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The Effects of Students' Physics Self-efficacy and Achievement Motivation on Their Learning Approaches

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Abstract

The purpose of this study is to investigate the effects of students' physics self-efficacy and achievement motivation on their rote learning and meaningful learning approaches. Students' meaningful understanding is important to increase their achievement. Therefore, determination of the variables that predicts meaningful learning is an important issue. The participants were 113 10th grade students. Research data were collected through physics achievement motivation scale, physics self-efficacy scale, and learning approaches questionnaire. The learning approaches questionnaire investigates whether students are a rote learner or meaningful learner. Stepwise multiple regression analysis revealed that physics achievement motivation and physics self-efficacy were significant predictors of 10th grade students' meaningful learning scores and the whole model explains 20% of the variance. Moreover, for rote learning, stepwise regression analysis was also conducted. Only the physics achievement motivation was found as a significant predictor that explains 5% of the variance. It is evident that improvement of students' physics self-efficacy will increase their tendency toward meaningful learning. Activities supporting sources of self-efficacy can be used to improve students' physics self-efficacy.

Keywords: Learning Approaches; Physics Self-efficacy; Achievement Motivation; Meaningful Learning; Rote Learning; Physics Education

1. Introduction

Researches on science education started with the researches on conceptual models underlying the thoughts of students on scientific concepts at the beginning of the 1970s. Since then, it has been stated that students have an incomplete comprehension of scientific concepts (Driver, 1989). Physical sciences contain abstract and complex sequential subjects when compared to other scientific branches. When one of the subjects or concepts in the sequence is not learned, the desired efficacy is not achieved in teaching other concepts that are linked to these concepts which the student failed to learn (Griffiths and Preston, 1992; Gokdere and Orbay, 2005). A review of the studies establishing a relationship between students' conception and their learning approaches may lead to the conclusion that students' science learning depends on different variables rather than merely a natural talent (BouJaoude, 1992; Cavallo and Schafer 1994).

While advancement in science and technology brought lifelong learning concept to the forefront, the studies in science education focused on the subject of "learning." The question "How does an individual learn?" has been addressed as the problem in many research studies. Studies focusing on how students learn put forth that not all students learn in the same manner but use different ways (Chamorro-Premuzic and Furnham, 2008). The learning approach notion is used to express both students' intention and his method of processing information (Biggs, 1999). Cavallo et al. (2004) categorized learning approaches as (a) meaningful learning approach and (b) rote learning approach. The students who adopt meaningful learning approach learn by establishing relationships between concepts, whereas students who adopt rote learning approach record concepts in their memory as individual pieces of information (Cavallo, 1996). Meaningful learning is when the student consciously relates new knowledge to relevant concepts and processes they already know (Ausubel, 1968). However, meaningful learning occurs if prerequisite knowledge, ideas, and concepts are fully present (Seymour and Lonaden, 1991). If the new subject to be learned contradicts with the existing knowledge of the student or if prerequisite knowledge is missing, the student has difficulty in comprehending the subject. If preliminary knowledge and knowledge on the subject do not merge and complement each other, learning the concepts occurs in the form of memorization of the facts (Chin and Brown, 2000). According to Novak (1993), the most significant difference between meaningful learning and rote learning is that there is no significant interaction in the cognitive structure in rote learning. However, in meaningful learning, the student consciously relates new knowledge with existing knowledge.

One of the variables known to have an effect on an individual's learning is the individual's self-efficacy belief. According to Bandura (1997), people guide their behavior in line with their self-efficacy belief. Moreover, self-efficacy belief is the underlying factor for voluntary behavior. According to Zimmerman and Schunk (2004), self-efficacy is the student's belief on his possession of required competency to perform a certain behavior. Bong and Skaalvik (2003. P. 5) define self-efficacy as "self-efficacy represents individuals' expectations and convictions of what they can accomplish in given situations." Self-efficacy belief affects how the individual studies, the level of effort as well as the achievement. As opposed to students with a high belief of self-efficacy, students with a low perception of self-efficacy find it more difficult to adapt to school and have lower levels of academic achievement (Schunk, 1991). However, the student's expectation of achievement in physics indicates the individual's belief of achievement rather that his competency to succeed in physics. When viewed from this perspective, it is important to support the individual's self-efficacy belief. Sources that support the individual's self-efficacy are defined as enactive mastery experience, vicarious experience, verbal persuasion, and physiological reactions (Pajares, 1996).

Various studies demonstrate that self-efficacy influences variables such as achievement, learning, and motivation (Pajares, 1996). For example, it may not be possible for a student to adopt the meaningful learning approach if he has a low level of self-efficacy belief regarding his achievement on a certain course. Similarly, students who adopt the rote learning approach are not expected to have a high level of self-efficacy (Ekinci, 2015). Self-efficacy belief may be considered in the general sense or specific to various fields such as health, sports, sciences, and mathematics.

In addition, another variable considered to predict the learning approaches has been determined to be physics achievement motivation. According to Pintrich and Schunk (1996), motivation provides an important foundation for planning, organization, decision-making, and assessment to define a cognitive behavior. Motivation might be described that internal drive leads one to perform something so that acquire achievement (Harmer, 2001. p. 51). Achievement motivation is one's effort to be successful in a matter (Weinberg and Gould, 1995). According to Atkinson and Feather (1966), "One of the more novel implications of a consistently applied expectancy X value-type of theory of motivation is the notion that the anticipation of a negative consequence should always produce negative motivation, that is, a tendency to inhibit activity that is expected to produce the negative consequence" (p. 6).

Self-efficacy is an important variable that affects motivation. As opposed to individuals with low level of self-efficacy, individuals with a high level of self-efficacy are involved in harder tasks, make more effort, and worry less (Awang-Hashim et al., 2002). Moreover, some researchers stated that self-efficacy belief is related to mastery goal orientation (Roeser et al., 1996; Skaalvik, 1997). Students' preferred learning approaches are highly important for their quality of learning. Therefore, it is important to determine the variables that influence students' learning approaches. The aim of this study is to examine the effects of physics self-efficacy belief and physics achievement motivation on students' learning approaches.

2. Method

2.1. Participants

This research was carried out with 113 public high school students at 10th grade. 48 of the students who participated in the study were female (42.5%) and 65 were male (57.5%). The average age of students is 15.

2.2. Data collection instruments

2.2.1. Learning approach questionnaire

The learning approach questionnaire developed by Cavallo (1996) has been used to determine students' learning approaches. This instrument consists of two sub-scales, namely, meaningful learning and rote learning and has 22 items in total. The instrument was adapted to Turkish by Yenilmez (2006). The instrument measures participant's responses using 4-point Likert scale ranging from "Strongly agree" to "Strongly disagree." There are 11 items each in subscales of meaningful and rote. The minimum score is 22, whereas maximum is 88. Cronbach alpha reliability coefficients for the original instrument are 0.81 for meaningful learning sub-scale and 0.76 for rote learning sub-scale. Cronbach alpha reliability coefficients for the questionnaire adapted to Turkish by Yenilmez (2006) were calculated as 0.78 for meaningful learning sub-scale and 0.62 for rote learning sub-scale. For the current study, the Cronbach alpha coefficients were calculated as 0.79 for meaningful learning sub-scale and 0.55 for rote learning sub-scale.

2.2.2. Physics self-efficacy questionnaire

The physics self-efficacy questionnaire developed by Gungor et al. (2007) was used to determine students' physics self-efficacy. This instrument consists of 5 items. Participant's responses are measured using 5-point Likert scale ranging from "Strongly agree" to "Strongly disagree." The total possible scores range from 5 to 25. The Cronbach alpha reliability coefficient for the original scale is 0.91 (Gungor et al., 2007). As a result of the reliability analysis performed for the present study, the Cronbach alpha reliability coefficient for physics achievement motivation was calculated as 0.87.

2.2.3. Physics achievement motivation questionnaire

The "Achievement motivation in physics scale" sub-scale was also developed by Gungor et al. (2007) was used to determine students' achievement motivation in physics. The instrument consists of 4 items and participant's responses are measured using 4-point Likert scale ranging from "Strongly agree" to "Strongly disagree." The total possible scores range from 4 to 20. The Cronbach alpha reliability coefficient is 0.91 (Gungor et al., 2007). As a result of the reliability analysis performed for the present study, the Cronbach alpha reliability coefficient for physics achievement motivation was calculated as 0.89.

3. Analysis of Data

The data have been analyzed using SPSS 20.0 software package. A descriptive statistical analysis has been conducted. The relationships between meaningful learning, physics self-efficacy, and physics achievement motivation have been examined using Pearson product moment correlation. Furthermore, a stepwise multiple regression analysis has been conducted to determine the effect of students' physics self-efficacy and physics achievement motivation on predicting meaningful learning and rote learning.

4. Findings

Descriptive statistics for meaningful learning, rote learning, physics achievement motivation, and physics self-efficacy beliefs are summarized in Table 1.

According to Table 1, it is seen that the average score of the students in meaningful learning is 31.30. Minimum and maximum scores that students can attain in the sub-scale of meaningful learning vary between 11 and 44. Accordingly, it is observed that the meaningful learning scores of the students are above the average. Moreover, score of the students in rote learning is 29.21. Minimum and maximum scores that the students can attain in the sub-scale of meaningful learning vary between 11 and 44. This result also reveals that the rote learning scores of the students are above the average. Physics achievement motivation score of the students is 15.28. Minimum and maximum scores attained in the sub-scale of physics achievement motivation vary between 4 and 20. Moreover, it is also observed that the scores of students in physics achievement motivation are above the average. Physics self-efficacy scores of the students are 16.21. Minimum and maximum scores attained in the sub-scale of physics achievement motivation vary between 5 and 25. It is seen that the physical self-efficacy of the students is at medium level.

Table 2 presents the results of Pearson product moment correlation analysis carried out between meaningful learning, rote learning, physics achievement motivation, and physics self-efficacy. According to Table 2, there is a positive, medium level ($r = 0.55$), and significant relation between the meaningful learning and rote learning. Similarly, there is a significant, positive and medium level relation ($r = 0.43$) between meaningful learning and physics achievement motivation; and a significant, positive and medium level relation between meaningful learning and physics self-efficacy. A significant, positive, and low-level relation ($r = 0.23$) was determined between rote learning and physics achievement motivation. However, there is no significant relation between rote learning and physics self-efficacy. It is seen that there is a significant, positive, and high-level relation ($r = 0.67$) between physics achievement motivation and physics self-efficacy belief.

In this study, stepwise multiple regression analysis was utilized to determine the variables predicting the meaningful learning and rote learning among the students. Meaningful learning and rote learning scores are the dependent variables, whereas physics achievement motivation scores and physics self-efficacy belief scores are independent variables. In Table 3, it is seen that according to the results of the stepwise multiple regression analysis, the variable explaining the rote learning is physics achievement motivation ($R^2 = 0.054$, $F(1, 111) = 6.373$, $p < 0.05$). Physics achievement motivation explains 5% of the variance related to rote learning. However, physics self-efficacy belief scores do not have an effect on rote learning.

Table 4 presents the results of the stepwise multiple regression analysis was applied to examine the effect of physics achievement motivation and physics self-efficacy belief on meaningful learning.

Table 1: Results of descriptive statistics

Descriptive statistics	Meaningful learning	Rote learning	Physics achievement motivation	Physics self-efficacy
Mean	31.30	29.21	15.28	16.21
Standard deviation	5.34	4.44	4.14	4.70
Skewness	−0.717	−0.215	−1.21	−0.384
Kurtosis	1.6	2.42	1.14	−0.204
N	113	113	113	113

Table 2: Results of the Pearson correlation analysis

Variables	Meaningful learning	Rote learning	Physics achievement motivation	Physics self-efficacy
Meaningful learning	1	0.55*	0.43*	0.42*
Rote learning			0.23*	0.17
Physics achievement motivation				0.67*

*Correlation is significant to the level of 0.05

Table 3: Stepwise multiple regression analysis related to rote learning

Model	B	SE	Beta	t	Significant
Constant	25.392	1.568		16.199	0.000
Physics achievement motivation	0.250	0.099	0.233	2.524	0.013

SE: Standard error

Table 4: Stepwise multiple regression analysis result related to meaningful learning

Model	B	SE	Beta	t	Significant
Constant	21.608	1.824		11.847	0.000
Physics achievement motivation	0.336	0.146	0.261	2.302	0.023
Physics self-efficacy	0.281	0.129	0.247	2.184	0.031

SE: Standard error

Accordingly, it is seen that the variable that best predicts meaningful learning is physics achievement motivation ($R^2 = 0.181$; $F(1,111) = 24.584$, $P < 0.05$). It was determined that physics achievement motivation explains 17% of the variance related to meaningful learning. It was found out that when physics self-efficacy is included in the model, these two variables contribute significantly to explaining meaningful learning ($R^2 = 0.20$; $F(2,110) = 15.095$, $P < 0.05$). Physics achievement motivation together with physics self-efficacy explains 20% of the variance related to meaningful learning.

5. Conclusion and Discussion

This study aims to examine the effect of physics achievement motivation and physics self-efficacy belief on 10^{th} students' meaningful learning and rote learning approaches. According to the results of descriptive statistics presented in Table 1, meaningful learning and rote learning scores of the students are above the average. Accordingly, it may be asserted that students learn by establishing relationships between physics concepts. However, sometimes they do not relate new knowledge in physics with their existing knowledge. Moreover, both intrinsic and extrinsic motivations of the students for learning a physics topic are high. In addition, it may be stated that the physics achievement motivation and physics self-efficacy scores of the students are above the average. This reveals that students have a high level of self-efficacy belief for their achievement in physics regardless of the difficulty of a task.

According to the results of Pearson correlation analysis, there is a significant and positive relation at a medium level between meaningful learning and rote learning. The reason may be that the students might have perceived the items as similar and answered accordingly since the sub-scales of both meaningful learning and rote learning both contain items concerning the learning approaches of the students. Cavallo et al. (2004) found a similar result in their research. Therefore, this correlation value is an expected result. There is a positive, medium level ($r = 0.43$), and significant relation between meaningful learning and physics achievement motivation just like the positive, medium level ($r = 0.42$), and significant relation between the meaningful learning and physics self-efficacy. This means that a student adopting the meaningful learning approach has high levels of physics self-efficacy belief and physics achievement motivation. This points that the students with a high level of achievement motivation and a high level of self-efficacy belief for achieving in any task related to physics regardless of its difficulty have a tendency to learn by relating the new information with their previous knowledge. A positive, poor level ($r = 0.23$), and significant level of relation were determined between the rote learning and physics achievement motivation. Accordingly, it may be said that students who cannot relate new information with their previous knowledge and who perceive information as separate independent units do not have high-level achievement goals and tendencies. Moreover, in research carried out by Cavallo (2004), the estimated effect of learning approaches, motivation goals, self-efficacy, epistemological beliefs, and reasoning skills on understanding physics courses and on achievement in physics course were examined. As a result of this research, a positive relation was determined between the learning goals and meaningful learning; and rote learning and success goals. A positive, high level (r = 0.67), and significant relation were found out between the physics achievement motivation and physics self-efficacy variables. In a study carried out by Gungor et al. (2007), a significant and positive relation was determined between physics achievement motivation and physics self-efficacy of the students. Another result of the study revealed that there was a positive, poor (r = 0.17), and not significant correlation between physics self-efficacy and rote learning.

In this study, the effects of physics achievement motivation and physics self-efficacy beliefs on meaningful learning and rote learning were examined. It is observed that the physics achievement motivation and physics self-efficacy explains 20% of the variance related to meaningful learning. In a study carried out by Kizilgunes et al. (2010), a positive and significant relation was determined between the learning goals tendency and meaningful learning. As it is observed from the results of this study, meaningful learning is affected by physics achievement motivation and physics self-efficacy. It is observed that physics achievement motivation explains the variance related to rote learning scores while physics self-efficacy belief does not.

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