The Relationship between Problem-Solving Ability and cognitive styles Among high school students in Ghorveh city

Abstract

This research aimed to investigate the relationship between visuospatial problem-solving ability and field-dependent (FD) and field-independent (FI) cognitive styles in high school students of Qorveh City. This is an applied research study in terms of purpose and descriptive correlational in terms of method. The statistical population consisted of all first-grade secondary school students of Qorveh City in the 2014-2015 academic year (n=830 as announced by Qorveh Education Management). The sample size was calculated to be 220 using Cochran's formula. The samples were selected from the statistical population using multistage cluster sampling. This study employed the structural equation modeling (SEM) correlation method. The subjects were asked to complete the Group Embedded Figures Test (GEFT) and Kohs Block Design Test (KBDT). Data were analyzed using SmartPLS. The results indicated a significant direct effect of cognitive styles on students' problem-solving ability.

Keywords: *Problem-Solving Ability, Cognitive Styles, High School Students, Qorveh City*

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Introduction

Problem-solving has always been considered one of the key educational goals throughout the history of education. Thus, one of the demands of teachers and parents has been the acquisition of problem-solving ability by students. Different psychologists and theorists have always emphasized the importance of problem-solving activities in effective learning. By definition, when a learner is faced with a situation to which he/she cannot quickly respond using current information and skills, or when he/she pursues a goal and has not yet succeeded in realizing it, it can be said that he/she is facing a problem. According to the definition of the problem, problem-solving ability can be defined as the recognition and application of knowledge and skills that help find the best response to the situation or the realization of the goal by the learner. Therefore, the basic element in problem-solving is the application of previously learned knowledge and skills in new situations (Saif, 2009). In Gagne's theory of instructional learning (1985), learning problem-solving is called higher-order rule. According to this theory, the learner tries to create a higher order by combining simple rules, which leads to problem-solving. Thus, in problem-solving, one's prior knowledge, especially previously learned rules or principles, must be combined in a new way. (It should be remembered that in problem-solving, one's prior knowledge, especially combined principles that create the problem, must be combined in a new way.). In other words, problem-solving is not just about knowing information, concepts, or principles and putting them together, the learner should discover new ways to combine prior knowledge for problem-solving (Saif, 2009).

Problem-solving is a more objective activity than creativity, which pursues a specific goal. This means it is mainly based on facts with an objective and external goal, while creativity is mostly subjective and depends on intuition and imagination instead of problem-solving. In other words, in problem-solving, a person faces a situation for which he/she must find a solution; on the contrary, in creativity, a person creates both the situation of the problem and its solution. Another important feature of creativity distinguishing it from problem-solving is the novel results obtained from the creator's thinking. Hence, creativity emphasizes novel effects or intellectual efficiency. The main core of all concepts of creativity is novelty. Creativity leads to novel, authentic, independent, and imaginative ways of thinking about things (Saif, 2008).

Today, psychology (scientific study of behavior and mental processes) increasingly serves to improve learning and teaching processes. Some students have relatively fixed study characteristics, which can be called learning styles (Woolfolk, 1995). Learning styles refer to the learner's learning process (Saif, 2009). In general, they can be divided into three categories: cognitive, emotional, and physiological. Field-dependent and field-independent (FD/FI) styles are among the most important cognitive styles (Saif, 2009), which were first identified and studied by Witkin (1977) (Woolfolk, 1995). These styles indicate that the personal judgments of some learners are influenced by the subject of the learning field, whereas the context plays an inconsequential or no role for others (Witkin, Morre, Goodenough, and Cox, 1981). According to Witkin's theory, these differences have important applications in learning and job opportunities. FD individuals refuse to separate a component from the visual field collection and have difficulty separating visual details, patterns, and designs (Woolfolk, 1995). They are interested in subjects like social sciences and choose professions like teaching (Dembo, 1994). Conversely, FI individuals perceive different parts of a set of patterns separately and have a great ability to perceive complex designs and figures (Woolfolk, 1995). Such characteristics manifest themselves in the process of problem-solving and creativity (Witkin and Goodenough, 1981). They show interest in subjects like mathematics and prefer jobs like engineering over other professions (Dembo, 1994). Cassidy (2006) defined cognitive styles as regular subjective behaviors that address mind maps and problem-solving.

The relationship between different cognitive styles and intelligence (Watkins and Astilla, 1980; McKenna, 1983; Fujii, 1996), parental child-rearing attitudes (Kord Noghabi, 1999), gender (Hickson and Baltimore, 1996; Tharakan, 1987), field of study (Hosseini Largani, 1998; Rezaei, 1999; Rai and Prakash, 1987; Frank, 1986; Goodenough, 1977), and creativity (Chaddha, 1985; Bal, 1988) has been investigated. Elwood & Klenowski (2002) and McAlpine (2000) showed that humanities students have different cognitive styles than basic and technical science students. Regarding the relationship between personality, cognitive styles, and pair matching, Joseph Glickson (2001) concluded that FD/FI-matched pairs were more successful.

In a study entitled "A comparison of cognitive styles of female and male computer and humanities students," Zare et al. (2014) argued that computer students' cognitive style was more FI than humanities students. In his research on the relationship between FD/FI cognitive styles and problem-solving skills, Azadmard (2000) maintained that FI individuals had higher problem-solving abilities than their FD counterparts. In his study on the interaction between gender and FD/FI cognitive styles in academic achievement in two subjects, i.e., mathematics and social sciences, Safaripour (2001) demonstrated that FI students made more progress in mathematics than FD students. Eftekhari's (2000) research indicated a positive relationship between FI cognitive style and performance on multiple-choice tests in both boys and girls, while no significant relationship was observed between the aforesaid cognitive style and performance on true/false questions, limited-response (closed-ended) descriptive tests, and completion questions.

Elahi (2002) explored the relationship between FD/FI cognitive styles and English learning progress. The results indicated a positive relationship between FI's cognitive style and English learning progress. Mashayekhi (2002) compared the cognitive styles of mathematical physics, experimental sciences, and humanities adult students in Tehran high schools. The results indicated that mathematical physics and experimental sciences students tended to choose the FI style, while humanities students preferred the FD style. Rezaei (1999) compared the learning styles of mathematical physics and humanities students. The results revealed a difference in their learning styles; mathematical physics students were more FI, while humanities students were more FD. In his research, Kord Noghabi (1999) showed a positive relationship between parental child-rearing attitudes and cognitive styles of their male children. That is, the more authoritative the parental child-rearing attitude is, the more FI cognitive style their sons will have; in contrast, the more despotic the parental child-rearing attitude is, the more FD cognitive style their sons will have. In modern times, to face the amazing developments in the third millennium AD, students should improve their creative skills to make appropriate decisions and solve complex social problems. They should sharpen their research and problem-solving skills as well as their searching morale (Ganji, Pasha Sharifi, and Mir Hashemi, 2005). In every historical period, this, as the basic power of the human mind, has been the main goal pursued by schools and educational centers. In light of the foregoing, this research aimed to investigate the relationship between visuospatial problem-solving ability and FD/FI cognitive styles in high school students of Qorveh City.

Research Methodology

This was an applied research study in terms of purpose and descriptive correlational in terms of method. The statistical population consisted of all first-grade secondary school students of Qorveh City in the 2014-2015 academic year (n=830 as announced by Qorveh Education Management). The sample size was calculated to be 220 using Cochran's formula. The samples were selected from the statistical population using multistage cluster sampling. For this purpose, four high schools were randomly selected from among all-boys high schools in Qorveh City, where two classes were randomly selected, on which tests were conducted (five classes of 28 students, two classes of 27 students, and one class of 26 students).

Research tools

Group Embedded Figures Test (GEFT)

GEFT was first developed by Oltman, Raskin, and Witkin (1971) to assess FD/FI cognitive styles. This test contains 25 complex figures. In each figure, the subject is asked to find and highlight a simple geometric shape of the sample form embedded in a complex design with a pencil. The test includes three sections: 1) 7 relatively complex figures, performed for 2 minutes only for practice, 2 and 3) more complex figures, as the main sections of the test, each containing nine figures with a total response time of 10 minutes. People are not allowed to see the sample form and test plans simultaneously. For this purpose, a sample figure form has been printed on the back of the booklet. The subject's ability to find simple geometric shapes of the sample form without being distracted by the complex design indicates the degree to which he is FD or FI. A score is assigned to the subject for each correct response (score range: 0-18; 0: fully FD cognitive style, and 18: fully FI cognitive style). Oltman et al. (1971) reported the validity of this test for both men (N=80) and women (N=97) using the retest method, which was consistent with the retest validity of the Embedded Figures Test (EFT), 0.82. for men (N=51) and 0.79 for women (N=51). In this study, the criterion validity coefficient was calculated to be 0.82 for men (N=73) and 0.63 for women (N=63) (Bosaki, Innerd, and Towson, 1997). Also, Witkin et al. (1971) reported a validity coefficient of 0.82 between the second and third sections of the test using the Spearman-Brown formula (Raviv and Nabel, 1988). Safaripour (2001) utilized this test to examine the interaction between gender and cognitive style in mathematics and social sciences academic achievement. The validity coefficient was calculated to be 0.85 and 0.87 using retest and Cronbach's alpha methods, respectively.

Kohs Block Design Test (KBDT)

KBDT materials consist of two parts: i) 16 fully equidimensional yellow, red, white, and navy wooden cubes and ii) 17 different geometric shapes arranged from simple to difficult. The scoring test is based on two variables: the time spent and the accuracy of the created images. Hutt's (1932) studies on a large group of 9-11-year-old children indicated the ability of KBDT to classify children based on mental activity, especially in measuring visuospatial skills. A similar study was conducted by Dubois (1975) on 609 children aged 5-9 years, which confirmed the results of Hutt's studies. This study calculated internal consistency and test-retest reliability as 0.91 and 0.89, respectively (Reio et al., 2004).

Other research reported a correlation coefficient of 0.6-0.8 between KBDT and the Stanford-Binet test (Bahrami, 2003). KBDT is widely used to measure visuospatial skills (Reio et al., 2004).

If necessary, the tester helps the subject make the first images, explains the requirements, and waits for a square to be made. An allowed time is included for making each image. If the subject succeeds in making the image during this time, he/she will be scored according to the relevant table; on the other hand, if the time spent on making images exceeds the allowed time, no scores will be assigned to the subject. In images 3-17, the tester does not help the subject. The maximum allowed time for making each image is included both on the image itself and the score sheet. The test is stopped after three consecutive failures. Practice test responses are not included in scoring; each image must be made in the allowed time. An image not made completely correctly will not get a score after the allowed time is over. If the subject manages to create the image completely, scoring is performed according to the time spent. The number of scores and allowed time to make different images are different. The scoring method and allow time for making different images are written on the score sheet. During the test, the tester notes the time spent to make each image in front of it on the score sheet. To find the score of each image, the tester attempts to find the time immediately higher than or equal to the time spent by the subject in front of the number of each image. The number inserted on the left side of the mentioned time is the score that should be given to the subject. This study employed centrality and dispersion indices according to the measurement level of variables and structural equation modeling (SEM) in SmartPLS for data analysis.

Findings

Table 1: Description of research variables

Variable	Sample size	Mean	Standard error of the mean	Min	Max	Range	Variance	Standard deviation	Skewness	Standard error of skewness	Kurtosis	Standard error of kurtosis
Cognitive styles	220	7	0.204	2	17	15	9.173	3.029	1.377	0.164	1.976	0.327
Problem-solving	220	88.81	1.053	51	132	81	243.953	15.619	1.383	0.164	2.294	0.327

According to the data in Table 1, the mean scores of the subjects for cognitive styles and problem-solving are 7 and 81.88, with a standard deviation of 3.03 and 15.62, respectively.

Table 2: The results of Kolmogorov-Smirnov and Shapiro-Wilk tests for the normality of the distribution of research variables

Variable	Kolmogorov-Smirnov	DoF	Significance level	Shapiro-Wilk	DoF	Significance level
Cognitive styles	0.168	220	0.0001	0.868	220	0.0001
Problem-solving	0.143	220	0.0001	0.872	220	0.0001

The results of the Kolmogorov-Smirnov test indicate the non-normal distribution of the variable data of cognitive styles

($p<0.01$ and Z=0.168) and problem-solving ($p<0.01$ and Z=0.143).

Table 3: Cronbach's alpha values

Variable	Composite reliability	Cronbach's alpha
Cognitive styles	0.729	0.715
Problem-solving	0.669	0.665

According to Table 3, the reliability coefficient of the variables was calculated to be 0.715 for cognitive styles and 0.665 for problem-solving based on Cronbach's alpha, indicating an acceptable reliability. The average variance extracted (AVE) was also calculated to be 0.559 and 0.475 for cognitive styles and problem-solving, respectively, indicating an acceptable validity. Table 4 lists the XXX and coefficients of determination for the research variables.

Table 4: Coefficients of determination for the research variables

Variable	shared coefficients	Coefficient of determination (R^2)
Cognitive styles	0.559	0.339
Problem-solving	0.475	0.602

According to Table 4, the shared coefficients are 0.56 for cognitive styles and 0.47 for problem-solving, indicating an acceptable validity. Coefficients of determination are also 0.339 and 0.602 for cognitive styles and problem-solving, respectively, which are moderate or acceptable.

Table 5: The effect of research variables on problem-solving

Variable	**Direct effect**			**Total effect**		
	b	t	p	b	t	p
The effect of cognitive style on problem-solving	0.264	3.403	$p<0.01$	0.558	8.046	$p<0.01$

As can be seen, cognitive styles significantly directly affect students' problem-solving ability ($p<0.01$, t=3.40 and b=0.26). Also, the total effect of cognitive styles on problem-solving through creativity is significant ($p<0.01$, t=8.05 and b=0.56).

Conclusion

The results indicated that cognitive styles significantly directly affect students' problem-solving ability. According to the many investigations and searches made by the researcher, since the relationship between FD/FI cognitive styles and problem-solving ability has not been explored so far, and the present study can be considered innovative in this sense, the results obtained in this section cannot be compared with other results. However, the findings of this research can be consistent with those of Thomas (2005), Chiu (2009), Lin (2011), and Kudryavtsev (2011). In explaining this finding, it can be argued that the field has little or no effect on those with high creativity (Witkin, Morre, Goodenough, and Cox, 1977). FD individuals refuse to separate a component from the visual field collection and have difficulty separating visual details, patterns, and designs (Woolfolk, 1995). On the other hand, FI individuals perceive the parts of a set of patterns separately and have a great ability to perceive complex designs and images (Woolfolk, 1995). These characteristics appear in creativity and problem-solving processes (Witkin and Goodenough, 1981).

A limitation of the present study was the limited statistical population regarding age. FD/FI cognitive styles measurement tools, such as GEFT, were used in centers for counseling and psychological services to provide educational and vocational guidance and counseling. Explaining this model in learning environments is recommended to predict people's visuospatial problem-solving ability.

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