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Role of Cognitive and Emotional Factors on Educational Achievement among High School Students in Physics

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Abstract

The purpose of this study was to investigate effects of cognitive and emotional factors on physics achievement of high school students in Tabriz City. Using multistage sampling, 400 students were selected. Epistemological beliefs (EBAPS) scale, physic anxiety rating scale and questionnaire of attitudes towards physics were employed to gathering needed data in the study. Data were analyzed by Pearson's correlation test, and stepwise regression using SPSS. The results showed a significant and positive relationship between epistemological beliefs, attitude towards physics, prior knowledge of chemistry and mathematic with physics achievement. Also, a significant and negative relationship between physics anxiety and physics achievement was also found.

Keywords: physics achievement, epistemological beliefs, attitude towards physics, physics anxiety, prior knowledge

Introduction

Physics is an important and basic subject in today's science world. It plays a significant role in human life and is changing all the time. Due to the effect of physics in achievement of industry, science, and technology, many attempts should be exercised to motivate physics' learning. Many students have problems using physics and they show educational drop in this field (Manhmoodi, 2012). Learning is of great interest for psychologists and education scholars. They try to recognize complexities of learning to facilitate it. One dimension for facilitating and deepening learning is epistemological beliefs (Manhmoodi, 2003).Thus, in recent years; the role of one's belief in nature of knowledge has been highlighted. Epistemological beliefs refer to personal beliefs about nature of knowledge (Hofer and Pintrich 1997; Kardash and Scholes, 1996) with different and distinguishable dimensions. Such beliefs may affect one's perceptions about educational processes and necessary activities for fulfilling duties. They may even form educational behaviors (Rezaei, 2009).

Some studies suggest that epistemological beliefs are predictors of educational achievement. For example, belief that learning is quick and that knowledge is certain predicted poor performance on comprehension mastery tests with oversimplified and inappropriate absolute conclusions (Schommer, 1990). In addition, Phillips (1999) found epistemological beliefs were able to differentiate class performance on unstructured case analyses but did not on multiple choice exams.

Belief in knowledge being definite and unchangeable predicts absolute incorrect results in tasks to be performed. Thus, epistemological beliefs can affect learners' motivations.

Rezaei (2009) found that epistemological beliefs, simple/definite knowledge and self-regulating learning strategies were significant predictors of academic performance. Also epistemological beliefs of simple/definite knowledge have higher beta than self-regulating learning strategies. In the study of Chen and Pajares (2010), epistemological beliefs mediated the effect of

implicit theories on the ability of orienting achievement goal, self-confidence, and educational achievement.

The beliefs that learning depends on effort and ability were associated with performance approach and mastery approach goals (Kadioglu, Uzuntiryak, Capa Aydin and Gaziosmanpasa). For example, Dweck and Legget (1988) reported that if students believe that their learning ability is changeable, they involve themselves in the task more. Then, they try to utilize better learning strategies in problem solving. Stathopoulou and Vosniadou (2007) showed that epistemological beliefs about structure and consistency of physics predict physics learning. Lising and Elby (2005) concluded that epistemological beliefs of students in physics and its education have a direct effect on students' learning. Ramani et al. (2012) showed that there is a significant correlation between all elements of epistemological beliefs and final scores of physics.

Another variable examined in previous literature is prior knowledge, an affective factor in educational achievement. When a student starts learning, he/she has a history which involves all his prior learning and achievements. Omotade and Adeniyi (2013) showed that all math skills are strong and positive predictors of physics performance of students. Meltzer (2002) states that many studies have found a positive correlation between math skills and exam scores of students in physics. Results of Delialioglu and Askar (1999) showed that variables of math skills and spatial ability are able to predict 31% of variance of scores in physics achievement. Uz and Eryilmaz (1999) found that variables of economic-social status, control source, prior achievement, average score, and educational achievement in math have significant effect on students' attitude towards physics. Darvishpour (2003) showed a significant correlation between math skills of students and their educational achievement in physics. Increasing math skills of students leads to educational achievement in physics.

Other effective factors are emotional factors. According to bloom, attitude is an emotional factor, playing an important role in learning. When a group of students start learning a task or unit, they show differences in dealing with tasks. Some learn issues enthusiastically and see it interesting; some see it mandatory and reflect low eagerness. Others reveal explicit resentment towards tasks. People also differ in emotional readiness for dealing with educational issues. When students show interest in learning, its processes will be easier for them to handle. They do tasks faster with more achievements than less eager students (Bloom, 1984). Students showed that their perception from physics 'concepts affect their achievements in physics' faculty. Performance of them in conceptual proficiency tests for identifying these images indicate better predictions of physics ' scores in university rather than high school or precollege levels (Benford, 2006). Sale and Norma (2006) showed that attitudes of students play an important role in learning science among students. Drake (2009) showed that students with positive attitudes towards physics reveal more educational achievement.

Physics anxiety is another emotional variable. It is a set of behaviors preventing from correct calculations of physics, not allowing students to reach proper performance level (Timothy, 2009). Anxiety can distort cognitive performance and influence students' performance in exam sessions so, it must be considered in educational system (Azarnia, 2003). In the study of Laukenmann (2003), factors such as self-concept, prior knowledge, interest, anxiety, and fatigue affect educational achievement; also, anxiety and fatigue are negatively correlated with achievement.

Therefore, the question of this study was "what is the relationship between epistemological beliefs, students' attitudes towards physics, prior math and chemistry knowledge, and physics' anxiety with physics 'achievement? What is the share of each of these variables in predicting academic performance of students?

Methodology

This study was conducted on 400 students (206 female, 194 male) from high schools in Tabriz city; with consideration to the location of the schools. Based on the table presented by Krejcie and Morgan (1970), 400 students were selected via multistage sampling.

Instruments

Background information: This included items relating to participant's age, gender, occupation and place of residence – rural or urban.

Epistemological Beliefs Assessment for Physical Science (Elby and Fredericksen 2002): This is a five-factor scale (knowledge structure, nature and learning knowledge, knowledge applications, knowledge development, and ability source) comprised of 30 items designed to examine epistemological beliefs of high school students about physics and chemistry on a 5-point Likert scale (1=much agreed, 5=much disagreed) (cited in Marzooghi and Seif, 2010). Generally, higher score of this measure shows more development of epistemological beliefs about experimental sciences especially physics and chemistry. Although, it first was used by Marzooghi and Seif (2010), but its Chronbach Alpha was not reported.Thus, in this study, Chronbach Alpha was achieved to be 0.68.

Students' attitude and perceptions towards physics: Students' attitude and perceptions towards physics (Robiah et al., 2001 and Jegede, 2007) was developed to measure students' attitudes towards physics, its applications, and usefulness in life. This is a 30 item instrument which asks students to rate their level of anxiety on a 5-degree scale. The internal reliability of the survey was calculated by using Cronbach's Alpha formulae and found 0.91.

Physics anxiety questionnaire: It is a researcher-made questionnaire with9 items and the answers are distributed on a scale with five degrees of intensity, measuring students' anxiety about physics. Reliability factor of the test is found to be as Cronbach's Alpha=0.78.

Results

Table 1 shows that maximum mean relates to students' perception from physics learning (M=45.53, M=54.40) and minimum mean relates to prior math knowledge (M=15.93, M=13.04). About changes of standard deviation (SD), it is said that maximum standard deviation belongs to perception about physics learning (SD=9.96, SD=12.75). But, minimum standard deviation belongs to prior chemistry knowledge in female students (SD=3.23) and prior math knowledge in male students (SD=3.23).

Table 1. Descriptive statistics for the variables of the study

	female		Male	
Variable	mean	SD	mean	SD
Physics achievement	16/71	3/35	14/15	3/49
Epistemological beliefs	37/67	6/35	39/27	7/70
prior chemistry knowledge	15/99	3/23	14/20	3/37
prior math knowledge	15/93	3/34	13/04	3/23
attitudes towards physics	27/42	7/15	31/33	10/33
perception about physics learning	45/53	9/96	54/40	12/75
Physics anxiety	22/26	7/14	22/61	6/70
score	17/36	2/44	15/41	2/21

Table 2 shows correlation coefficients of predictor variables with physics achievement. As is shown in Table 2, except for epistemological beliefs, all variables have significant correlation with physics achievement ($p<0.001$). Maximum significant correlation is between physics achievement and prior math knowledge (r=0.80) and minimum correlation belongs to epistemological beliefs and physics achievement (r=0.040).

Table 2. Correlation coefficients of physics achievement and predictor variables

variable	correlation coefficient	P
Epistemological beliefs	0/040	0/48
Prior chemistry knowledge	0/75	0/001
Prior math knowledge	0/80	0/001
Attitudes towards physics	0/27	0/001
Physics anxiety	-0/25	0/001

To identify share of each predictor variable in predicting physics achievement, stepwise regression analysis was used whose data are shown in Table 3.

Table 3. Results of stepwise regression analysis for study variables

Model	R	(R^2)	(ΔR^2)	sd
1	0/750	0/722	0/721	1/977
2	0/765	0/747	0/747	1/796

According to table 3, only two variables of prior math knowledge and prior chemistry knowledge accounted 74 percent of variance of physics achievement. Thus, remaining variables didn't significantly predict physics achievement ($p>0.05$) and then were removed from equations.

Table 4. Beta coefficients of predictor variables

Statistics indices	Non- standardized coefficient SD B	Standardized coefficient		
		B	t	Sig.
Constant	0/524 1/104		2/109	0/04
prior chemistry knowledge	0/ 035 0/932	0/750	26/495	0/001
constant	0/509 0/573		1/125	0/26
prior chemistry knowledge	0/057 0/691	0/630	12/217	0/001
prior math knowledge	0/056 0/295	0/273	5/295	0/001

According to table 4, standardized regression coefficient for prior chemistry knowledge was 0.75 and it was0.27 for prior math knowledge and both are significant ($p<0.001$).

Discussion

In this study, effects of cognitive and emotional factors examined on educational achievement of high school students in physics in Tabriz City. Based on the findings, epistemological beliefs and physics achievement are positively correlated but their correlation is not significant. This result was inconsistent with findings of Lodewyk (2007), Chen and Pajares (2010), Stathopoulou and Vosniadou (2007), Lodewyk (2007), Ramani, Chekuri, and Allevato (2012), Rezaei and Pashaei (2010), Seif and Marzooghi (2009), Seif et al.(2007), Rezaei and Khodakhah (2010), and Rezaei (2010).

In those studies, epistemological beliefs are main predictors of physics achievement but this study did not confirm this result. Our result agrees with theory of Alex and Nick Filler .These theoreticians have identified cognitive and environmental explanations about reduction of task value. They explain that children have beliefs about their abilities such as flexibility and changeability while they reach a natural and fixed view with age increase. Thus, if an elementary student has a poor performance in math, it won't be attributed to his low ability; but, if this happens at higher ages, the teenager will attribute it to his low abilities. Then, he lowers his perception about math value to preserve his validness (Paul, 2006). Our result can be explained by implicit beliefs of Dweck Intelligence (1999), one important approach about the relationship between motivational and cognitive factors with educational and performance consequences, attracting much attention in recent decades. Intelligence beliefs and achievement goals are key words of this approach. Dweck et al. (1986,1999) suggested that different goal orientation in educational achievement result from beliefs about nature of intelligence. There are two implicit theories about intelligence, supporting different goals. In-born belief in which intelligence is a fixed and uncontrollable feature that may be improved with performance orientation; Because, following such goal is to the benefit of positive judgments about ability or hindering negative judgment about ability. Increasing belief is a belief in which intelligence is flexible and controllable; it improves quality of a work, and provides a chance for more learning or achievements. According to achievement studies and behaviors, when people are challenged, the ones with in-born beliefs have lower performance that affects their perceptions negatively. But, people with increasing belief tend to show adoptive motivational patterns such as persistence, positive feelings, and effective strategies of problem solving (cited in Khani, 2012). Dweck et al. (1995, cited in Khani) offer evidences and keys for connecting implicit intelligence beliefs and epistemological beliefs. They reason that theory of fixed ability pictures social world in a way to be fixed, predictable, and accessible. In return, people with increasing implicit believes see world dynamic and complex.

Another finding shows positive and significant correlation between attitudes towards physics, prior math and chemistry knowledge and physics achievement. This result agrees with findings of Guzel (2004), Craker (2006), Saleh, (2004), Newble (1997), Tuan Soh et al.(2010), Okpala et al. (1988), Selcuk (2010), Kee Jiar and Yi Long, Meltzer (2002), Delialioglu and Askar (1999), Uz, and Eryilmaz (1999), Razavieh et al. (2005), and Darvishpour (2004).

The relationship between attitudes towards physics and physics achievement can be attributed to the fact that students in education period earn negative or positive attitudes towards themselves and their environment. This issue depends on successful or unsuccessful experiences of students in education period. They react to different factors affecting cognitive, emotional, and social changes. By educational achievement and learning increase, students get mental health besides scientific growth. On the contrary, in case of educational failure and mental pressure resulting from that, their mental health distorts and imposes harms to its owner and society. Thus, effective factors in educational achievement and drop should be considered to improve students' abilities with their recognition (Gholipour, 2013).

Another finding of this study was a negative and significant correlation with physics anxiety and physics achievement. This result agrees with the findings of Okpala and Onocha (1977) and Razavieh et al. (2003). This anxiety can distort cognitive performance and affect performance of a student in exam session (Azarnia, 2004).

Regression analysis showed that prior math and chemistry knowledge can predict physics achievement. This agrees with results of Guzel (2004), Selcuk (2010), Meltzer (2002), Delialioglu and Askar (1999), and Okpala and Onocha (1977). .

Results of path analysis showed that prior math and chemistry knowledge, average score, perception about physics learning, and gender can affect physics achievement. This agrees with Guzel (2004), Selcuk, Kee Jiar and Yi Long, Meltzer (2002), Delialioglu and Askar (1999), Uz, and Eryilmaz (1999), Okpala and Onocha (1977), and Razavieh et al.(2003); thus, if students have higher knowledge of math and chemistry with positive perception about their learning, a better physics achievement will be expected from them.

Like other studies, the present study was also faced with limitations that affect generalization of its results. Since this study was conducted in Tabriz and for not controlling other effective variables such as intelligence and personal qualities, generalizing its results to other areas should be with caution. Using correlation method in results' analysis prevents us from considering casual relationship between variables. The lack of a standard tool for measuring variables and using self-measuring questionnaire with high volume of questions that affect accuracy of respondents are other limitations.

Since this study was conducted on high school students of Tabriz city, further studies can be utilized in other communities or different education levels. This study has used self-report tools in gathering data. In next studies, tools based on real observations and measurements can be used. Regarding predictability of research variable, further studies can utilize them as well to complement findings of this study.

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