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Students' Perceptions of Learning Effiency of Introductory Physics Course

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Abstract

The aim of this study was by using students' self-assessments to identify the learning efficiency of introductory (mechanics and waves) physics course connecting physics to students' everyday life. Physics is one of the most difficult courses for students, mainly because its presentation is theoretical, mathematical and abstract without everyday applications and examples. Moreover, connections to students' everyday life are crucial for learner's mental construction of the information they learn and for achieving meaningful learning. The findings of this study are significant in evaluating the learning efficiency of the physics course, which was presented by connection to students' everyday life. The sample consisted of a total of 92 first year undergraduates, 82 of which were male and 10 were female. Data was collected by a likert type scale which was prepared in line with the post-then-pre test method called "Students' Perceptions of Learning – Students' Self-Assessment" developed by the Author. Hake's formula was used in order to calculate learning efficiency. The findings of this study indicated that learning efficiencies were high for the areas in which students were interested in everyday life. Moreover, that learning efficiencies were higher for topics students had learnt before in comparison to new ones. Mean that learning efficiency of the lesson was calculated as 0,5 , which was between 0,3 and 0,7 , and thus indicated moderate learning efficiency.

Key words: Everyday Physics; Learning Efficiency; Post-Then-Pre Method; Self-Assessment; Students' Perception

Introduction

One of the most important aims of educational activities is to prepare individuals for real life. The information presented to individuals with these activities should ensure that individuals can make sense of events they might face in everyday life. Science subjects are crucial to accomplish these aims (Baran, Doğan & Yalçın, 2002; Yiğit, Devecioğlu & Ayvacı, 2002; Coştu, Ünal & Ayas, 2007; Ayas, Karamustafaoğlu, Sevim, & Karamustafaoğlu, 2001).

Educational dictionaries (Deeson, 2007; Avison, 2005) and physics educators (Hewitt, 2004; Romer, 1993; Lindenfeld, 2002) define physics, which is an essential science subject,

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as a branch of science which helps us make sense of natural events (Hewitt, 2004; Romer, 1993; Lindenfeld, 2002). On the other hand, according to students, physics is a course which presents formulas in order to solve problems in the course books and which has little relation to the real world (Redish, Saul & Steinberg, 1998).

As first year undergraduates could not connect physics to their everyday life, they found the course difficult (Aycan & Yumuşak, 2002; Hammer, 1994; Ayas et al. 2001; Trumper, 2006). Moreover, this perception was the same in the secondary school (Karaman, 2005). Abstract thinking and mathematics were required for success in physics, but not sufficient (Capizzo, Nuzzo & Zarcone, 2006). Mere theoretical presentation of physics courses without its applications as well as the provision of abstract and mathematical knowledge made physics incomprehensible for students (Aycan & Yumuşak, 2002; Hammer, 1994; Whiteleggy & Parry, 1999). In order to recover the perception of the physics course as abstract, not directly related to society and people, uninteresting, difficult and boring, we could connect it to students' everyday life and events (Aycan & Yumuşak, 2002; Hammer, 1994; Whiteleggy & Parry, 1999; Örnek, Robinson & Haugan, 2008).

Hence, it was demonstrated that students wanted to learn how physics was related to their surroundings and the society before studying physics intensively (Pritchard, Barrantes & Belland, 2009). Likewise, in a study on a total of 450 first year undergraduates by Prosser, Wlaker & Millar (1996), students stated that they learned physics better when it was presented in relation to everyday life events. Moreover, students perceived physics as studying the world around us or as understanding how the universe works. They further argued that the best way to learn physics was to think about what lies behind everything around us.

It is crucial to relate course topics to everyday life events in order to positively develop first year undergraduates' views about physics. A physics course based only on mathematical formulas and solving numerical problems prevented first year physics students from making sense of the concepts of physics (Chu, Treagust & Chandrasegaran, 2008).

According to Coştu and colleagues (2007) relating physics to everyday life would increase interest in physics, motivate students by improving attitudes and make conceptual teaching more efficient; because students would have an opportunity to construct their prior everyday life experiences and achieve meaningful learning by relating their prior knowledge to what they learn in the physics course (Coştu et al., 2007; Andrée, 2003).

According to the constructivist approach, educational activities should assist students in associating new knowledge with their previous knowledge and with everyday life events (Özmen, 2004). Implementing newly acquired information to different situations is a fundamental step in the constructivist approach. New concepts would be reinforced when students associate everyday life events with new information (Çepni, Ayas, Johnson & Turgut, 1997; Köseoğlu & Kavak, 2001).

Constructivist approach includes students' self-assessment in addition to teachers' assessment of the students. Students who learn to assess themselves will have higher self-confidence (Olina & Sullivan, 2004). On the other hand, students' self-assessments are an opportunity for the teacher to reconsider his/her teaching methods, philosophy and aims.

Based on the relevant literature, this research identified learning efficiencies of the introductory physics I course, connected to students' everyday life, using students' self-assessments.

The aim of this study was by using students' self-assessments to identify the learning efficiency of introductory (mechanics and waves) physics course connecting physics to students' everyday life and to discuss the findings.

Method

92 first year undergraduates at Marmara University Technical Education Faculty participated in the study. Students took Physics I four hours per week during the winter term of 2008-2009 academic year. The objective of the course was to teach mechanics as part of the foundational physics course by giving everyday life examples and teach them how to do self-assessments in line with the constructivist approach.

In order to achieve course objectives, everyday life questions in relation to the topic of the week were addressed to the students in each lesson, and the relationship between physics and everyday life was discussed around these questions. Using the questions addressed to the students, students' level of acquisition of the course concepts was identified. The answers to some of these questions were explained to the students and the rest of the questions were assigned as homework.

For course evaluation, students were also asked to self-assess how much they had learnt the mechanics topics. A post-then-pre test method was used for self-assessments. The retrospective post-then-pre test method is a popular method in order to obtain students' self-assessments about the changes in their knowledge, skills, confidence, attitude, behaviour and perceptions. It is a method that is easy to implement, takes a short time and has little interference with the students. Excessive sensitivity to the test and problems of positive or negative response-shift, which might be caused by the classic pre-post test method, does not occur in post-then-pre test (Rockwell & Kohn,1989; Howard, 1980). When students are asked to self-assess prior to the study, students might perceive themselves more or less than they really are or could project themselves like that. Yet, if they self-assess after the study, they can see and project how much they have changed prior and after the study more clearly (Rockwell & Kohn,1989; Howard, 1980).

This study used post-then-pre test method and asked students to self-assess how much they had learnt mechanics. A likert type scale called "Students' Perception Of Learning – Students' Self- Assessment" developed by the second author, which had 124 questions, was administered at the end of the term. To ensure validity of the scale, the questions covered all topics of mechanics and to calculate the consistency of student responses the questions were repeated in different places. The cronbach alpha reliability coefficient of the scale calculated by a reliability test using SPSS statistical package was 0,98.

In order to measure perceived learning efficiencies in relation to students' self-assessments, Hake's (1998) method was adopted. This method, which is used to calculate learning efficiencies, is a valid and reliable method (Şahin, 2010; Meltzer, 2002). Accordingly, learning efficiencies for each student for each question was calculated by the following formula (Hake, 1998):

Learning Efficiency = (Post Test Score – Pre Test Score) / (Max Text Score – Pre Test Score)

Maximum text score for the scale used in the study was '10'. The numerator of the formula signifies how much the student has learnt at the end of the course, and the denominator signifies students' maximum amount of learning. The division of numerator to denominator demonstrates students' perceived learning gains. If the learning efficiency coefficient is bigger than 0,7, it is high; if it is less than 0,3, it is low; and if it is between 0,3 and 0,7, than a moderate learning efficiency is obtained (Hake, 1999).

The learning efficiencies of each student for each question and of the whole class for each question were calculated using SPSS statistical package. Moreover, learning efficiencies were calculated for each physics topic covered in the course at student and class level.

Findings

In this study, 103 of the 124 questions were evaluated. Learning efficiencies of a total of 92 students, 82 of which was male and 10 was female, for each question were initially calculated using the SPSS statistical package and the learning efficiency mean was identified by calculating the mean score for each question. These learning efficiencies scores are presented in Table 1 below.

Table 1. Mean Learning Efficiencies of First Year Undergraduate Students for Each Question

Mean Learning Efficiency		**Mean Learning Efficiency**		**Mean Learning Efficiency**		**Mean Learning Efficiency**	
Question 1	0,49	Question 27	0,67	Question 53	0,38	Question 79	0,42
Question 2	0,57	Question 28	0,55	Question 54	0,42	Question 80	0,48
Question 3	0,74	Question 29	0,48	Question 55	0,44	Question 81	0,40
Question 4	0,64	Question 30	0,43	Question 56	0,53	Question 82	0,37
Question 5	0,50	Question 31	0,44	Question 57	0,46	Question 83	0,44
Question 6	0,66	Question 32	0,46	Question 58	0,47	Question 84	0,44
Question 7	0,61	Question 33	0,56	Question 59	0,47	Question 85	0,43
Question 8	0,57	Question 34	0,53	Question 60	0,42	Question 86	0,39
Question 9	0,48	Question 35	0,60	Question 61	0,46	Question 87	0,38
Question 10	0,61	Question 36	0,58	Question 62	0,50	Question 88	0,37
Question 11	0,70	Question 37	0,69	Question 63	0,49	Question 89	0,42
Question 12	0,59	Question 38	0,71	Question 64	0,56	Question 90	0,40
Question 13	0,71	Question 39	0,49	Question 65	0,56	Question 91	0,44
Question 14	0,49	Question 40	0,57	Question 66	0,53	Question 92	0,40
Question 15	0,60	Question 41	0,54	Question 67	0,50	Question 93	0,36
Question 16	0,42	Question 42	0,48	Question 68	0,34	Question 94	0,36
Question 17	0,50	Question 43	0,54	Question 69	0,36	Question 95	0,50
Question 18	0,53	Question 44	0,55	Question 70	0,63	Question 96	0,51
Question 19	0,41	Question 45	0,55	Question 71	0,42	Question 97	0,53
Question 20	0,63	Question 46	0,46	Question 72	0,45	Question 98	0,57
Question 21	0,37	Question 47	0,47	Question 73	0,37	Question 99	0,39
Question 22	0,52	Question 48	0,49	Question 74	0,51	Question 100	0,50
Question 23	0,49	Question 49	0,46	Question 75	0,53	Question 101	0,57
Question 24	0,45	Question 50	0,55	Question 76	0,49	Question 102	0,61
Question 25	0,49	Question 51	0,45	Question 77	0,45	Question 103	0,67
Question 26	0,49	Question 52	0,45	Question 78	0,38		

As shown in Table 1, as the learning efficiency was bigger than 0,70 in questions 13 and 38, the learning efficiencies of the class were high in these questions. There questions were “What is the physics law for a horse that cannot pull its cart?” and “What is the law for kicking the ball highest in football?” respectively. As our sample was composed of mostly male students, these questions were everyday life examples which would be of interest to male students. For the rest of the questions in Table 1, the learning efficiency scores of the class were between 0,30 and 0,70 , which meant a moderate level of perceived learning efficiencies. The lowest learning efficiency was for question 68 at 0,34. This question was "How are planes and ships connected to auto pilot?" and was related to the law of angular momentum.

Second, perceived learning efficiencies of the topics in the physics I course were calculated. Table 2 below shows the perceived learning efficiency means of the class for each topic.

Table 2. Learning Efficiency Means of First Year Undergraduate Students for Each Topic.

Topics	Mean Learning Efficiency
Newton's Laws of Motion	0,55
Circular Motion	0,44
Motion on the World	0,56
Collisions and Linear Momentum	0,48
Angular Momentum	0,48
Conservation of Angular Momentum	0,52
Change of Angular Momentum	0,50
Direction of Rotational Momentum	0,40

According to Table 2, learning efficiencies for the topics were between 0,30 and 0,70 and thus were at a moderate level. The results indicated that the highest learning efficiency was in "Motion on the World" with 0,56; and the lowest was in "Direction of Rotational Momentum" with 0,40. The learning efficiency mean of "Circular Motion" was 0,44, whereas it was 0,55 in "Newton's Laws of Motion".

In sum, the results of this study indicated that learning efficiencies in terms of question and topic based on students' self- assessments were at moderate levels. When the whole course was considered, the mean learning efficiency of all of the questions was 0,50 which is a moderate learning efficiency (Hake,1999).

Conclusions and Further Research

When we analyze learning efficiency calculated by using students' self- assessments, we observed that learning efficiency was higher for situations students encountered in everyday life most. It is significant that most of the sample was male and the highest learning efficiency was in a question that was related to football. Moreover, the topics with high learning efficiencies were "Motion on the World" and "Newton's Laws of Motion". As these topics were also covered during students' secondary education in detail, students' familiarity with these topics perhaps increased their learning efficiencies. In earlier studies it was seen that higher learning efficiency was observed when students had experienced at that topic (Coştu, Ünal & Ayas, 2007, Yiğit, Devecioğlu & Ayvacı, 2002).

The topics which had low learning efficiencies were "Direction of Rotational Momentum" and "Circular Motion". Both topics require students' spatial thinking skills. In order to increase learning efficiencies in these topics, more examples should be given from everyday life and students should try these examples. Aycan and Yumuşak (2002) reported similar result that if physics topics are related to everyday life then physics will be easy to students.

This study identified learning efficiencies only in relation students' perception of how much they have learned the given course. Future studies could investigate the relationship between students' academic achievement and their perceived learning efficiencies. A positive correlation between students' self- assessments and their academic achievement will indicate that students can correctly assess their own academic development.

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