Higher-order Correlates of Gifted Students' Motivation towards Science Learning in Turkey

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ABSTRACT

The purpose of this study is to investigate possible higher-order correlates (IQ, logical thinking and critical thinking) of gifted students' motivation towards science learning. The study was designed as a correlational study and it focused on 65 gifted students at the level of sixth, seventh and eighth grades. The data was collected by applying Motivation towards Science Learning Questionnaire, Wechsler Intelligence Scale (WISC-R), Group Assessment of Logical Thinking Test, Critical Thinking Test. The data was analyzed by applying Spearman correlation analysis. The findings represented that motivation towards science learning of gifted elementary level students were not significantly correlated by logical thinking, IQ performance , IQ verbal, IQ total and critical thinking scores. The findings refer to gap between motivation and cognitive learning in gifted students.

Keywords: *IQ, motivation towards science learning, critical thinking, logical thinking*

INTRODUCTION

Being an informed decision maker in today's information-driven world is very important and individuals need to learn about science to fulfill this requirement. Informed decision making by using science knowledge makes daily life more comfortable and understandable since daily life problems such as adjusting amount of ingredients when making a cook or being aware of heat isolation problems require being active in use of scientific knowledge. As similar to people who are not determined as gifted, gifted individuals are also in need of effectively acquiring and using scientific knowledge for their lives (VanTassel-Baska, Bass, Ries, Polan and Avery, 1998).

Gifted students' potential to acquire and use scientific knowledge puts them into focus of science teaching and learning studies. But activities focusing on science learning processes in common schools focus on learning needs of ordinary students therefore there is a need to study learning process of gifted students on science by considering the problem as a separate research problem. As like learning of ordinary students, gifted students' learning of science might be classified into three measurable different domains; affective, cognitive and psycho-motor domains (Corallo, 1994). Before using cognitive and psycho-motor processes in learning science, instigating and sustaining a goal directed activity should be induced by affective change for

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more coherent learning. Moreno and Mayer (2007) explained the function of motivation in learning as "motivational factors mediate learning by increasing or decreasing cognitive engagement". In following years, relationship between achievement as the most studied cognitive variable and motivation was investigated by analyzing empirical evidence. Schwinger, Steinmayr and Spinath (2009) investigated the relationship between motivation and achievement of 231 11th and 12th grade German high-school students and they found that motivation was indirectly related to achievement. The researchers stated that motivation had direct relationship with effort regulation leading to increased achievement. Schwinger and Stiensmeier-Pelster (2012) established a path model on the data of 301 twelfth grade students and the tested model indicated that motivational state of students has indirect effect on achievement since motivation is positively related learning effort. The current studies focusing on motivation do not take motivation as a domain dependent variable (Eder, Elliot & Harmon-Jones, 2013; Kim, Park and Cozart, 2012; Rodriguez-Keyes, Schneider and Keenan, 2013). But the domain independent measures of motivation are insufficient to explain associations of motivation towards science learning with focused variables. For this reason, some researchers have measured motivation towards science learning in a domain dependent way (Loukomies *et al*; 2013; Ng, Soon and Fong; 2010; Tuan, Chin and Sheh, 2005).

Among affective factors in learning science, motivation towards science learning has a discrete place because Fisher (2000) indicates that motivation to learn science is the most powerful determinant of whether or not an individual will learn science. In addition, Rumelhart and Norman (1978) overweight motivation on cognitive variables. Giving more attention to motivation in science learning over the other affective factors regarding science learning was also recommended by Osborne, Simon and Collins (2003). Motivation is defined as the process which instigates and sustains a goal directed activity (Pintrich and Schunk, 2002). Being motivated towards science learning provides advantage to gifted students in using deep learning strategies, achievement, producing creative solutions to problems (Cho and Lin, 2011; Gottfried and Gottfried, 2004; Neber and Schommer-Aikins, 2002). But the studies on motivation of gifted students also took motivation as domain-independent variable to explain associations of gifted students' motivation towards learning with interested variables.

Cho and Lin (2011) studied with 733 scientifically talented Korean students (fourth-twelfth grades) and focused on the relationship between creative problem solving and motivation. Their findings show that motivation levels of the participants towards learning were high and predicted significantly creative problem solving. Vallerand, Gagné, Senécal and Pelletier (1994) compared gifted (n = 69) and ordinary (n = 66) elementary students in terms of intrinsic motivation toward school activities indicate that gifted students' levels of intrinsic motivation towards school activities were higher than those of ordinary students. Neber and Schommer-Aikins (2002) studied with 133 gifted elementary and high school students and discover

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that the strongest correlation was found between the strategy use and the intrinsic value of science (r = 0.63). This is an indication of considering motivation of gifted student towards science learning as a separate problem. The studies on motivation towards science learning with gifted students investigated association of the motivation with affective self-report findings or perception scores on competency (Koksal, 2012; Koksal, 2013, Vallerand *et al.*, 1994). But relationship between higher-order cognitive variables and motivation towards science learning were not considered enough to detect higher-order correlates of motivation towards science learning. Higher-order thinking includes reflective thinking, being sensitive to the context, and self-monitoring learning process (Halpern, 1998). Resnick (1987) defined that higher-order thinking should be non-algorithmic and complex, it should be produce multiple solutions and the application of self-regulation, uncertainty and multiple criteria should be done. Higher-order cognitive variables include critical thinking (Facione, 1986), creativity (Williams, 1999), logical thinking (Sendag and Odabasý, 2009) and intelligence (Brown and French, 1979).

Previous studies show relationship between motivation and some of the higher-order cognitive variables such as critical thinking, logical thinking and intelligence (Elder, 1968; Garcia and Pintrich, 1992; Soerjaningsih, 2001). Elder (1968) in his study using data of Oakland Growth Study (n = 167) represents existence of a significant relationship between IQ scores and motivation scores of elementary level students. Another relationship, critical thinking and motivation was investigated by Garcia and Pintrich (1992), in the study which 758 college level students were involved. Their findings show a positive correlation between critical thinking and motivation. Soerjaningsih (2001) investigated relationship between student outcomes, learning environment, logical thinking and motivation among 422 university students, hence, argues that logical thinking and motivation were indirectly related to each other.

Investigation of higher-order correlates of motivation towards science learning has importance since high level of motivation towards learning science in gifted students might be explained by its higher-order correlates. With this idea in mind, it might be expected that if learning science or using IQ, logical thinking and critical thinking requires high motivation towards learning science, having and sustaining high motivation towards learning science might be related to having higher-order cognitive capacities. Based on this expectation, it is a requirement to focus higher-order correlates of motivation towards science learning. In addition finding higher-order correlates of the motivation might also contribute to understand motivational differences between ordinary and gifted students. Therefore the purpose of this study is to investigate possible higher-order correlates (IQ, logical thinking and critical thinking) of gifted students' motivation towards science learning.

METHOD

For the purpose of the study, correlational research approach was utilized. In this type of research, major purpose is to determine relationships between variables of

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the study (Fraenkel and Wallen, 2006). In the study one predicted variable (motivation towards science learning) and five predictor variables (critical thinking, logical thinking, IQ verbal, IQ performance and IQ total) were considered. For analyzing data, non-parametric Spearman correlation analysis was utilized due to non-normality of the motivation scores and insufficient number of the participants. In the study, 65 sixth (n = 22), seventh (n = 28) and eighth (n = 14) grade gifted students were involved. Thirty six of the participants were male while the remaining individuals were female. The gifted students have been enrolled in a public school for all students but they also take additional education in a center called Science and Art Center in Turkey after their current school time. In the center the students take courses on science and make laboratory studies with their mentor teachers. The data were collected by using four different instruments: Motivation towards science learning questionnaire, Group assessment of logical thinking test, Critical thinking ability test, and Wechsler intelligence scale (WISC-R).

Critical Thinking Ability Test: Critical thinking ability test was developed for elementary level gifted and ordinary students by the researcher. In the test, there are seven factors including truth-seeking, ability of asking questions, analyticity, and systematicity, self-confidence in reasoning, inquisitiveness and open-mindedness. The test included 22 multiple-choice items and total reliability of the scores was found as .77. The scores of the test were validated with 227 sixth, seventh and eighth grade students including gifted and ordinary students and the findings represented acceptable fit values (CFI = .95, GFI = .93, RMSEA = .03) after confirmatory factor analysis. In addition the scores on the test significantly showed difference between gifted and ordinary students.

Group Assessment of Logical Thinking Test (GALT): The logical thinking ability test (GALT) was developed by Roadrangka, Yeany and Padilla (1982). In the test, 21 items focusing 6 logical processes were involved. These processes consist of mass, length, volume, conservation, proportional comparison, controlling the variables, consolidative comparison, probabilistic comparison and relational comparison. The alpha reliability of the test is 0.71. The test is appropriate for students at the 6th grade level and above. Completion of the test takes 45 minutes and reliability of the Turkish version was found as .88 (Aksu, Berberoðlu and Paykoç, 1991).

WISC-R: WISC-R was developed for determining gifted students in 1974 (Weschler, 1974). The scale has two different components; verbal and performance components. Standardization of the scale for Turkish culture was done by Savasýr and Sahin (1995). The authors applied the scale to 1639 individuals from age 6 to age 16. Split-half reliability of the scale was found as .97, the reliabilities of the components were .97 and .93 for verbal and performance components relatively. The correlation between the scores on sub-components ranged from .51 to .86. The sub-components are vocabulary, comprehension, information, word reasoning,

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arithmetic, similarities, block design, picture completion, picture concept, matrix reasoning, letter-number sequencing, digit span, coding, symbol search, cancellation (Öner, 1997).

Motivation towards Science Learning Questionnaire: The questionnaire was adapted by the researcher from Tuan, Chin and Sheh (2005). The items of the questionnaire were translated into Turkish by Yýlmaz and Cavas (2007). The items of Turkish version were applied to the gifted students of this study. Due to the application of the instrument to a new group (gifted students, n = 65). Explanatory factor analysis was applied after examining KMO and Barlett criteria for factorability of the scores (KMO = .82, Barlett Chi-Square = 832.385; p < .00). The results approved factorability of the scores (Sharma, 1996 and Tavsancil, 2002). Then applying the explanatory factor analysis (principle component analysis with varimax rotation) reduced number of the items into 18 items in four factors explaining 75% of the variance: self-efficacy, setting performance goal, setting mastery goal and willingness to learn science.

RESULTS AND DISCUSSION

The reliability values regarding the factors of the motivation questionnaire can be seen on table 1. The purpose of the study was to examine higher-order correlates of motivation towards science learning. Before the Spearman correlation analysis, descriptive scores of the participants (n = 65) on the variables were determined. Descriptive values on the variables might be seen on the table 2. On table 2, it is seen that levels of motivation towards science learning, critical thinking and logical thinking are higher than average scores (2.5 for the motivation score, .5 for logical thinking and 1 for the critical thinking). After the descriptive analysis, correlation analysis of the variables with Boferroni adjustment ($\acute{a}$ = .01) was done by Spearman correlation analysis. Table 3 represents findings of the correlational analysis. On table 3, it is seen that motivation towards science learning scores of the gifted elementary level students are not significantly associated with higher-order cognitive variables including IQ, logical thinking and critical thinking (p>.01).

The findings of the study supported the literature in terms of higher scores of the gifted students on motivation towards science learning, critical thinking and logical thinking. The gifted education literature consistently represented that gifted children are more motivated to learn (Koksal, 2013; Davis and Rimm, 1989). At the same time, having high critical thinking and logical thinking features are characteristics used in diagnosis of giftedness (Case, Demetriou, Platsidou and Kazi, 2001; Hiatt and Covington, 1991). However correlational findings of the study represented a different picture, there is no significant correlation between motivation towards science learning and verbal IQ, performance IQ, total IQ, critical thinking and logical thinking scores. This means there is no significant higher-order cognitive correlates of motivation towards science learning scores of the gifted

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elementary students. This result is in conflict with the literature since Elder (1968) indicates existence of a significant relationship between IQ scores and motivation scores. However Castejon, Gilar and Perez (2006) found opposite result. Their study included 70 university students. They investigated relationship between acquired knowledge, intelligence, motivation and learning strategies. They found no significant relationship between motivation and intelligence of university students. Similarly Gagne and Pere (2002) studied with 208 eight grade female students by focusing on relationship between motivation and intelligence. Their findings showed that there was no significant relationship between motivation and intelligence. In another conflicting study, critical thinking and motivation was investigated by Garcia and Pintrich (1992). The findings of the study showed a positive correlation between critical thinking and motivation. On relationship between logical thinking and motivation, Soerjaningsih (2001) investigated relationship between student outcomes, learning environment, logical thinking and motivation. The findings showed that logical thinking and motivation were indirectly related to each other. These conflicting results might be explained by the sample size and characteristics (elementary school level or not) differences. In this study, 65 elementary students were investigated, thus using findings of the study requires attention. At the same time, the participants were students of a science and art center, this might be a limitation in generalization of the findings.

Table 1: Reliability values regarding to the factors of the motivation questionnaire

Factors	**Cronbach Alfa**
Self-efficacy	.94
Mastery goal	.93
Performance goal	.79
Willingness	.74
Total	.92

Source: Correlational research, 2014

Table 2: Descriptive values on the variables of the study

Variables	**Mean**	**SD**
Motivation	3.84	.80
Verbal IQ	136.34	8.51
Performance IQ	131.38	7.86
Total IQ	137.59	5.67
Logical Thinking	.55	.22
Critical Thinking	1.34	.36

Source: Correlational research, 2014

Table 3: Spearman correlation coefficients between the variables of the study

First Variable	**Second Set of Variables**	**Spearman Rho**	***p***
Motivation towards	Verbal IQ	.15	.27
science learning	Performance IQ	.06	.66
	Total IQ	.11	.43
	Logical Thinking	.10	.44
	Critical Thinking	.16	.22

Source: Correlational research, 2014

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CONCLUSION

The findings of this study have importance due to the fact that this study contributes to the literature by its two differences from previous studies. The first one is that this study focuses on motivation towards science learning rather than motivation toward learning so the domain dependent measure of motivation shows different scene in terms of the relationship between motivation and, logical thinking, intelligence and critical thinking. This finding might speculate different resources of these variables in learning of gifted students. The second difference is that the study includes gifted elementary level students while previous literature focuses on college or university level students. Interesting finding of this study suggest that gifted students have higher scores on both motivation towards science learning and higher-order cognitive variables whereas their higher motivation is not related to their higher cognitive development in logical thinking, critical thinking and IQ. This finding might speculate possible existence of mediators in the relationship between motivation and, logical thinking, intelligence and critical thinking.

In sum, these findings of the study might contribute to both literature and science teachers of gifted by suggesting that there is a need to consider different resources of motivation towards science learning rather than assuming direct relationship between motivation and, logical thinking, intelligence and critical thinking. In future research, number of the participants should be increased and after the increase in the sample size, more complicated analysis such as path analysis should be applied to the data. Since moderator variables such as gender and level of IQ might also be factors for non-significance in this study. For the purpose of this study, only total scores on the variables were considered, following studies should take into account sub-components of the each variable by applying the instruments to higher number of the participants than those for this study.

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