it is seen that the effect of course method applied to experimental group (Cohen's-*d*=1.565) is higher. It is seen that the effect of course method applied to control group (Cohen's-*d*=0.500) is in medium level (Becker, 2000). Considering Table 3, it can be expressed that course method applied to experimental group (*d*=1.565) seems more effective than conventional course method applied to control group (d=0.500).

Findings Depending on School Type

In Table 4, number of participants (N), average points ($\bar{X}$), of AHL and ATHS students, standard deviation (sd), degree of freedom (df), t-test value and significance level (p) values of experimental and control group depending on school type are given.

Table 4. Pre-test and post-test application of DCTE data, depending on school types.

Groups	N	$\overline{X}$	sd	df	t	p
Experimental Group (AHS)						
Pre-test Application	27	112.62	12.41	26	6.87	0.000
Post-test Application	27	130.59	11.57			
Control Group (ATHS)						
Pre-test Application	46	128.47	17.15	45	2.67	0.010
Post-test Application	46	137.50	17.90			

In p: 0.05 significance level

According to data presented in Table-4, it is observed that there is a significant difference between pre-test and post-test scores of experimental group [$t(26)=6.87$; $p<.05$]. It is seen that post-test scores of the experimental group ($\overline{X}=130.59$) is greater than that of the pre-test ($\overline{X}=112.62$). Hence, it can be argued that the course method increased the achievement of the experimental group. It is observed that there is a significant difference between pre-test and post-test scores of the control group [$t(45)=2.67$; $p<.05$]. It is seen that post-test score of control group ($\overline{X}=137.50$) is greater than their pre-test score ($\overline{X}=128.47$). As a result, it may be said that the conventional course method applied to control group is also effective.

According to data given in Table 3 and Table 4, depending on the difference between pre-test and post-test scores, it can be seen that the gain of the experimental group ($p=0.000$) is higher than the control group ($p=0.010$).

Results and Discussion

"Experimental Video Course Materials in Elevator" was applied to experimental group while traditional lecture method was applied to control group. The efficiency of the courses and effect of the methods were examined by pre- and post- test application of DTCE instrument.

It was found out that effect of course method applied to experimental group ($\langle g \rangle=0.23$) was higher than effect of conventional course method applied to control group ($\langle g \rangle=0.14$). However, it was determined that effect sizes of both methods were low depending on normalized efficiency values determined by Hake (Hake, 1998).

Based on the data from the DCTE sub-dimension, it was observed that the course method yielded better achievement levels than the conventional method in the bascule application and this value was in medium level. Normally the effect size values of daily physics methods in the experimental group were generally higher compared to the conventional group (Hake, 1998). Hence, it can be concluded that the effect of course method applied to experimental group (Cohen's-d=1.565-high) was higher than the effect of conventional course method applied to control group (Cohen's-d=0.5 -medium).

The pre-test and post-test average score increased at the same time, but the rate of increase was higher in the experimental group. Although Rensselaer's Studio Physics courses might have led to active learning environments, conceptual learning gain was still low (Cummings and et al, 1999). Coşkun (2010) who used similar instructional method in his study, found a medium level effect which may be the result of not providing necessary learning opportunities.

Suggestions

In this study, we found that course efficiency in Interactive Education (IE) methods was higher compared to conventional methods (Hake, 1998; 2000; 2007). It was found out also in this study that efficiency of teaching with "experimental video course materials in elevator" was medium and/or high levels in comparison to conventional methods. In analyses carried out depending on sub-dimensions, it was determined that course efficiency of students was in low level in net force and motion concepts. As it is known, physics subjects are connected with each other. As a result of this, students' achievement levels in the concepts mentioned above might show a decline. For this reason, much more importance should be attached to studies providing conceptual learning of students (Costu, Ünal & Ayas, 2007; Çorlu, 1990).

Although efficiency value of course method applied is low, it was found out that effect of course method was higher than conventional method.

It is stated in related sources that the approach of developing learning environment design accepted in academic circles is not enough in increasing the course efficiency; and this should be supported with appropriate assessment methods (Gündüz and Corlu, 2008; Collette & Chiappetta, 1989).

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