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Predictive Abilities Of Metacognitive Strategies In Solving Creative Problems Among Gifted Students

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Abstract

The study aimed to identify the predictive abilities of metacognitive strategies in solving creative problems among gifted students at King Abdullah Schools for Excellence in Jordan. In order to collect and analyze the sought-after data for this study, a descriptive analytical approach and structured quantitative analysis were employed. 113 secondary school students were randomly chosen for the study sample. The metacognitive thinking and problem-solving scales were administered to the study sample. The students demonstrated excellent levels of metacognitive thinking and problem-solving abilities, based on the collected data. Likewise, a strong correlation between metacognitive thinking and original problem-solving was found. These findings underline how critical it is to provide training in metacognitive techniques within a structured educational environment. To smooth efficient knowledge transfer to gifted students, the study recommends metacognitive strategies be implemented in creative problem-solving, supply of material and technological resources, implementation of teacher education courses, and development of an environment-supporting infrastructure. The study offers insights into the significance of metacognitive thinking in developing gifted children' problem-solving skills.

Keywords: Predictive abilities, metacognitive strategies, creative problem-solving, gifted students, King Abdullah schools for excellence, Jordan.

Introduction

The current era has been witnessing significant scientific and technological development, which has resulted in many challenges, changes, and cognitive revolutions in contemporary life in its various fields. Student's success in identifying with and adapting to them depends not only on the use and application of knowledge but also on activating creative thinking skills to encounter these challenges (Chen, 2020). Therefore, educational systems need to assume their responsibility in building students according to a comprehensive educational perspective that aims at helping students to grow in a balanced way and to release their creative energies to tackle life's problems from various sources and forms. This has resulted from society having faced complex challenges that require creative approaches to solve problems. Creativity should be a goal of education (Kim & Lee, 2021).

Therefore, there is an urgent need for those who can provide creative solutions to the current or future problems while promoting new ideas that help develop life in this information age. The strongest countries are those which do invest in their children. This may be achieved by adopting educational models that contribute to developing creative problem-solving skills (Lee & Park, 2021). So, it is argued that one of the most important goals of contemporary education is to cultivate the creative abilities of students, and that the idea of creativity has recently assumed greater importance among educators, and creativity has become one of the common themes in many conferences, seminars, discussions, and seminars (Heilat, 2017).

Creative thinking is the highest type of human activity. Since the fifties of the last century, it has become a main axe of scientific research in many developed and developing countries (Lin & Wang, 2020; Liu & Chen, 2022). Likewise, life problems that arise from this progress need creative thinking to overcome them (Park & Kim, 2020). Therefore, all decision-makers, educational institutions, and those in charge of the teaching process must work towards nurturing different areas of creative thinking and developing them among students. The researcher believes that developing thinking about thinking (beyond Knowledge) requires the development of self-control and self-contact, because individuals who are preoccupied with solving a problem perform several roles while doing this work,. They perform roles at different times, and thus they are generators of ideas. They are planners, critics, progress monitors, specific idea supporters, and specific behavior directors, all on the trail of reaching a solution. To be a productive thinker, undoubtedly, these skills are required to be sharpened early (Sun & Li, 2020). Furthermore, it is the challenge facing the future of education, which is now being called into question in playing its role in preparing the citizen who possesses not only knowledge but what is beyond knowledge and who is capable not only of thinking but also of reflecting on their thinking.

John Flavell discusses the historical development of his theory of metacognition, as he was a researcher in the theory of metacognition at Stanford University and was influenced by the work of Jean Piaget. While many researchers rejected

several concepts of Jean Piaget's theories, there were many ideas that he proposed found their way into a traditional metacognitive equilibrium, including intentional form that refers to preconceived notions that are intentional, goal-oriented, and involve sequential planning of events (Flavell, 2016). Costa also proves that the historical roots of this concept go back to Socrates and his style of dialogue and debate, and then to Plato, who said: "When the mind thinks, it speaks to itself (Costa, 2015). Metacognition emerged in the early seventies that added a new dimension to cognitive psychology and wide-opened horizons for experimental studies and theoretical discussions in intelligence, thinking, memory, comprehension, and learning skills. Metacognition was mentioned in language in several synonyms, including metacognitive, thinking about thinking, and metacognition (Al-Humaideen & Al-Zaq, 2019). Accordingly, students' monitoring of his thinking and his integration into thinking processes are called metacognitive processes, thinking about thinking, or metacognitive thinking. Students' interest in these processes yields vital growth of the ability for self-learning and leads to understanding and positive and effective learning (Al-Ghablan & Al-Jarrah, 2022).

Metacognitive thinking is a necessary component of effective teaching strategies that make students active and effective learners in the face of various educational tasks, as many of the problems and difficulties that students face in the learning process, or the transmission of its impact arise from the deficit in their metacognitive processes. Learners who are involved in metacognitive thinking use effective strategies to discover what they need during learning. When they use strategies beyond the cognitive strategies, they reach more optimal and better performance, as these strategies allow them to plan and control their learning. Thinkers consider problem-solving a pattern of deductive thinking that involves complex processes of transformation, processing, organization, loading, assembly, and evaluation of information present in a problematic situation (Ongardwanich & Gumjudpai, 2021). Therefore, Problem-solving is directed towards solving specific problems through two types of mental activity: developing and formulating specific, and then choosing the appropriate response for the related problem.

Individuals face countless problems in their daily life, so they must form specific plans for their responses and choose the appropriate responses by examining the necessary responses to solve given problems (Park & Choi, 2021). Problem-solving is considered an essential category of cognitive activity. It is practiced daily, often unconsciously, especially in a complex society where established rules and procedures are insufficient for success. It is the pursuit of a goal when the path to that goal is not clear and definite. Solving problems is one of the methods that have proven effective in helping learners acquire scientific thinking skills and develop the ability to face different life situations (Daghistani, 2015).

Educating students to become thinkers and creators is a project, a mental and moral adventure, and an experience that merits taking the lead. It also cultivates attitudes, inclinations, and aptitudes. Curiosity, encouragement towards research and verification, and the belief that thinking will be available and productive are the focus of the habits of the mind. It uses and employs habits of mind in new situations through specific mental practices such as perseverance, listening, self-regulation, meta-cognitive thinking, applying prior knowledge to current situations, controlling impulsiveness, creative thinking, and others (Lee & Kim, 2020).

Creative thinking is a process that helps individuals to be more sensitive to problems, deficiencies, and changes in the field of knowledge and information, and imbalances in harmony. It identifies points of difficulty, searching for solutions, forecasting, formulating hypotheses, testing them, rephrasing them, or amending them, and reaching new outcomes that individuals can be shared with others. Jarwan defines the concept of creative thinking as a complex and purposeful mental activity directed by a strong desire to search for solutions or reach original, previously unknown outputs. Creative thinking comprises comprehensiveness and complexity, involving intertwined cognitive and ethical elements that form a unique state of mind (Liu, 2022).

Theoretical literature has identified three models to describe the relationship between intelligence and metacognitive skills as predictors of learning. The first model relates to metacognitive thinking as a manifestation of intelligence. According to this model, metacognitive skills cannot have predictive value for learning independent of intelligence. In contrast, the second model considers intelligence and metacognitive thinking as independent learning predictors. The mixed model holds that metacognitive thinking is related to intelligence in predicting learning results (Park & Choi, 2021).

The psychometric approach pays attention to measuring creative abilities, similar to how other abilities, such as intelligence, are evaluated. Torrance's famous test is named after him, which measures creative abilities, such as fluency, flexibility, and originality. Guilford also emphasized the role that divergent thinking plays in generating creative ideas for the problem facing individuals. It is the opposite of convergent thinking, which is concerned with generating specific answers; convergent thinking is prevalent in schools, because most teachers focus on it. The most common way to detect giftedness is through intelligence tests. Some view it with suspicion because the content of the tests does not raise originality and innovation among students, while others view it as the only objective method (Al-Humaideen & Al-Zaq, 2019). This method is considered as one of the standard methods in the detection of giftedness because innovation is an individual's process, leading to the invention of something new. Another measure involves teachers nominating gifted children in mathematics, which is an important method widely used to recognize gifted students who are then enrolled in gifted enrichment programs and services. The reason for the prevalence of this method of identifying gifted students is

that gifted children unveil cognitive, motivational, and personality characteristics that may not be recognized through traditional intelligence tests or achievement tests (Al-Ghablan & Al-Jarrah, 2022).
The current study focuses on determining the predictive capabilities of meta-cognitive strategies in solving creative problems among gifted students, which has prompted the researcher to identify the effectiveness of metacognitive strategies in developing creative problem-solving skills among gifted students. This study branches out into the following questions.

Research Questions

1- What are the most used metacognitive strategies among gifted students?
2- What is the level of creative problem-solving potential among gifted students?
3- What is the predictive capacity of metacognitive strategies in solving creative problems?

Literature Review

In the existing scholarship, there is a consensus among numerous studies that used quasi experimental designs, which signifies there is a significant improvement in creative problem-solving skills among the experimental group students. Chen (2022), Choi (2021), Liu (2022), Park and Lin (2021) Lee and Kim (2020) demonstrated the program's effectiveness in improving problem-solving behavior. Okasha Wadha (2012) conducted a study on the effectiveness of a training program based on metacognitive skills in a collaborative context on problem-solving behavior among first-grade secondary students. He found statistically significant differences in the experimental group's problem-solving behavior test scores.
Gumjudpai & Ongardwanich (2021) studied habits of mind among Thai secondary school students and the impact of gender, study plan, and school size on the habits of mind. The study results showed higher levels of mental habits, the presence of statistically significant observed between genders and various study plans. Science students have higher mental habits than art students. In Saudi Arabia, Daghistani (2015) found that there was a moderate level of perception and metacognitive thinking among kindergarten students, while the level of metacognitive thinking was high. The results also indicated significant differences in the association size between the need for cognition and thinking. Schraw and Dennison's (1994) and Abbott's (2010) scales were applied for metacognitive thinking and creative self-efficacy and were used by Heilat's (2017) to investigate the relationship between creative self-efficacy and metacognitive thinking among female students in the professional postgraduate diploma-teaching program at Abu Dhabi University. The results showed that creative self-efficacy and metacognitive thinking scales were high (> 3.67 out of 5); also, the results revealed that the mean score of self-efficacies of science background students was statistically higher ($P<0.05$) than arts students.
In Kuwait, Al-Ghablan and Al-Jarrah (2022) investigated the predictive ability of the habits of mind on the creative personality of gifted secondary school students. The two-way ANOVA analyses revealed no statistically significant differences between students' estimates of their creative personalities according to the variable of gender and grade level. Furthermore, the results showed a statistically significant gender-related difference in the remaining open to continuous learning habit in favor of males. The results of the multiple regression analysis revealed that the two habits of mind, "thinking and communicating clearly and accurately" and "finding humor", contributed to the variance of the creative personality.
In Jordan, ALHameedyeen and Alzig (2019) explored the predictive ability of the metacognitive thinking strategies and the level of processing in problem-solving skills among 10th-grade students. The results indicated a positive relationship between problem-solving skills, metacognitive thinking strategies, and deep processing. Meanwhile, there was a negative relationship between problem-solving skills and shallow processing. The main finding indicated that metacognitive thinking strategies account for (44%) of the total variation in problem-solving skills. These results confirm that metacognitive strategies predict performance in problem-solving skills.
By reviewing pertinent literature in the global and local contexts, it can be argued that a plethora of studies have been conducted on the metacognitive thinking strategies; however, the predictive skills of metacognitive strategies of gifted students in the Jordanian context has not been scrutinized yet, which calls for a new investigation in this context. Therefore, this study fills the gap in the literature by conducting an empirical investigation into the predictive skills of metacognitive strategies among gifted students in the Jordanian context.

Methodology

This Research follows a descriptive analytical approach. The study population consists of gifted students (753) enrolled in King Abdullah Schools for Excellence in the southern region of Jordan, namely Karak, Tafila, Ma'an, and Aqaba. The sample was randomly selected, where the tools were applied to the rows that were chosen randomly, with a percentage of

(15%) of the total population. The table below shows the number of male gifted students (61) while female ones reached (52).

Table (1) Research Sample

Class	Total					
School	male	%15	female	%15	total of school	%15 total of school
King Abdullah II School for Excellence \ Tafila	109	16	55	8	164	25
King Abdullah II School for Excellence \ Karak	122	18	101	15	223	33
King Abdullah II School for Excellence \ Maan	0	0	49	7	49	7
King Abdullah II School for Excellence \ Aqaba	175	26	142	21	317	48
Total	406	61	347	52	753	113

Research Tools

1. Metacognitive Thinking Scale: The researcher used the metacognitive thinking scale that he developed based on the work of Schraw & Dennison. It includes two dimensions: knowing knowledge and organizing knowledge. Kumar (1998) used the scale and made use of the factorial analysis. The scale was developed to suit the Jordanian context (Obeidat, 2009; Jarrah & Obeidat, 2011; Baqi, 2014).
2. Problem-Solving Scale: Nazih Hamdy (1997) developed a problem-solving scale based on a model proposed by Heppner, (1978) for solving problems. The scale encompasses five stages used in solving problems: general orientation, problem definition, generation of alternatives, decision-making, and verification of results

In order to validate the scale, the researcher administered it to 35 male and female gifted students from both the research population and outside the research sample. It also establishes the relationship between the tool's dimensions and investigates the independence of each dimension from the other dimensions.

Table (3) Pearson's Correlation Coefficients for Metacognitive Thinking Scale

The dimension	Knowledge of Knowledge	Knowledge organization	Knowledge processing	Total
Knowledge of Knowledge	1	0.707**	0.730**	0.849**
Knowledge organization		1	0.689**	0.817**
Knowledge processing			1	0.739**
Total				1

1. Correct Problem-Solving

The researcher administered the scale to a sample of 35 male and female gifted students from the research sample to ensure the validity of the scale. The results of the research are as follows:

Table (4) Relationship between Total Score of Scale

Dimensions of problem-solving scale	**correlation coefficient**	**significance level**
Define the Problem	0.67**	0.01
General Orientation	0.62**	0.01
Generating alternatives	0.53**	0.01
Make decision	0.41**	0.01
Check results	0.47**	0.01

2. The Reliability of the Metacognitive Thinking Scale

The values of reliability coefficients, which were calculated using Cronbach alpha, ranged from 0.74 to 0.82. The midterm split ranged from 0.71 to 0.77, indicating the reliability of the problem-solving scale. It is of value to note that all alpha Cronbach's alpha coefficients are significant at the level of significance (0.01), as they ranged between (0.41-0.67), which indicates the significance of the scale.

Results

Most Metacognitive Strategies

It is obvious from the table that the respondents possess a high level of metacognitive thinking. The arithmetic means for metacognitive thinking on the scale as a whole was 3.78, and the standard deviation was 0.48. As for the dimensions of the scale, the highest mean score was attained for knowing knowledge, where the mean was 3.82 and the standard deviation 0.54. the dimension of organizing knowledge came in second place, with an arithmetic mean of 3.80 and a standard

deviation of 0.51. Lastly, the dimension of knowledge processing revealed a mean of 3.73 and a standard deviation of 0.51.

Table (7) Means and Standard Deviations on Scale

The dimension	# sample	Means	standard deviation
Knowledge of Knowledge	113	3.82	0.54
Knowledge organization	113	3.80	0.51
Knowledge processing	113	3.73	0.51
Scale all	113	3.78	0.48

The researcher believes that the main reason for the result that emerged from this question is that gifted students tend to have advanced metacognitive strategies that are essential for their success in learning and problem-solving. These strategies include knowledge of knowledge, knowledge organization, and knowledge processing. Gifted students possess a deep understanding of how they learn best. They are aware of their strengths, weaknesses, and preferred learning styles. They are also skilled at setting learning goals and developing plans to achieve them. They can identify which strategies work best for them and adjust their approach accordingly.

Regarding knowledge organization, gifted students are highly skilled at organizing information meaningfully. They can identify a topic's key concepts, principles, and relationships and organize information into a coherent structure. They also use graphic organizers, such as mind maps, to visualize and connect ideas, which aids in retaining and retrieving information.

In terms of knowledge processing, gifted students are highly efficient at processing information. They can quickly analyze and synthesize new information, relate it to their prior knowledge, and apply it in new situations. They are also skilled in critical thinking, problem-solving, using reasoning, deduction, and induction, all to develop solutions to complex problems. They also use self-questioning to evaluate their thinking processes and make necessary adjustments. Overall, gifted students' metacognitive strategies are highly developed and effective in helping them learn and solve problems. By understanding their thinking processes, organizing information effectively, and processing new information efficiently, they can achieve their goals and succeed academically and beyond.

Level of Creative Problem

It is noted from the above table that the respondents possessed a high level of problem-solving ability. To solve problems, the overall scale for solving-problem on the scale was 3.74 and the standard deviation 0.50. Regarding the dimensions of the scale, general orientation was in the first place, with an arithmetic mean of 3.82 and a standard deviation of 0.5. ‘Define the problem’ came second in place, with an arithmetic mean of 3.81 and a standard deviation of 0.51. ‘Making the decision’ came in third place, with an arithmetic mean of 3.80 and a standard deviation of 0.51. The fourth place was for ‘verifying the results’, with an arithmetic mean of 3.73 and a standard deviation of 0.51. Lastly, ‘generating alternatives’ had an arithmetic mean of 3.72 and a standard deviation of 0.5. All dimensions exhibited a high standard.

Table (8) Means and Standard Deviations on Scale

Dimensions of problem-solving scale	# sample	Means	standard deviation
general orientation	113	3.82	0.54
Define the problem	113	3.81	0.51
Make decision	113	3.80	0.51
Check results	113	3.73	0.51
generating alternatives	113	3.72	0.51
Scale for all	113	3.74	0.50

The researcher attributes the results observed in the study to the fact that gifted students are often known for their high creativity and problem-solving skills. Their ability to think outside the box, generate new ideas, and approach problems from multiple perspectives is often much higher than their peers. Regarding general orientation, gifted students are typically more self-directed and motivated to solve problems than their peers. They tend to have a strong sense of curiosity and a desire to understand the world around them. This can lead to more advanced problem-solving skills as they can dig deeper into complex problems. In terms of problem definition, gifted students can often identify the key issues and challenges quickly and accurately. They have a knack for identifying the root cause of a problem and focusing their attention on it. This allows them to approach the problem in a more targeted and efficient way.

Regarding generating alternatives, gifted students can often come up with a wider range of solutions than their peers. They have high creativity and can approach problems from multiple angles. This allows them to see solutions that others may not have considered, in decision-making, gifted students tend to be more confident in making decisions. They can weigh

the pros and cons of different options and decide based on their analysis. They can often make decisions more quickly and confidently than their peers, finally, when it comes to verifying results, gifted students can often critically evaluate their work and the work of others. They have a strong intellectual curiosity and are motivated to continually improve their problem-solving skills. They are often able to identify areas where they could have done better and make adjustments accordingly. Overall, gifted students tend to excel in all aspects of creative problem-solving. They can approach problems with high creativity, identify key issues, generate a wide range of solutions, make confident decisions, and critically evaluate their work. These skills are essential for success in many areas, including academics, business, and everyday life.

Predictive Capabilities of Metacognitive Strategies in Solving Creative Problems

To answer this question, multiple regression was used to answer this question. The table shows the value of the correlation coefficient for the independent variable (metacognitive thinking) and the dependent variable (creative problem solving) reached 0.539. The value of the coefficient of determination (r2) was found to be 0.29. That is, the regression model accounts for 53.9% of the total variance, while other factors explain the remainder. It turns out that value F computerized was (21,019), and the level of statistical significance reached (0.000); that is, it is smaller than (0.05), and thus the null hypothesis was rejected. The alternative hypothesis was accepted, which means that there is a statistically significant effect at the level of statistical significance ($\alpha \leq 0.05$) on the predictive capabilities of metacognitive strategies in solving creative problems among gifted students in King Abdullah Schools for Excellence. This means that the regression model that was used is suitable and sufficient.

Table (9) Analysis of Variance to Decline Private with Third Question

Source	Factor R	Factor R square	Data Source	sum of squares	Degree Freedom	mean of squares	Value F computerized	Indication level Sig
overall linear regression	0.539	0.291	Regression	39,679	4	9,920	21,019	0.000
			Residual	96,746	109	0.472		
			Total	136,425	113			

Table (10) Coefficient for the Independent Variable (coefficient)

Element	Coefficient B	Standard Error Std. Error	standard transactions Beta	Value T	Sig.
Constant	1,218	0.287		4,249	0.000
Knowledge of Knowledge	0.171	0.077	0.167	2,220	0.028
Knowledge organization	0.152	0.077	0.150	1,970	0.050
Knowledge processing	0.243	0.075	0.240	3,233	0.001

It is clear from the table above that the independent variable 'metacognitive thinking' had a statistically significant effect at the significance level of 0.00, which is less than (0.05) Accordingly, the researcher shows that there is a positive and statistically significant effect on the predictive capabilities of metacognitive strategies in solving creative problems among gifted students. The researcher attributes this result to the fact that many researchers stressed the need for training in metacognitive strategies within an organized educational environment that allows students to learn and practice metacognitive thinking, indicating that students need encouragement and reinforcement from the outside to practice this thinking through educational activities.

Moreover, one effective method for this is educational situations in groups, where teachers and students engage in dialogues about their work and problems, which indicates whether the teacher is capable of leadership. Furthermore, direct this dialogue appropriately. It turns into a social think-aloud formula where every student in the group expresses their thoughts. So, these groups make dialogue, reasoning, planning and observation a general thing in which everyone participates and through which they realize cognitive processes in action. An excellent educational environment contains students, provides them with opportunities to interact with the teacher and their classmate, and provides an atmosphere of comfort, familiarity, cooperation, and brotherhood to help him express himself freely and directly, which achieves positive and effective educational results.

The researcher believes that the usual method in the educational environment is the interaction between (the teacher and the student) or (the teacher, the student, and the educational material only). Instead, there is a third type of interaction that strongly influences the classroom and raises the motive of competition and the desire to learn, which is the interaction (student with student) confirmed by metacognitive strategies. Therefore, this type of environment is the student at the heart of the educational process, and the role of the teacher is as a guide and guide to the process.

In terms of learning within the classroom, the educational environment should be active, effective, and rich in educational attitudes that the teacher and students organize and create together. The results align with the findings of studies employing both quasi-experimental designs, (Liu 2022; Chen 2022; Park and Choi 2021; Lin 2021; Lee and Kim 2020; Okasha

Wadha 2012; Gumjudpai & Ongardwanich 2021; Daghistani 2015; Heilat 2017; The Al-Ghablan and Al-Jarrah 2022; ALHameedyeen and Alzig 2019).

Recommendations

- Activate the use of metacognitive strategies in creative problem-solving in all schools.
- Provide material and technological capabilities to support teachers' task of dealing with a metacognitive strategy.
- Conduct training courses for teachers to keep them updated on the essential metacognitive strategies and the nature of their use.
- Conduct similar studies involving other educational areas and studies dealing with metacognitive strategies and explore their application in schools under the Ministry of Education.
- Train teachers to effectively implement metacognitive strategies in the educational process.
- Establish a supportive environmental infrastructure to nurture these strategies.

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