

Explaining the Structural relationships between thinking styles and Creativity based on the Mediating role of Intelligence and Knowledge in Teenagers

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Abstract

Introduction: The purpose of this research was to explain the structural relationship between thinking styles and creativity based on the mediating role of intelligence and knowledge.

Methods: The current research is a descriptive design of the correlation type. The sample includes 300 secondary school students of Karaj city, who were selected by stratified random method. How to fit the model with the collected data was investigated with the help of structural equation modeling analysis method and using AMOS 24 software and maximum likelihood estimation.

Results: The results of the present study showed that the path coefficient between normative thinking style and creativity with the mediation of knowledge ($p < 0.05$, $\beta = 0.051$) is positive and significant at the 0.05 level. On the other hand, the path coefficient between productive thinking style and creativity with the mediation of knowledge was not significant at the 0.05 level ($p < 0.05$, $\beta = 0.006$). Also, the path coefficient between productive thinking style and creativity with the mediation of intelligence ($p < 0.05$, $\beta = 0.068$) was positive and significant at the 0.05 level. On the other hand, the path coefficient between normative thinking style and creativity with the mediation of intelligence was not significant at the 0.05 level ($p < 0.05$, $\beta = 0.055$).

Conclusion: In general, the results showed that the two variables of intelligence and knowledge mediate the relationship between productive and normative thinking styles with creativity.

Keywords: creativity, knowledge, thinking styles, intelligence

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Introduction:

The distinctive characteristics of a human being are the power of thought. Throughout his life, he was never free from thought and with the power of correct thinking, he was able to solve problems and grow and excel and achieve. Therefore, all human progress depends on his fertile, dynamic and effective thinking. One of the most complex and excellent manifestations of human thought is creative thinking. Human creativity helps to foresight, initiative and problem solving (1). Creativity is one of the factors that are closely related to learning. In the past years, the educational system has emphasized on activating learners in learning. The purpose of activating learners is to cultivate their creativity. Creativity is an intellectual and mental activity that has always been a great need in all aspects throughout human life, and people who have this skill will be able to organize knowledge and information. In fact, the main goal of all educational institutions is to create creativity in students. It is clear that in order to achieve these goals, a heavy responsibility is placed on the shoulders of educational centers, especially education (2). In the definition, creativity is the development and expansion of ideas, solutions and judgments that are firstly fresh and novel and secondly appropriate and desirable according to the situation. Creativity is considered to mean the ability to combine ideas in a unique way or create connections between ideas and establish new connections, see things in new ways and define new issues (3). Creativity is considered a kind of mental ability and skill that can create new and unusual ideas and solutions by depicting problems and phenomena and analyzing them. Creativity is the ability to combine ideas in a unique way to make unusual connections between different ideas (4). Torrance (5) considers creativity as the process of sensing problems, issues, gaps in information, missing elements, awkward things, guessing and hypothesizing about these flaws, evaluating and testing these guesses and hypotheses, revising and testing them again, and finally communicating the results. Torrance (5) considers creativity to be the combination of the following four main factors: 1) fluidity: the ability to produce many ideas, 2) elaboration: the ability to pay attention to details, 3) innovation: the ability to produce new and unusual ideas and 4) Flexibility means the ability to produce many different ideas or methods.

There are three factors affecting creativity and innovation: intelligence, personality and thinking style (6). Creativity depends on three variables, each of which is divided into several factors. These variables are cognition, environment and personality. Factors that make up knowledge include intelligence and wisdom, and environmental variables are made up of social, cultural, political, religious factors, and education. At the same time, personality traits such as self-confidence, initiative and motivation also have an effect on creativity. In fact, creativity is the interaction between talent, process and environment by which an individual or group produces an understandable product that is both new and useful in a defined social context (7). Intelligence is defined as the ability to learn reason and perceive (8). Thinking styles, a factor that seems to affect people's intelligence and knowledge. When people give meaning to their thoughts and somehow organize meaningless information and data and place them in different classes, they actually gain

knowledge (9). Knowledge helps to understand perceived individual differences and predict people's behavior (10).

Ford (11) several factors such as abilities and motivations are necessary to create innovation, but thinking style plays a significant role in this field. Nowadays, educating creative and innovative students in universities and schools is very important, and identifying people's thinking styles is one of the important and key factors for creating creativity and recognizing creative people (12). Thinking styles can be considered as one of the important sources of variability, especially in academic situations. How people prefer to think and behave in certain situations can be as important as how well they think and act (13).

Stenberg (14) has named the different ways of people in processing information as thinking styles. Stenberg's thinking styles model includes the three functions of legislator, executive and judge; the four forms of individual leader, payer leader, Jirga leader and non-leader; holistic and detailed levels; there are two ranges, introspective and extroverted, and two tendencies are free-thinking and conservative. In this regard, in the research of Ghazi Vakili et al. (15), the results showed that there is a significant relationship between learning styles, critical thinking and academic performance. Bernardo et al. (16) showed in a research that there is a relationship between thinking styles and average grades, and thinking styles are related to academic progress.

Methods:

The current research is a descriptive-observation design of the correlation type. The statistical population consists of all male and female students of the second secondary level (mathematical, experimental and humanities) who were studying in the academic year 2017-2018. The sample includes 300 secondary school students (154 girls and 146 boys) who were selected by multi-stage random sampling. The tools used in this research include:

Zhang and Sternberg's creativity test: Li Feng Zhang and Robert Sternberg (17) a questionnaire for evaluating creativity at several different levels (MAC) at the University of Hong Kong and Tufix was prepared to evaluate the abilities of creative students of this scale. The MAC system considers 6 resources that people consider to measure creativity (intelligence and information, science, way of thinking, personality, motivation and environment) during evaluation. Two MAC samples (one for measuring boys and one for measuring girls) were assigned to 270 cases (120 boys and 150 girls) of Chinese students. Overall, the results of this research strongly support the creativity investment theory.

Thinking styles questionnaire: Stenberg's 1997 thinking styles questionnaire has 36 questions that are scored on a Likert scale from completely disagree to completely agree, and the subscales of legislative thinking style, executive thinking style, judgmental thinking style, holistic thinking style, It evaluates critical thinking style, free thinking style, conservative thinking style, introverted thinking style and extroverted thinking style. Black and McCutch (18) for this instrument reported

Cronbach's alpha in the range of 0.67 to 0.84 and the internal correlation of the subscales with each other as an indicator of the instrument's validity. Pouratshi and Zamani (19)) reported Cronbach's alpha coefficients in the range of 0.92 to 0.74 for this tool. In their research, the findings related to the confirmatory factor analysis confirmed the construct validity of the thinking styles questionnaire.

Rayon's progressive matrix test: Rayon's progressive matrices test (20) (mostly called Rayon's matrices) or RPM for short, is a set of non-linguistic tests that are usually used in educational fields. This 60-question test is used to measure people's abstract reasoning as a part of general intelligence. Raven's IQ test is the most common and famous test designed for ages 5 and up. The structure of this test consists of 60 questions that are answered in the form of multiple-choice answers (6-8 options) and the order of difficulty of the questions is from easy to difficult. This test measures reasoning intelligence and general intelligence of the examinee, which is known as "Spearman's General Intelligence Factor". In this research, students' academic achievement average is used to measure knowledge.

Results:

In this research, 154 female students and 146 male students of the second secondary level were present, whose mean and standard deviation of their age was 0.89 ± 16.93 , respectively. According to the statements of the participants, 80 people were studying in the field of mathematics, 74 people were studying in the field of experimental science, and 146 people were studying in the field of humanities. And finally, 211 of the participants were studying in the 11th grade and 89 in the 12th grade.

Average, standard deviation and correlation coefficients between productive thinking style (legal, judicial, hierarchical, general and free-thinking), normative thinking style (executive, partial, conservative and royal thinking), intelligence, knowledge and creativity components (verbal, the interpretation of images and the completion of images) shows.

In this research, the assumption of normality of data distribution was evaluated by examining the values of skewness and kurtosis and the assumption of collinearity by examining the values of the variance inflation factor (VIF) and the tolerance coefficient of the predictor variables. Considering that the skewness and kurtosis indices of all research variables were within ± 2 and on the other hand, the values of tolerance coefficient and variance inflation related to predictor variables were greater than 0.1 and smaller than 10 respectively, so this result it was concluded that the two assumptions of normality of data distribution and collinearity among the data of the current research are established. It should be mentioned that the evaluation of the values of elongation and skewness of the information related to "Mahlenbauis distance (D)" showed that the distribution of multivariate data is normal. Because the values of skewness and kurtosis related to the information of Mahlenbauis distance were equal to 0.728 and -0.315 respectively.

In order to test the measurement model of the research, confirmatory factor analysis was performed using AMOS 24.0 software and maximum likelihood (ML) estimation, and the results showed that, according to the expectation, the chi-square index is significant at the level of 0.01 (<0.01). $P, 77/108 (df=51) 2 \beta$). This result indicated that the model did not fit with the collected data. Because the chi-square index is affected by the sample size, other fit indices were examined and it was observed that all of them include the root mean square error (RMSEA = 0.062), goodness of fit index (GFI = 0.946), Adjusted goodness of fit index (AGFI=0.918) and comparative fit index (CFI=0.942) support the acceptable fit of the model with the data. Table 1 shows the factor loading, standard error, and critical ratio for each of the variables' indicators.

Table 1: Measurement model parameters in confirmatory factor analysis

| | b | β | SE | t |
|---|-------|---------|-------|-------|
| Productive thinking style - legal thinking | 1 | 0.783 | | |
| Productive thinking style - judicial thinking | 0.950 | 0.650 | 0.090 | 10.60 |
| Generative thinking style - Hierarchical thinking | 1.094 | 0.697 | 0.096 | 11.37 |
| Productive thinking style - general thinking | 0.905 | 0.576 | 0.097 | 9.36 |
| Productive thinking style - free thinking | 1.144 | 0.727 | 0.097 | 11.83 |
| Normative thinking style - Executive thinking | 1 | 0.572 | | |
| Normative thinking style - partial thinking | 1.161 | 0.663 | 0.140 | 8.30 |
| Normative thinking style - conservative thinking | 1.525 | 0.846 | 0.171 | 8.0 |
| Normative thinking style - Royal thinking | 0.799 | 0.587 | 0.104 | 7.66 |
| Creativity - verbal creativity | 1 | 0.619 | | |
| Creativity - completing the pictures | 0.227 | 0.484 | 0.08 | 5.96 |
| Creativity - interpretation of images | 0.865 | 0.742 | 0.141 | 6.14 |

Table 1 shows that the relationships between the factors and their related indicators are significant and in the expected direction. The highest factor load belonging to the indicator of conservative thinking ($\beta=0.846$) was the latent variable of normative thinking and the lowest factor load was the indicator of completing images ($\beta=0.484$) the latent variable of creativity. In this way, considering that the factor loadings of all indicators were higher than 0.32, and therefore all of them had the necessary power to measure the current research variables.

b) Structural model: After ensuring the acceptable fit of the measurement model, its structural model was checked using the structural equation modeling method, in which it was assumed that the styles of productive thinking and normative thinking were both directly and with mediation.

Intelligence predicts creativity. The results of the analysis showed that, with the exception of the CFI fit index, other indices support the acceptable fit of the primary structural model with the collected data ($206.41=(df=70)$, $df=2.95$, $882=2.95$ CFI = 0.916, GFI = 0.874, AGFI = 0.874, and RMSEA = 0.081). Considering the importance of the CFI fit index in evaluating the fit of the model with the data, the structural model was modified by creating covariance between the errors of the two indicators of knowledge and intelligence, and in this way the fit indices were improved ($(df=69)2\chi^2=151.95$, $df/2\chi^2=2.20$, CFI=0.928, GFI=0.936, AGFI=0.903 and RMSEA=0.063). Table 2 shows the direct, indirect and total path coefficients between research variables.

Table 2: Total and direct and indirect path coefficients between the research variables in the structural model

| | | predictor variable | b | S. E | β | sig |
|----------------------|------|------------------------------------|--------|-------|---------|-------|
| Total coefficient | path | Normative thinking - creativity | 0.294 | 0.390 | 0.082 | 0.495 |
| | | Productive thinking - creativity | 1.126 | 0.445 | 0.321 | 0.002 |
| Direct coefficient | path | Normative thinking - creativity | -0.085 | 0.364 | -0.024 | 0.778 |
| | | Productive thinking - creativity | 0.868 | 0.394 | 0.248 | 0.011 |
| | | Normative thinking - intelligence | 0.893 | 0.512 | 0.150 | 0.080 |
| | | Normative thinking - knowledge | 0.163 | 0.064 | 0.220 | 0.008 |
| | | Productive thinking - intelligence | 1.082 | 0.474 | 0.186 | 0.023 |
| Indirect coefficient | path | Productive thinking - knowledge | 0.018 | 0.069 | 0.025 | 0.819 |
| | | Intelligence - creativity | 0.220 | 0.050 | 0.365 | 0.001 |
| | | Knowledge - creativity | 1.118 | 0.351 | 0.230 | 0.002 |
| Indirect coefficient | path | Normative thinking - creativity | 0.379 | 0.172 | 0.106 | 0.012 |
| | | Productive thinking - creativity | 0.258 | 0.125 | 0.074 | 0.039 |

The above table shows that the total path coefficient between productive thinking style and creativity ($p < 0.01$, $\beta = 0.321$) is positive and significant at the 0.01 level. On the other hand, the total path coefficient between normative thinking style and creativity was not significant at the 0.05 level. Table 3 also shows that the path coefficient between intelligence and creativity variable ($p < 0.01$, $\beta = 0.365$) on the one hand and the path coefficient between knowledge and creativity variable ($p < 0.01$, $\beta = 0.230$) on the other hand is positive and significant at the 0.01 level. The results of Table 3 show that the indirect path coefficient between productive thinking style and creativity ($P > 0.05$, $\beta = 0.074$) on the one hand and the indirect path coefficient between normative thinking style and creativity ($P > 0.05$) $\beta = 0.106$) on the other hand is positive and significant at the

0.05 level. Next, in order to determine the unique contribution of each of the mediating variables in mediating the relationship between productive and normative thinking styles with creativity, Baron and Kenny's formula was used, the results of which are in Table 3 can be seen.

Table 3: Significance test of the mediating role of intelligence and knowledge motivation in the relationship between thinking styles and creativity

| routes | a*b | β | SEab | Z |
|--|-------|---------|-------|-------|
| Normative thinking -intelligence-creativity | 0.197 | 0.055 | 0.124 | 1.57 |
| Normative thinking –knowledge-creativity | 0.182 | 0.051 | 0.087 | 2.092 |
| Productive thinking –intelligence-creativity | 0.238 | 0.068 | 0.117 | 2.034 |
| Productive thinking –knowledge-creativity | 0.020 | 0.006 | 0.081 | 0.247 |

Table 3 shows that the path coefficient between normative thinking style and creativity with the mediation of knowledge ($p < 0.05$, $\beta = 0.051$) is positive and significant at the 0.05 level. On the other hand, the path coefficient between productive thinking style and creativity with the mediation of knowledge was not significant at the 0.05 level ($p < 0.05$, $\beta = 0.006$). Also, the path coefficient between productive thinking style and creativity with the mediation of intelligence ($p < 0.05$, $\beta = 0.068$) was positive and significant at the 0.05 level. On the other hand, the path coefficient between normative thinking style and creativity with the mediation of intelligence was not significant at the 0.05 level ($p < 0.05$, $\beta = 0.055$).

Discussion and Conclusion:

The results of the present study showed that the two variables of intelligence and knowledge mediate the relationship between productive and normative thinking styles and creativity.

In the definition, creativity is the development and expansion of ideas, solutions and judgments that are firstly fresh and novel and secondly appropriate and desirable according to the situation. Creativity is considered to mean the ability to combine ideas in a unique way or create connections between ideas and establish new connections, see things in new ways and define new issues (21). Psychologists have defined intelligence as the ability to function effectively in life. Intelligent people are those who are driven to acquire knowledge and skills resulting from experience for efficient management and tasks of daily life. One of the most important aspects of intelligence is accepting dynamic global changes, environmental changes, skills and knowledge from past experiences that are undeniable and challenging. Effective information includes the use of existing systems in learning, expansion of existing knowledge, analysis of new conditions, development of new conditions and solutions to help improve the quality of the environment (22).

Intelligence is one of the significant factors in people's adaptation to the environment and also considered as one of the factors of individual differences (23). Thinking styles help people to know how they can develop their strategies in making decisions and solving problems. Thought means movement from the known to the unknown. In many cases, people unconsciously use thinking styles (24). When a person is faced with a problem and wants to solve it, each of the thinking styles can be considered methods that can be used to successfully complete part of the problem solving process. . Therefore, creativity, or in other words, creative thinking methods, are ways of thinking with the help of which various ways are obtained to solve the problem, and the greatest success is achieved when so that the person's thinking style is in harmony with the situation (25).

Ethical considerations:

Ethical considerations of the project included: written information about the research to the, reassuring the candidates about the confidentiality of the information and using it only in research matters, voluntary participation and obtaining written consent from the participants.

Research Limitations:

Conducting this research was accompanied by some limitations; one of the basic limitations is the generalization of the results of this research to the students of Karaj District 2 schools. In this research, the variables of teachers' teaching methods, schools' educational system, social class, social and family culture of students were not controlled.

Applied research results

It is recommended that another research be carried out in predicting creativity with the variables of teachers' teaching style, schools' educational system, social class, social and family culture of students. Also, education should pay attention to creativity as one of the main factors of progress, independence and empowerment of students, so that a new perspective is placed in front of students.

Conflict of interest

There is no conflict of interest between the authors.

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