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The effect of the (metacognitive Learning Course) strategy on Habits of the productive mind are among Intermediate stage school students in mathematics

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Abstract

The aim of this study was to investigate the impact of the metacognitive learning strategy on the productive thinking habits of middle school students in mathematics. To achieve this objective, the researchers adopted an experimental design with pretest-posttest for two equivalent groups. Participants were selected based on intelligence, previous achievement, and prior knowledge. The sample consisted of 67 female students, with 35 students in the experimental group and 32 students in the control group. A scale for measuring the productive thinking habits of second-grade middle school students was developed, and its validity and reliability were found to be satisfactory. Appropriate statistical methods were used for data analysis.

Keywords

Metacognitive learning strategy, productive thinking habits, middle school students, mathematics.

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Introduction

Firstly, the research problem:

The current era is characterized by rapid development and advancement of knowledge. This cognitive development is one of the most prominent features of the present time. There is a crucial need to enhance teacher development through training programs, as they play a fundamental role in educating students (Salwa & Baism, 2018, p. 1208). The concept of "givens" in mathematics is derived from the mathematical structure, which commands a content that resembles a reliable and interconnected building.(Mjeed , 2020 ,p333) Furthermore, the subject of mathematics is one that has significant connections with other sciences and plays a role in both individual and societal life. This highlights the necessity of emphasizing the teaching of this scientific subject in a way that reflects its relevance to students' lives and their environment. As a result, students now require new methods to adapt to society and interact with various aspects of life. They need to be equipped to navigate challenging situations and continuous challenges they may encounter in the era of scientific and cognitive explosion. The focus should be on the student's mind, how they receive information, process it, organize it, and store it in order to effectively utilize it in different situations. This process leads to the development of easily practicable and applicable mental habits in the present and the future. It is essential for learners to make informed choices regarding behaviors and actions when facing specific issues or situations in their lives. This requires the rationalization of the mind to make decisions that yield positive outcomes and avoid negative consequences (Al-Jubouri, 2013, p. 4).

Upon reviewing and analyzing the students' data, the researcher noticed a weakness in their behaviors and mental habits, as well as a lack of knowledge acquisition. This prompted the need to identify the reasons behind this decline in academic performance. The researcher found that there was a deficiency in the application of modern strategies and a reliance on

traditional teaching methods by teachers. This finding is supported by a study conducted by Jassim and Al-Azmi (2022).

The researcher observed that teachers were not practicing any cognitive habits during their teaching process, which led the researcher to consider using the "Metacognitive Learning Cycle" as a teaching strategy. It was hoped that this strategy would contribute to addressing the problem of low acquisition levels of mathematical concepts and productive thinking habits among students. To investigate the impact of this strategy, the researcher formulated the following question:

"What is the effect of the Metacognitive Learning Cycle strategy on the development of productive thinking habits among middle school students in mathematics?"

Research significant :

1-The importance of this research lies in its contribution to the field of local education and teaching. It focuses on examining the impact of the Metacognitive Learning Cycle on productive thinking habits in mathematics among middle school students (Grade 8). By exploring the effectiveness of this cycle, the research aims to enhance students' learning abilities and make them active participants in the educational process. This is achieved through collaborative learning experiences that enable students to better understand mathematics concepts and solve mathematical problems more easily (Lina et al., 2021, p. 173).

2- The modern education system plays a significant role in achieving educational goals, particularly in the realm of mathematics, by emphasizing the accumulation of experiences within the cognitive structure of the learner. This begins in the primary stage, continues through the crucial middle school stage, and extends to the higher levels of education. By adopting innovative strategies and models, educators can keep pace with the evolving world around us (Al-Azmee & Jassim, 2019, p. 521).

3-The research findings can lead to the development of a reliable psychometric scale to measure productive thinking habits, specifically tailored for the middle school stage. This scale can serve as a trustworthy reference for future research in related areas.

4-The research contributes to establishing a realistic connection between concepts and real-life problems, providing a solid foundation for understanding the topics and challenges that students encounter in their daily lives (Al-Maayouf et al., 2017, p. 3).

5-The use of mathematics applications in teaching should aim to prepare a generation of innovative and creative individuals capable of contributing to the advancement of civilization (Hamadi, 2016, p. 317).

6-The adoption of a modern strategy in mathematics that has not been previously utilized can be beneficial in organizing students' thoughts (Kareem & Jassim, 2013, p. 372).

Thirdly: Research Objective:

The impact of the Meta-Cognitive Learning Cycle (M.L.C) on the productive thinking habits of middle school students in the subject of mathematics

Fourthly: Research Hypothesis:

There is no statistically significant difference at a significance level of (0.05) between the mean scores of the experimental group students who were taught using the Meta-Cognitive Learning Cycle and the mean scores of the control group students who were taught using the traditional method in the measure of productive thinking habits

Fifthly: Scope of the Research:

The research will include students in the second grade of intermediate schools and daytime secondary schools for boys, affiliated with the General Directorate of Education in Al-Karkh Second, for the academic year (2022-2023).

The research will focus on productive thinking habits, including self-regulation habits, critical thinking habits, and creative thinking habits.

The research will cover the first semester of the academic year (2022-2023).

Research terminology :

A. **Strategy:** According to Atiya (2013), it is defined as "the set of procedures and means used by the teacher to enable the learner to achieve planned educational experiences and achieve educational goals." (Atiya, 2013, p. 262

B. Meta-cognitive Learning Cycle:
Defined by:

(Blank, 2000) defined it as: "A teaching model that combines Piaget's theory and beyond-knowledge strategies, emphasizing the interaction between the teacher and the learner during the instructional situation. This is accomplished through four stages: concept evaluation, concept exploration, concept presentation, and concept application." (Blank, 2000, p. 489)
Theoretical Definition: The researcher adopted the theoretical definition (Blank, 2000) as it aligns with the research procedures.
Procedural Definition: The researcher defines it procedurally as an instructional strategy that combines the meta-cognitive learning cycle and beyond-knowledge strategies. It consists of four instructional steps to teach mathematics to second-grade students, aiming to assist students in constructing their knowledge based on their prior knowledge and acquired understanding.

Pivotal Thinking: Defined by:
(Marzano, 2000) as: "Behaviors used by organized thinkers and critics to enable individuals to control their thinking behaviors and processes, helping them learn any experience they need in the future." (Marzano, 2000, p. 17)
Theoretical Definition: The researcher adopts the theoretical definition (Marzano, 2000) in this study.
Procedural Definition: The researcher defines pivotal thinking procedurally as the ability of second-grade students to respond to test items related to pivotal thinking habits, which were prepared by the researcher for the purposes of the research. The scale consists of 30 behavioral situations aligned with the three pivotal thinking habits, and it is measured by the total score obtained by the respondent on the Pivotal Thinking Habits Scale for the purposes of this research.

Chapter Two: Literature Review
Firstly, Theoretical Background: First Axis: (M.LC) Meta-cognitive Learning Cycle Strategy
Firstly, The theories that support the concept of meta-cognition and its strategies are as follows:
The concept of meta-cognition and its general frameworks are attributed to the psychologist Flavell, who was a professor at Stanford University. He was a supporter of Piaget's theory

and coined the term "metamemory." Flavell is also credited with introducing the concept of meta-cognition and described it in his writings in 1976. He stated that what is actually accomplished in the lifespan of 127 years is the organized knowledge of tangible objects and events. (Mohsen, Jassim, 2020, p.6).

The concept of meta-cognition:

The term "meta-cognition" was first used by Flavell in educational research in 1976. Through his observations of learners, he noticed that they engage in a process of monitoring their understanding and other cognitive activities. Al-Deen and Jassim (2022) pointed out that teachers should ask their students, who are fully aware of their actions, some questions. These questions could be as follows: Why did you think of this solution? How did you come to believe that, and why did you do that? These questions can serve as a step towards developing the thinking process itself and the way of thinking. (Al-Deen & Jassim, 2022, p.953)

Thirdly: The Meta-cognitive Learning Cycle (M.L.C):

The meta-cognitive learning cycle consists of several stages. After the development that took place in the learning cycle, we will now focus on the steps of the Meta-cognitive Learning Cycle (M.L.C), which have been adopted as an independent variable for this research, as follows**:**

Firstly: The first stage (Exploration):

In this stage, the teacher should provide opportunities for the learners to reflect on their scientific ideas and become familiar with the information they already have about the concept they are studying. The goal of this stage is to give learners the opportunity to explore the phenomena associated with the concept under investigation.

Secondly: The second stage (Concept Presentation Assessment):

In this stage, the teacher should collect the data generated by the learners and, based on that data, engage with the learners to develop the concept. The teacher should also provide opportunities for the learners to reconsider their scientific ideas .

Thirdly: The third stage (Concept Application Assessment):

In this stage, learners are presented with additional examples that apply the scientific concept, which can be understood using the data generated during the previous stages. One of the key features of the meta-cognitive learning cycle is that it allows for guided thinking throughout all four stages**.**

Fourthly: The fourth stage (Concept Evaluation Assessment):

In this stage, learners reflect on their scientific ideas, and each learner should maintain a concept journal where they record their scientific thoughts about the concept. If the learner's idea is reasonable and clear, they should be able to provide examples of the concept and explain their idea to their classmates. (Ibrahim, 2007, p. 82)

The second axis: Productive Thinking Habits

Firstly: The concept of productive thinking habits:

The information revolution and the significant cognitive explosion have impacted the lives of people and societies. Since schools are the tools of society, this necessitates the provision of new generations capable of meeting the demands of the job market, thinking critically, making decisions, and solving the problems they encounter within their environments (Sabah, et al., 2023, p. 42).

The second axis: Productive Thinking Habits

Secondly: Classifications of productive thinking habits:

Productive thinking habits are relatively modern concepts in the fields of psychology and contemporary education (Al-Kubaisi & Al-Amli, 2016, p. 7). Various theoretical orientations have emerged in classifying productive thinking habits, yet they all share commonalities in terms of the effectiveness and efficiency of learners (Barbakh, 2015, p. **14).**

One of these classifications, proposed by Marzano and others, divides learning dimensions into five dimensions, as follows:

The first dimension: Perceptions and positive attitudes towards learning.
The second dimension: Acquiring and integrating knowledge.
The third dimension: Deepening and refining knowledge.
The fourth dimension: Meaningful application of knowledge.
The fifth dimension: Productive thinking habits.

These dimensions encompass the key aspects of productive thinking and highlight the importance of cultivating effective thinking habits in the learning process.

This dimension is considered one of the dimensions of learning and the principle of purposeful performance that permeates the dimensions of learning, according to Marzano. Learners utilize it when they strive to have conscious awareness and directed attitudes towards knowledge. When acquiring knowledge, they need to achieve precision and accuracy (Marzano, 1998, p225). The current research adopts the classification of productive mind habits by Marzano and others (2000) as one of the dimensions of thinking in the strategy. It is divided into the following categories

First, habits of self-organization ability.
Second, habits of critical thinking ability.
Third, habits of creative thinking ability.

Second, previous studies:

A. Previous studies that included the independent variable (Metacognitive Learning Cycle strategy) and the dependent variable (habits of mind) are as follows:

1- Al-Rukabi (2015): "The Effectiveness of Metacognitive Learning Cycle and SWOM Strategy on Physics Achievement and Metacognitive Thinking Skills of Fourth-Year Science Students."

2- Al-Qahtani (2014): The study aimed to examine "the effectiveness of an enrichment program based on the Dimensions of Learning strategy for Algebra in improving the habits of productive thinking among high-achieving students in the second grade of middle school."

Chapter 3: Research Methodology

This chapter presents the research procedures used in the study:

First: Experimental Design:
A partial control experimental design was employed, using two equivalent groups. The Metacognitive Learning Cycle (M.L.C) strategy was used as the independent variable in the experiment, while the acquisition of mathematical concepts and habits of productive thinking served as the dependent variables in the experiment, as illustrated in Table 1.

Table (1) experimental design of research

GROUP	Group Equivalence	Independent Variable	Dependent Variables	Research tool
Experimental	Intelligence Prior knowledge in mathematics Previous achievement in mathematics	Traditional style	Acquisition of mathematical concepts	Assessment of acquisition of mathematical concepts
Control		The Metacognitive Learning Cycle (M.L.C)		

Secondly: Research Community and Sample:
Research Community: The research community was defined as second-grade intermediate students in government day schools under the General Directorate of Education in Baghdad, Al-Karkh Second District, for the academic year 2022-2023

The research sample: The King Ghazi Intermediate School for Boys was deliberately chosen as the site for implementing the research experiment. The research sample was selected as follows:

Class (A) was chosen to represent the experimental group, with a total of 35 students.

Class (B) represented the control group, with a total of 32 students.
Thus, the total number of students in both groups was 67.
Thirdly: Control Procedures: Before commencing the experiment, measures were taken to control any factors that could affect the credibility of the experiment's results.

A. Internal Validity of the Experimental Design:
Internal validity was ensured by controlling and establishing equivalence between the two groups in certain variables believed to have an impact on the dependent variable, such as intelligence, previous achievement, and prior knowledge.

B. External Validity of the Experimental Design:
External validity was enhanced by controlling for certain variables that could potentially affect the experiment. These variables include:

1- Experimental Conditions and Associated Incidents: The participants in the experiment (sample) did not encounter any notable incidents that could affect the dependent variables alongside the independent variable.

2- Experimental Attrition: The experiment did not experience any interruptions or discontinuations throughout its duration, except for individual cases of absence.

3- Processes Related to the Maturation of Sample Individuals: The experiment commenced on Sunday, 6th November 2023, for each group, and concluded on Thursday, 12th January 2023**.**

The Impact of Experimental Procedures:
A. Teacher: The researcher himself conducted the teaching for both the experimental and control groups.
B. Experimental Setting: Specific classrooms were assigned for conducting the experiment.
C. Scientific Content: The same scientific material was presented to both groups.
D. Distribution of Teaching Sessions: Each group received a total of 5 teaching sessions per week.

The Testing Procedure: Both research groups were assessed on their habits of productive thinking.

Fourthly: Research Requirements:
Identification and analysis of the scientific material.
Determination of concepts.
Formulation of behavioural objectives.
Preparation of teaching plans.

Fifthly: Research Instrument:
As part of the requirements of the current research, a test and scale were developed to measure the extent of students' acquisition of productive thinking habits.

Objective determination: The scale aims to assess the effectiveness of the independent variable (M.L.C. strategy) in developing productive thinking habits among the research sample according to its domains.

Identification of scale domains: The scale addresses productive thinking habits based on Robert Marzano's model of "Dimensions of Learning - The Fifth Dimension - Productive Thinking Habits." The scale consists of 30 behavioral situations distributed across three dimensions, as mentioned earlier.

Preparation of Scale Instructions:
The instructions related to the scale were developed, providing an overview of the purpose of the scale and how to respond to the scale items. The items of the productive thinking habits scale were formulated using alternative responses, which are "Always, Sometimes, Never." Each response is assigned a weight of 1, 2, or 3, respectively, in cases of positive formulation. In cases of negative formulation, the weights are reversed to 3, 2, or 1. The total score of the scale ranges from 30 to 90 points.

The scale items of the productive thinking habits, consisting of 30 items, were presented to a group of experts in mathematics teaching, psychology, and assessment and evaluation methods

Survey Application
To ensure the clarity of scale items and instructions, and the time required for completion, the researcher administered the productive thinking habits scale to a sample of 30 students from the second grade at Al-Heerah Intermediate School for Boys. After calculating the average time, it was found that the appropriate time for answering the scale items was 38 minutes. Following that, the productive thinking habits scale was administered to another sample of 100 students from the second grade, who are part of the research population, in order to calculate the discriminatory power of all scale items.

The Discriminatory Power of Scale Items:
The t-test was used for two independent samples to calculate the item discrimination value for each item, with a degree of freedom of 52. The significance level was compared to the

level of significance (0.05). It was found that all items had statistical significance. Therefore, all items were considered to have acceptable and good discrimination coefficients, indicating good discrimination ability as mentioned by Stiqlal & Elham Jabbar (2019, p. Faris).

Psychometric Properties:
A. Construct Validity:

Item-Total Correlation: The computed correlation coefficients ranged from 0.275 to 0.709, all of which were statistically significant.
Item-Domain Correlation: The correlation coefficients ranged from 0.753 to 0.857, all of which were statistically significant.
Domain-Total Correlation: Pearson correlation coefficient was used to determine the relationship between each domain and the total score of the scale. It was found that all correlation coefficients were statistically significant.
B. Reliability:
The reliability coefficient was calculated using Cronbach's alpha, and it was found to be 0.89. This indicates a high level of reliability, as values above 0.80 are considered to be high in terms of reliability (Ghanem et al., 2022, p. 633)

Seventh: Statistical Methods
Appropriate statistical methods were used to analyze the data, including measures of difficulty, discrimination, and effectiveness of alternatives. The researchers employed the Cooper equation and utilized statistical tools such as SPSS (Statistical Package for the Social Sciences) and Excel for data analysis.

Chapter 4: Research Results
Second Axis: Presentation of Results for the Variable "Productive Thinking Habits Scale"
To verify the second null hypothesis, which states:
"There is no statistically significant difference at a significance level of 0.05 between the mean scores of students in the experimental group taught using the M.L.C strategy and the mean scores of students in the control group taught using the conventional method in the Productive Thinking Habits Scale."
To test this hypothesis, the scores of students in both the experimental and control groups were calculated in the Productive Thinking Habits Scale, as shown in the following table.

Table (2)
Statistical Description of the Experimental and Control Groups in the Variable "Productive Thinking Habits Scale"

Group	Branch	Students number	Mean	Standard Deviation	Standard Error of the Mean	95% confidence interval for the mean	
						Maximum	Minimum
Experimental	A	35	73.9714	9.14422	1.54566	16.34515	4.66021
Control	B	32	63.4688	14.43111	2.55108	16.48921	4.51614

By applying an independent t-test to the two samples, the results indicate a significant difference between the means of the scores of the experimental group, who were taught using the M.L.C strategy, and the control group, who were taught using the conventional method in the Productive Thinking Habits Scale. The results suggest that the students in the experimental group outperformed the students in the control group in terms of their acquisition of productive thinking habits.

Table (3)
Values of (F) and (t) for the experimental and control groups in the variable (Productive Thinking Habits Scale)

Variable	S Levene' test		t-test for two mean equivalent		Df	Statistical significance At (0.05)
	F	Significance	T	Significance at two ends		
Productive mind habitat scale	3.107	0.083	3.590	0.001	65	Significant

Thus, the null hypothesis has been rejected, and the alternative hypothesis has been accepted, which states that:
(There is a statistically significant difference at a significance level of (0.05) between the mean scores of the experimental group, who were taught using the (M.L.C) strategy, and the mean scores of the control group, who were taught using the conventional method in the Productive Thinking Habits Scale). The results favour the experimental group

Effect Size: To determine the effect size of the independent variable, as shown in the following table

Table (4): Effect Size of the Independent Variable on the Dependent Variable

Independent variable	Dependent Variable	η2 value	D value	Impact size
MLC strategy	Mind habitat scale	0.165	0.89	Large

Teaching using the (M.LC) strategy has proven effective in consolidating knowledge among students. This confirmation of knowledge can be attributed to the (M.LC) strategy. The average scores of the experimental group in the Productive Thinking Habits scale for middle school students, as shown in Table (26), were higher than the average scores of the control group. This indicates that students have positive thinking habits. It means that competent students are committed to the assigned task until completion, gather evidence for the success of the strategies they follow, think carefully before taking any action, and establish a productive vision or action plan. It is natural for intelligent individuals to plan and think in order to become more effective and influential on themselves and others. Costa has long emphasized the virtues of these intelligent behavioral patterns and regarded them as a pillar of productive thinking habits and a means of learning. These results are consistent with previous studies (Al-Qahtani, 2014) and (Al-Khazaali, 2020).

Firstly, Conclusions:

Teaching using the M.L.C strategy has led to an increase in the acquisition of mathematical concepts among middle school students in the Second Al-Karkh Directorate in the subject of mathematics.

Secondly, Recommendations:

Adoption of the M.L.C strategy in teaching mathematics to middle school students.

Thirdly, Suggestions:

Conducting similar studies on samples from other educational stages such as primary, preparatory, and university levels.

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