Original Article

# Critical Thinking as a Mediator between Metacognition and Creative Problem Solving in Zanjan University of Medical Sciences students; Academic Year 98-97

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## Abstract

**Background & Objective:** Metacognition and critical thinking are some of the factors that can help students to solve difficult problems. Therefore, it is necessary to examine the relationship between these factors and creative problem solving. Therefore, this study aimed to determine the mediating role of critical thinking in the relationship between metacognition and creative problem solving among students of Zanjan University of Medical Sciences in 1997-98.

**Materials & Methods:** This was a descriptive-correlational study. The statistical population was all PhD students in Zanjan University of Medical Sciences in the academic year of 1997-96. The sample size was 311 students using Morgan method and were selected by stratified random sampling. Of the 275, 167 (60.7%) were male and 108 (39.3%) female. Data were collected using Wells & Cartwright's Metacognition Questionnaires (2004), Baser Creative Problem Solving (2004) and Rickets Critical Thinking Questionnaire (2003). Data analysis was performed by using Pearson correlation and multiple regression tests in SPSS 24 software. The four-step method of Baron and Kenny was used to determine the mediator role.

**Results:** The results showed that there is a relationship between metacognition and creative problem solving ($P<0.05$). In addition, metacognition can significantly explain creative problem solving in students ($P<0.05$). The mediating role of critical thinking in the relationship between metacognition and creative problem solving was also confirmed in this study.

**Conclusion:** Meta-cognition can explain creative problem solving in students. Critical thinking also strengthens the relationship between the two variables of metacognition and creative problem solving in students.

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## Introduction

One of the most important responsibilities of universities is laying the proper foundation for the emergence of hidden talents of students, as well as fostering creativity and solving problems creatively in these individuals (1, 2). Along with learning about scientific facts, students should focus on scientific information search methods and learn how to think, decide and judge various affairs instead of the accumulation of scientific knowledge in mind (3). Creative problem-solving is one of the widest problem-solving methods that occur purposively. In this problem-solving method, the person strives voluntarily, intentionally, and consciously to achieve a specific goal (4, 5). Given the extent of today's societies and facing numerous problems in life, students must have the necessary and sufficient ability to cope with difficult life situations in order to grow and make advancement in various areas. In today's changing world, the social situations and work-related responsibilities necessitate the use of problem-solving skills by students (6). In addition to

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proper information, solving problems creatively requires skills that assist students in the appropriate use of this wide data. One of these skills is metacognition (5, 7), and metacognitive strategies have been taken into account to understand cognitive processes and find ways to improve these processes by education experts and psychologists (8).

Metacognition is defined as knowledge about oneself, or any knowledge or cognitive process that requires assessment, monitoring, and control of cognition. In addition, metacognition is described as a multidimensional set of processes, strategies, and knowledge that evaluate, review and control cognition (9). Metacognition is a process in which students learn about their learning method and how to use mass data to reach their learning goals. In metacognition, the evaluation aspect is as important as understanding the cognitive processes. In this method, students learn how to judge cognitive processes and assess their learning before and after the use of metacognitive strategies. Moreover, metacognition helps students properly manage information and cognitive processes (7). Meanwhile, it seems that factors such as critical thinking can increase metacognitive strategies and creative problem-solving in students. In fact, critical thinking is one of the most important education principles in any country, and societies need people with excellent critical thinking skills in order to grow and prosper (10).

Significant attention has been paid to critical thinking in today's world, and many universities obligate students to pass related courses before graduation (11). Critical thinking is the process of reflection and reasoning that one needs to discover situations, deal with difficult issues to make a hypothesis, and integrate all the information obtained through inquiry, which leads to the development of results and justifies the conclusion. Furthermore, critical thinking is used for problem-solving, decision-making, and deduction (12). Critical thinking is based on goals and results that require judgment. As a cognitive process, critical thinking leads to a fundamental understanding of the growth and benefit of knowledge. This type of thinking can be used in problem-solving and decision-making in any context that can be social, clinical, ethical, managerial, and political (13). In a research, Gary reported that the large volume of data could not lead to problem-solving and the way the information was selected and used played an extremely important role in the problem-solving process. In the foregoing study, the use of metacognitive strategies was proposed as an effective factor for successful problem-solving (4, 14). In another study, Cera (15) found a relationship between metacognition and self-efficacy and self-regulation. This scholar mentioned an association between metacognitive strategies and autonomy and self-efficiency of students, suggesting the development of these factors to achieve deep learning in students.

Gul (10) identified critical thinking as a fundamental cognitive process for growth and recommended the utilization of this knowledge and type of thinking to gain academic achievement and solve problems. In a research, Ulger (16) reported a significant relationship between creativity and critical thinking in students of some fields of study. Meanwhile, this association was not significant in some other disciplines. Therefore, Ulger proposed the use of non-conventional processes for problem-solving. In domestic studies, Safarzadeh (17) detected a relationship between metacognition and critical thinking with the variables of learning styles and academic success. Moreover, Moslemi (18) focused on the relationship between the mentioned two variables and information literacy. Nevertheless, no association was found between critical thinking skills and metacognitive strategies in the foregoing study. Since medical universities' mission is to train a committed and skilled workforce in the field of health and treatment, the development of creative problem-solving and identification of related factors leads to the growth of students and creative solving

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of challenges ahead. On the other hand, even though relatively similar studies have been performed on this issue, no research has fully explored this concept, especially in this geographical area and on this statistical population. Nonetheless, the evaluation of these studies showed a lack of congruence of results among them. Furthermore, the mediating role of critical thinking has not been mentioned in these studies, whereas the current research evaluated the role of this variable as a mediator. It is crucial to identify this mediating variable since it can be utilized as a completely or partially independent variable in educational and medical interventions and desired changes can be made in the dependent variable. With this background in mind, the present study aimed to determine the mediating role of critical thinking in the relationship between metacognition and creative problem-solving in students of Zanjan University of Medical Sciences in 2018-2019.

## Materials and Methods

This was a descriptive-correlational study, and its statistical population included all female and male general PhD students (n=1654) in Zanjan University of Medical Sciences in the academic year of 2018-2019. The sample size was estimated at 311 using Morgan's Table. The subjects were randomly selected from schools of medicine, dentistry, and pharmacy using a stratified random sampling method. In addition, students were chosen based on the total number of students in each field. Data were collected using the metacognitions questionnaire by Wells and Cartwright (2004), Basadur's creative problem-solving inventory (CPSP) (2004) and Ricketts' critical thinking disposition questionnaire (2003).

The Metacognitions questionnaire 30 (MCQ-30; Wells & Cartwright-Hatton): was designed in 2004 and included 30 multiple-choice questions with options of I do not agree, I slightly agree, I relatively agree and I completely agree, which are scored on a four-point scale. The questionnaire measures five subscales of positive beliefs about worry, negative beliefs about the controllability of thoughts and corresponding danger, cognitive confidence, negative beliefs about thoughts in general/need to control thoughts and cognitive self-consciousness. On this scale, a higher score is indicative of strong metacognition in the person. In fact, scores in the ranges of 30-60, 60-90, and 90-120 are recognized as poor, moderate and strong metacognition, respectively (19). The reliability of the tool and its components was confirmed at a Cronbach's alpha of 0.72-0.93, and the reliability of the retest (with a one-month interval) was reported at 0.73 (20). In Iran, Shirinzadeh et al. evaluated the validity and reliability of the tool in a research on 258 participants. The construct validity of the tool confirmed the five extracted factors using exploratory factor analysis. The validity of the instrument was calculated by the internal consistency coefficient for the whole scale at 0.91. The split-half method was also used to confirm the validity of the tool, which was estimated at 0.9 for the whole scale and 0.73 by retest (21). In a research by Salarifar (18), internal consistency coefficient and split-half methods were exploited to validate the tool, which was reported at 0.88 and 0.87, respectively. In another study, the reliability of the scale was confirmed by Abolghasemi et al. (22) at a Cronbach's alpha of 0.81. In addition, the internal consistency of the instrument was reported at 0.86 by Osoli et al. (23). Despite the standard nature of the tool, we assessed its face validity and internal consistency. To this end, the instrument was filled by five professors in the fields of psychology and educational science and their opinions were used to make adjustments in the questionnaire. Moreover, the internal consistency of the tool was confirmed at a Cronbach's alpha of 0.79.

Basadur's creative problem-solving inventory (CPSP): was designed in 2004 and includes 16 items scored based on a five-point Likert scale (never, rarely, sometimes, often, and most of the time). This questionnaire can be administered in groups and

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individually. In addition, items 1-10 and 13-15 are scored directly while other items (8, 11, 12, 16) are reversely scored. The total scores are added together after performing the test. The minimum and maximum scores of the tool are 16 and 80, where a higher score is indicative of a greater ability to solve problems creatively. Basadur reported the validity and reliability of the tool to be favorable. In fact, the construct validity of the questionnaire showed a suitable factor load of the items using factor analysis. In addition, the internal consistency of the questionnaire was approved at a Cronbach's alpha of 0.83 (24). In Iran, Zare et al. (2014) translated, did a psychometric test on, and validated the tool. The mentioned researchers used construct and concurrent validity to confirm the validity of the instrument. In addition, the concurrent validity of the tool was approved by the Torrance Tests of Creative Thinking (TTCT), the results of which showed the proper validity of the inventory. In terms of construct validity, the researcher reported proper factor load for all 16 items in the questionnaire. Moreover, the reliability of the tool was assessed using a test-retest approach. In addition, reliability was approved at a Cronbach's alpha of 0.762. Furthermore, the internal consistency of the instrument was confirmed at a Cronbach's alpha of 0.844 (25). In the present study, we evaluated the validity and internal consistency of the tool, and our findings confirmed the reliability of the tool at a Cronbach's alpha of 0.75 (25). Moreover, the validity of the instrument was approved by face validity.

Ricketts' critical thinking disposition questionnaire: was designed in 2003 and encompasses 33 items. The items are scored based on a five-point Likert scale from completely agree to completely disagree and includes three subscales; the first part contains 11 items to assess the creativity component, whereas the second and third parts encompass 9 and 13 items related to the components of growth and commitment, respectively. The minimum and maximum scores of the test are 165 and 33 (26). In Iran, the tool was translated and validated by Pakmehr et al., who confirmed the validity of the instrument using content and construct validity. The three subscales extracted by Rickett were confirmed in the factor analysis process, and all items had suitable factor load. In addition, internal consistency and split-half methods were used, and the Cronbach's alpha and the coefficient of reliability were both calculated at 0.7 (26). In the current research, the internal consistency coefficient of the instrument was confirmed at a Cronbach's alpha of 0.69.

First, the subjects entered the research from all schools, and the list of students (separated based on discipline) was received from the education department of the university, followed by the random sampling process. In random sampling, the random number method was used due to the availability of the list of all students. In the data collection stage, 311 questionnaires were distributed and collected, 36 of which were excluded due to lack of answering three or more questions and being distorted. In the end, 275 healthy questionnaires were analyzed.

Ethical Considerations

The present study was extracted from a specialized doctoral dissertation with the ethical code of IR.ZUMS.IREC.1398.023. First, the research objectives were explained to the participants and informed consent was obtained prior to the research. In addition, the subjects were ensured of the confidentiality terms regarding their personal information and they were allowed to withdraw from the research. Data analysis was performed in SPSS version 24 using the Kolmogorov-Smirnov test (to confirm the normal distribution of the data), Pearson's correlation coefficient, stepwise multiple regression, and Baron and Kenny's four-step approach (to determine the mediating role of critical thinking). The last method has been used in various studies as one of the most accurate techniques employed to determine the mediating role of a variable. In this method, the relationship between the predictor variable and the criterion variable without

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the presence of a mediator variable was investigated in the first stage. Considering the significance of the relationship, the relationship between the predictor variable and the mediator variable was examined in the second stage, and the relationship was significant in this stage as well. In the third stage, the relationship between the mediator variable and the criterion variable was examined, and given its significance at this stage, the relationship between the predictor variable and the criterion variable in the presence of a mediator variable. Finally, the mediating role of the variable was confirmed considering that the relationship between independent and dependent variables was not significant in the last stage.

## Results

In the present study, the subjects were selected from PhD students from the schools of medicine (n=103), dentistry (n=79) and pharmacy (n=93). In terms of gender, 167 subjects (60.7%) were male and 108 (39.3%) were female. In addition, the mean age of the students was 21.12 years and their mean GPA was 16.8.

**Table 1: Descriptive indicators of variables and study components**

| Variable | Low limit | High limit | Average | Standard deviation |
|---|---|---|---|---|
| Cognitive trust | 8 | 23 | 15/4516 | 3/50757 |
| Positive beliefs about worry | 5 | 22 | 13/2138 | 2/21800 |
| Cognitive self-awareness | 13 | 24 | 18/3646 | 3/69357 |
| Negative beliefs about uncontrollable thoughts and danger | 10 | 21 | 15/6027 | 2/54177 |
| Beliefs about the need to control thoughts | 8 | 23 | 18/7554 | 3/65773 |
| Metacognition (in total) | 29 | 117 | 81/3621 | 18/44363 |
| Creative problem solving | 18 | 78 | 62/2923 | 4/36689 |
| Creativity | 15 | 23 | 33/2945 | 4/72060 |
| growth | 11 | 22 | 26/3958 | 3/40100 |
| obligation | 17 | 24 | 39/3958 | 4/40100 |
| Critical thinking (in total) | 42 | 21 | 99/0712 | 15/09422 |

Table 1 shows the descriptive information about the research variables in the sample. As can be seen, the mean of metacognition (total score) is 81.36, creative problem solving is 62.29 and critical thinking (total) is 99.07.

According to Pearson's correlation test results presented in Table 2, there was a relationship between creative problem-solving and variables of cognitive confidence (r=0.443, P=0.01), positive beliefs about worry (r=0.219, P=0.01), cognitive self-consciousness (r=0.0502, P=0.01), negative beliefs about the controllability of thoughts and corresponding danger (r=0.252, P=0.01), negative beliefs about thoughts in general/need to control thoughts (r=0.631, P=0.01) and metacognition (overall) (r=0.485, P=0.01).

**Table 2: Metacognition correlation matrix and its dimensions by solving the creative problem in the participants**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1- Cognitive trust | 1 | 0/841** | 0/899** | 0/628** | 0/832** | 0/555** | 0/433** |
| 2. Positive beliefs about worry | 0/841** | 1 | 0/709** | 0/360** | 0/502** | 0.400** | 0.219* |
| 3- Cognitive self-awareness | 0/899** | 0/709** | 1 | 0/519** | 0/810** | 0/737** | 0/502** |
| 4- Negative beliefs about uncontrollable thoughts and danger | 0/628** | 0/360** | 0/560** | 1 | 0/531** | 0/184 | 0/252* |
| 5. Beliefs about the need to control thoughts | 0/832** | 0/532** | 0/810** | 0/531** | 1 | 0/463** | 0/631** |
| 6- Metacognition (in total) | 0/555** | 0/400** | 0/737** | 0/184 | 0/463** | 1 | 0/485** |
| 7- Creative problem solving | 0/443** | 0/219* | 0/502** | 0/252* | 0/631** | 0/485** | 1 |

*Significance at the level of 0.05
** Significance at the level of 0.01

**Table 3: Investigating the mediating role of critical thinking in the relationship between metacognition and creative problem solving**

| level | Predictive variables | Criteria variables | R2 | Adj. R2 | F | Sig. F Chng | β | Sig |
|---|---|---|---|---|---|---|---|---|
| First | Metacognition (without the presence of critical thinking) | Creative problem solving | 0/036 | 0/36 | 5/821 | P<0/001 | 0/336 | 0/009 |
| Second | Metacognition | Critical Thinking | 0/066 | 0/66 | 22/90 | P<0/001 | 0/582 | 0/001 |
| Third | Critical Thinking | Creative problem solving | 0/025 | 0/25 | 4/397 | P<0/001 | 0/220 | 0/028 |
| Fourth | Metacognition (in the presence of critical thinking) | Creative problem solving | 0/012 | 0/120 | 5/930 | P<0/001 | 0/128 | 0.056 |

Regarding the mediating role of critical thinking in the relationship between metacognition and creative problem solving was confirmed by the lack of significance of the metacognition beta coefficient in the fourth stage with the presence of critical thinking (β=0.128, P=0.056). This is mainly due to the fact that the β coefficient of metacognition had a significant relationship with creative problem-solving in the absence of critical thinking, which became insignificant at the fourth stage and in the presence of critical thinking.

**Discussion**

The current research approved the relationship between metacognition and its dimensions with creative problem-solving in specialized PhD students of Zanjan University of Medical Sciences. The relationship was direct and positive, in a way that an increase in the metacognition score of the students led to an increase in their creative problem-solving score. In line with our findings, Jalili et al. reported a significant relationship between metacognition and problem-solving, metacognition and academic

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performance and problem-solving and academic performance (27). In addition, Ghobari Bonab et al. mentioned that metacognition and its education affected students' problem-solving, marking a significant relationship between the two variables, which is consistent with our findings (28). Moreover, Heppner & Wells mentioned a relationship between metacognition and problem-solving techniques, which is congruent with our findings (29). In a research by Hargrove (30), the results were indicative of the effect of metacognitive strategies on creative problem-solving in students. In this quasi-experimental research, the case group received a higher mean score after learning about metacognitive strategies, compared to the control group. The results of this study strengthened the possibility that metacognition education can improve creative problem-solving in students, which also confirmed our findings.

We detected a positive and direct relationship between metacognition and creative problem-solving in students. According to Catherine (31), metacognition played a predictive role in the relationship with creative problem-solving. In addition, students with a high metacognition score had higher creative problem-solving abilities. In this context, the acquisition of metacognitive strategies is of great importance because teaching metacognitive strategies to students can be used to promote creative problem-solving in them. Therefore, these results were indicative of the positive effect and predictive role of these strategies in the relationship with creative problem-solving. On the other hand, when the student is faced with a lot of content and assignments in the course and perceives a large volume of assignments and content, it has a negative effect on their application and use of metacognitive strategies. Metacognitive strategies can help students optimize their learning activities' management and planning and assist them in the proper use of time and resources based on their individual features. Therefore, students are encouraged to use metacognitive strategies in universities today, and various workshops have been held in this regard. Having a proper understanding of the learning process can help students use their specific strategies and prevent time and resource loss. This way, we can witness optimized learning and creative problem-solving in students (41).

According to the results of the current research, there was a significant relationship between critical thinking and its dimensions with creative problem-solving in students of Zanjan University of Medical Sciences, which is in line with the results obtained by Alger (32). Performed in 2016, the foregoing research showed a positive and direct relationship between critical thinking and creative problem-solving in students. Kirmizia et al. (3) also found a direct and significant relationship between the tendency toward critical thinking and perception about problem-solving in students. Moreover, these results approved the findings obtained by Roberts et al., who reported a positive and significant relationship between the education of critical thinking skills and students' problem-solving ability. In addition, the training of critical thinking skills in the experimental group improved the problem-solving ability of the subjects (33, 34). Ultimately, these findings are in accordance with the results obtained by Zare and Nahravanian, Sheikholeslami & Omidvar, and Shabani (13, 35, 36). In these studies, critical thinking was related to academic achievement and problem solving of learners. According to the results of the present research and similar studies, there is a direct and positive association between critical thinking and creative problem-solving. Accordingly, there is a significant interaction between the two variables (37). In fact, when students are involved in difficult issues and problems, they need to use critical thinking and creative solution at the same time, and both of these variables will be useful for the student in these situations (38). Therefore, the simultaneous use of these two skills will lead to more suitable solving of problems. In other words, people can have a creative

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and critical attitude toward difficult situations and separation of these two seems impossible. Meanwhile, some researchers believe that there is a kind of creativity in critical thinking and there is a type of critical thinking in creative problem-solving (39). However, although the two variables have common features with each other, there are differences in these aspects that reveal the need to cultivate both of these variables. Meanwhile, an important issue is an attention to the education of these factors to students. Critical thinking and creative problem-solving can be developed through training, which should not be overlooked by educational planners. These skills can be improved in students by including them in their official curricula. On the other hand, the process of solving uncommon and non-routine problems can also affect the development of two variables (40). Moreover, we found a relationship between metacognition and critical thinking in the participants, which is in line with the results obtained by Gholamrezaei et al., who also reported a positive and significant correlation between metacognition and tendency toward critical thinking. In the mentioned research, metacognition significantly predicted students' tendency toward critical thinking (41). Therefore, the hypothesis that critical thinking has a mediating role in the relationship between metacognition and creative problem solving was also confirmed in the present study and it was found that critical thinking can play a mediating role in the relationship between metacognition and creative problem-solving. The mediating role of critical thinking means that this variable can increase their relationship and strengthen both variables of metacognition and creative problem solving in students by entering into the relationship between the two main variables of the study. Nevertheless, the mediating role of critical thinking was not unexpected considering the relatively strong relationship between the main variables and the mediating variable.

Even though we were able to achieve considerable results, we do not claim full control over confounding factors. Therefore, it is suggested that the generalization of the data be carried out with caution. In addition, the research was performed based on the wide range of courses and disciplines in Zanjan University of Medical Sciences and only on professional PhD students. Therefore, it is recommended that similar studies be performed in other fields and at other educational levels. In addition, the current research was descriptive-correlational while some other similar studies used a quasi-experimental approach to assess the effect of critical thinking and metacognition on creative problem-solving. Therefore, it is suggested that the quasi-experimental technique be used to assess the effect of the mentioned factors. Moreover, similar studies can be performed in other universities, and the mentioned variables can be compared among students and universities.

## Conclusion

According to the results of the present study, there was a significant relationship between metacognition and creative problem-solving, metacognition and critical thinking, and creative problem-solving and critical thinking. In addition, critical thinking played a mediating role in the relationship between metacognition and creative problem-solving. This result is important because significant attention has been paid to critical thinking in the present era and special national committees dealing with the quality of the educational system have acknowledged the inability of educational systems to cultivate critical thinking and have demanded adding critical thinking training to the curriculum as the fourth basic element after reading, writing and counting. Ultimately, our findings could be used by psychologists, psychiatrists, counselors, families, and researchers in the educational and psychology fields.

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**Conflicts of Interest:** The authors declare that there is no conflict of interest.

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