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The mental processes of secondary school mathematics teachers according to the presession model

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Abstract

The current research aims to determine the extent of mathematical teachers' proficiency in secondary education for mental operations according to the Presseisen model. The research adopted a descriptive diagnostic research methodology, the research sample consisted of 150 teachers who teaching mathematics in secondary and preparatory stages, affiliated with the Directorate of Education in Al-Karkh, Baghdad, specifically the Third Educational District, with 61 male teachers, 89 female teachers, In order to collect the data for the research, the researcher developed a test for mental operations. The test included 60 items, comprising both objective and essay-style questions. After administering the test and collecting the data, statistical analysis software (SPSS) was utilized to analyze the gathered information.

The most significant findings of the research were that mathematics teachers in secondary education possessed a proficiency in mental operations according to the Presseisen model at a rate of 69%. This percentage indicates their possession of an acceptable level of mental operations, as indicated by previous studies. Based on these results, a set of suggestions and recommendations were developed for stakeholders in the field of scientific research and education.

.**Keywords**

secondary school, mathematics teachers, presession model.

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Introduction:

Firstly: Research Problem:

Through the researchers' experience in teaching mathematics and their review of various studies, it has been found that there is a decline in students' level of mathematical thinking. A study conducted by Majeed (2022) and Atal (2021) has indicated this issue. The decline can be attributed to the prevalence of traditional assessment methods that focus on rote memorization without developing students' thinking skills and the tendency of some teachers to prioritize speed in explanation. Another reason is that educational institutions still lack the development of thinking skills, as their teacher training programs continue to focus on delivering information to students without actively engaging them in exchanging knowledge and ideas. A significant portion of the problem in mathematics education lies with the teacher (Jasim & Hamad, 2018, p. 1206).

he researchers observe a weakness in the cognitive and skill aspects among mathematics teachers, which has been confirmed by their annual evaluations. Some supervisors have noted that the percentage of mathematics teachers who receive an excellent rating does not exceed 10%, which can impact the achievement of their students. Additionally, studies conducted by Al-Kanani and Al-Saadi (2022) and Jasim and Khalil (2020) indicate that many mathematics teachers suffer from a lack of creative problem-solving skills and a lack of utilization of creative mental abilities.

Moreover, studies by Jasim (2018) and Mohammed (2013) have revealed a weakness in thinking skills and the inclination towards mathematics and its teaching among university students who are considered the future teachers. One of the reasons for this weakness is that teachers themselves lack thinking skills and therefore fail to transmit them to their students. Due to the scarcity of studies that have addressed this model, especially among teachers, particularly in the field of mathematics, the research problem arises. Thus, the research problem can be summarized by answering the following question.

How much do secondary school mathematics teachers possess mental processes according to the Presseisen model?

Secondly: Significance of the Research.

The significance of the research is manifested in the following:

This research aligns with the findings of the International trends of Mathematics and Science (TIMSS), which emphasizes the importance of preparing teachers and their ability to problem-solving skills that align with their mental abilities, inclinations, and attitudes towards teaching mathematics. This enhances teachers' positive orientation towards mathematics education.

This research may serve as a starting point for conducting further studies and making evidence-based decisions regarding teacher preparation curricula to ensure their broad knowledge and comprehensive understanding of mathematics, as well as the necessary skills for effective teaching, which ultimately reflects on the performance of their students.

Contributing to the educational field by providing a diagnostic test for cognitive processes according to the Presseisen model**.**

Thirdly : research goals :

The present research aims to :
to identify the level of mathematics teachers in the secondary stage in terms of their cognitive processes according to the Presseisen model, considering the gender variable.

Fourthly, the research hypotheses are as follows:

There is no statistically significant difference, at a significance level of 0.05, between the actual performance mean and the hypothesized mean among mathematics teachers in the secondary stage in the cognitive processes test according to the Presseisen model.

There is no statistically significant difference, at a significance level of 0.05, between the mean scores of male and female teachers who have taken the test, based on the gender variable.

Fifthly, **the scope of the research** is determined as follows:

Mathematics teachers for the secondary stage affiliated with the General Directorate of Education in Baghdad Al-Karkh / Third district for the academic year 2022-2023.

Mental processes according to the Presseisen model, which include basic mental processes and complex mental processes.

Sixth : research terminology :

Presseisen Model: Presseisen model, as defined by Arfa (2006), is "one of the models of thinking and its interpretive methods for mental activity." This model encompasses thinking processes classified into two types: basic mental processes, including causation, transformations, perception of relationships, classification, and discovery of unique features; and complex mental processes, including decision-making, problem-solving, critical thinking, and innovative thinking. The researchers define mental processes procedurally as a specific set of mental processes according to the Presseisen model, which can be measured by individuals' responses to the test developed by the researchers for this purpose.

Chapter Two: Theoretical Background and Previous Studies

First: Theoretical Background

First Axis: Thinking

Thinking is one of the most debated topics, as it encompasses various dimensions and intricately reflects the complexity of the human mind and its processes. It is similar to abstract concepts such as intelligence, for example, which are difficult to directly measure or define easily. Therefore, scientists have used multiple terms and descriptions to differentiate between different types of thinking and emphasize its complexity and the challenge of comprehending all its aspects (Al-Attom, 2006, p. 17).

Furthermore, Youssef (2017) states that thinking is a series of mental activities carried out by the brain when it is exposed to a stimulus received through one or more of the five senses

(Youssef, 2017: 478). Thinking is also considered one of the most complex cognitive processes practiced by learners, and it holds significant importance in both their general life and academic life. In modern education, thinking plays a crucial role in problem-solving (Ibrahim, 2005, p. 42). Ahmed (2014) emphasizes the importance of mathematics in organizing, consolidating, and developing thinking and reasoning abilities, as well as its inherent value in fostering the growth and development of thinking and inference skills (Ahmed, 2014, p. 217).

Mathematics and Thinking:
One of the main functions of education is to enable students at all levels to think, and mathematics plays a central role in fulfilling this responsibility. Teaching thinking through solving mathematical problems and mathematical reasoning is considered an important criterion in current curricula and is part of global standards. Therefore, the teaching of mathematics has evolved from a passive process of receiving and memorizing material to an activity where students can construct mathematical knowledge in their own unique way that aligns with their cognitive structure (Jawad, 2021, p. 172).
The objectives of teaching mathematics in most countries today include "focusing on different thinking patterns, as developing thinking skills has become a necessity to adapt to the advancements of the era. Achieving this lies within the scope of educational institutions through the content of their curricula and training teachers in thinking skills" (Hussein, 2017, p. 174).

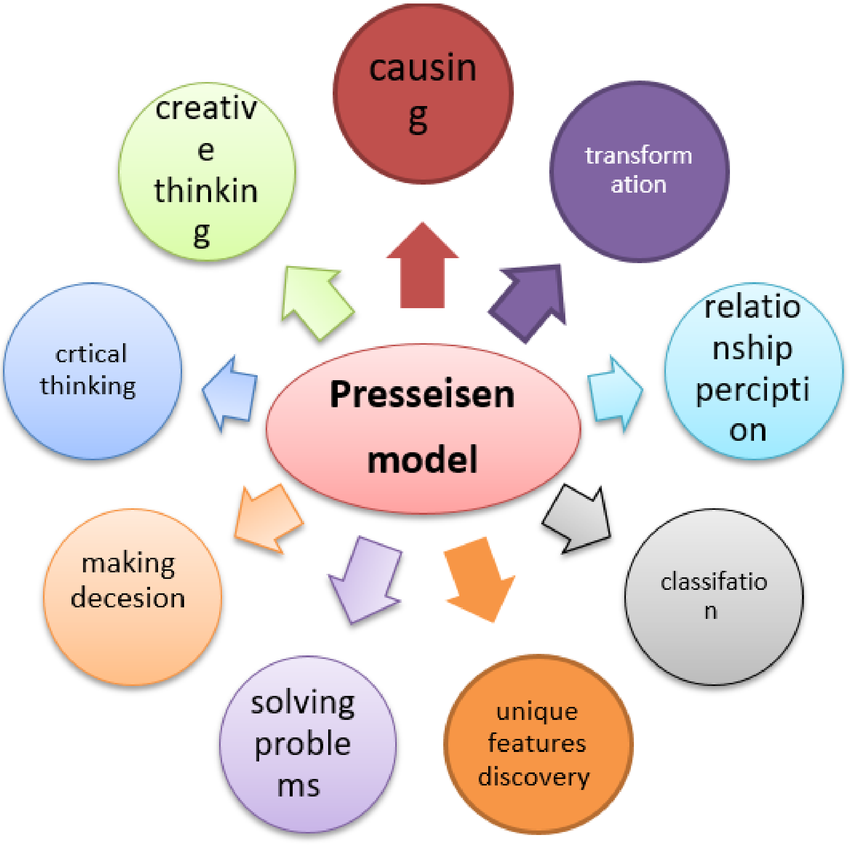
Thinking Models :
Thinking is one of the most prominent characteristics of human beings compared to other creatures. It is a fundamental need without which human life cannot function properly. It is the basis for productive and fruitful work, and we cannot accomplish any great task without thinking about it.
There have been various models that have addressed thinking, the interpretation of mental abilities, and cognitive organization. Among the notable models are:

1. Models that interpret thinking styles:
   - Herman's Model (1987)
   - Sternberg's Model (1997)
   - Harrison and Bramson's Model
   - Marzano and colleagues' Model
2. Models that interpret mental activity:
   - Costa's Model
   - Gubbins' Model (1985)
   - Luria Model
   - Triarchic Model of Mind Organization

These models provide different perspectives on thinking processes and help in understanding the complexities of human cognition (Arfa, 2006, pp. 197-217).

5. Presseisen Model of Thinking (1985):

The Presseisen model is one of the thinking models that interprets mental activity. This model categorizes thinking processes into two types: basic mental operations and complex mental operations.
Basic mental operations include causation, transformations, perception of relationships, classification, and discovery of unique features. These operations represent fundamental cognitive processes.
Complex mental operations include decision making, problem solving, critical thinking, and creative thinking. These operations involve more advanced cognitive processes.
The Presseisen model provides a framework for understanding the different aspects and processes of thinking (Arfa, 2006, pp. 201-202).



Mental processes according to Presseisen model

Basic mental operations are defined as non-complex mental activities that require the execution of the three lower levels of Bloom's taxonomy in the cognitive domain. These levels include knowledge, comprehension, and application, along with a few other skills such as observation, comparison, and classification. These skills need to be mastered before engaging in complex thinking processes (Saada, 2003, p. 60).
Wilson (2002) defines basic mental operations as "the mental processes we engage in to gather, store, and retrieve information, utilizing procedures such as analysis, planning, evaluation, drawing conclusions, and making decisions" (Al-Dulaimi & Musa, 2012, p. 21).

First: **Causation**: By perceiving the relationships between cause and effect and evaluating processes of prediction, inference, judgment, and evaluation. The skill of causation includes indicators such as prediction, inference, judgment, and evaluation

Second: Transformation: Through the relationship between known and unknown distinctive features and the production of meanings. The skill of transformation includes indicators such as representation, metaphor, and logical induction.

Third: Relationship Perception: Through organized exploration, linking particulars to wholes, using models, analysis, synthesis, sequence, organization, and logical deduction processes.

Fourth: Classification: Identifying descriptive characteristics of phenomena and objects (identifying common characteristics) and perceiving similarities, differences, grouping, comparison, elaboration, and differentiation.

Fifth: Discovery of Unique Features: Recognizing unique characteristics. The skill includes indicators such as identifying the problem or task, facts and opinions, and definitions.

Second: Complex Mental Processes

These processes require extensive and complex use of mental operations. They occur when individuals interpret and analyze information, processing it to answer a question or solve a problem that cannot be solved through ordinary use of lower-order thinking skills. These processes involve making judgments, providing opinions, and employing multiple criteria and standards to reach a conclusion.

Sixth: Problem Solving: It is primarily based on the processes of transformation and classification. This process is used to solve a known problem, which leads to generalizing the solution. The skill includes the following indicators: identifying the problem, understanding the problem, selecting alternatives, and solving the problem using the appropriate alternative.

Seventh: Decision Making: Decision-making is a process that involves several skills through which the learner can direct their thinking to solve the problem associated with the decision. The skill includes the following indicators: identifying and analyzing the problem, identifying possible alternatives to solve the problem, selecting the best alternatives, monitoring implementation, and evaluating the decision.

Eighth: Critical Thinking: It is a type of thinking in which the learner subjects the information they have to a process of analysis, sorting, and examination to determine its compatibility with other information they possess, ensuring its accuracy and stability. The skill includes the following indicators: predicting assumptions, interpretations, evaluating discussions, inferences, and conclusions.

Ninth: Creative Thinking: It relies on processes of transformation, perception of relationships, and discovery of unique features. It is used to produce new and authentic ideas, as well as aesthetically artistic and creative outcomes. It leads the learner to new meanings and satisfactory outcomes. The skill includes the following indicators: fluency, flexibility, and originality.

Previous studies :

Study by Al-Abdullah (2015): This study aimed to determine the effectiveness of the Presseisen model in decision making to solve physics problems among fifth-grade scientific stream students. The researcher used the experimental method, and the study sample consisted of 61 students evenly distributed between the experimental and control groups. The study tool was a decision-making scale, and the results showed that the experimental group outperformed the control group in the test of decision-making to solve physics problems.

Chapter Three: Research Methodology and Procedures

Firstly, Research Method: The researcher employed a descriptive diagnostic research method due to its suitability in achieving the research objectives.

Secondly, Research Population: The research population included mathematics teachers in secondary and preparatory schools affiliated with the Directorate of Education in Baghdad Al-Karkh III, totaling 364 male and female teachers.

Thirdly, Research Sample: The research sample was selected from the research population using a simple random sampling method.

Thirdly, Research Sample: The current research sample was determined to include mathematics teachers, totaling 150 male and female teachers. This consists of 61 male teachers and 89 female teachers, representing approximately 41.2% of the research population. The study sample was randomly selected from mathematics teachers, considering gender and geographic location as variables.

Fourthly, Research tool :

Stages of Developing the mental Processes Test based on the Presseisen Model:

1. Test Objective Identification:

The test aims to measure the extent of mathematics teachers' possession of cognitive processes in accordance with the Presseisen model. The test is designed to assess the cognitive abilities of secondary school mathematics teachers.

Identifying Test Skills: After reviewing the literature, including books and studies, the researcher prepared a list that includes the components of the model, which are the basic and complex cognitive processes: causation, transformations, perception of relationships, classification, discovery of distinctive features, problem-solving, decision-making, critical thinking, and innovative thinking.

Formulating Test Items: The test consists of 60 items, with 30 items covering the basic cognitive processes and 30 items covering the complex cognitive processes. The objective items comprised 38 items, while the subjective items comprised 22 items.

Preparing Test Instructions:

A. Answer Instructions: A set of instructions has been developed to guide test takers on how to answer the test. These instructions clarify the method of answering the items, the number of questions, and the importance of providing an answer for each item without leaving any question unanswered.

B. Scoring Instructions:

The test includes both objective and subjective items. For the objective items, one mark is awarded for each correct answer, while zero marks are given for incorrect answers or unanswered items. The total score for the objective items is 38 marks. As for the subjective items, a score of 1-10 is assigned to each item based on the quality of the response, while zero marks are given for incorrect or unanswered items. The total score for the subjective items is 79 marks. Consequently, the total score for the entire test is 117 marks.

Sample population: The test was administered to assess the clarity of the test items and determine the required time for completing the test.

Statistical analysis of test items: The test was corrected, and the obtained scores were arranged in descending order. The scores corresponding to the bottom 27% and top 27%

were selected to form two groups with maximum variability and distinctiveness. Subsequently, the following statistical analyses were conducted on these two groups:

A- **Difficulty of test items**:

The difficulty coefficient was calculated for each item in the objective test items, ranging from 38% to 62%. As for the essay-type items, a specific equation for difficulty coefficient was used, and the values ranged from 31% to 63%. Thus, all the items were considered acceptable according to the previous sources

B- Discriminating power of test items:

The discriminating power coefficient was calculated for each item in the objective test items, ranging from 29% to 81%. As for the essay-type items, the equation for calculating the discriminating power of essay items was applied, and the values ranged from 29% to 96%. According to the Ebel's criterion, all the items were considered acceptable.

T- **Effectiveness of distractors:**

When applying the equation for the effectiveness of distractors, it was found that all the effectiveness coefficients of the distractors were negative. Therefore, all the distractors were considered effective.

Psychometric properties of the test:

Test Validity:

A- Face Validity:

Face validity of the test was established by presenting the initial version of the test to experts specialized in mathematics and mathematics teaching methods. Their opinions were sought regarding the appropriateness of the test items. Some items were modified and rephrased based on their feedback, resulting in the final format of the test.

These findings support the construct validity of the test, as they demonstrate meaningful relationships between the test scores and the intended constructs or skills being measured.

Test Reliability:

B- Construct Validity:

Construct validity was established by examining the Pearson correlation coefficients to assess the relationships between the following variables:

Correlation between the scores of each skill and the total test score:

The coefficients ranged from **(0.65 - 0.86), indicating a moderate to strong positive relationship between the scores of each skill and the overall test score.

Correlation between the scores of each test item and the total test score:
The coefficients ranged from **(0.21-0.70), indicating a weak to moderate positive relationship between the scores of each test item and the overall test score.

Correlation between the scores of each test item and its corresponding skill score:
The coefficients ranged from **(0.26-0.88), indicating a weak to strong positive relationship between the scores of each test item and its related skill score.

Stability :

- **Test stability** :

The researcher used the (Cronbach's alpha) formula to assess the test reliability, and the obtained stability coefficient for the test was (0.92), indicating good stability .

Fifth: Final Test Application:

The test was administered to a sample of the research participants, consisting of 150 teachers and schools, with 61 teachers and 89 schools. Afterward, the responses of the examinees were scored and the results were statistically analyzed.

Chapter Four: Presentation and Interpretation of Results

In this chapter, the researcher will present the research findings obtained using the statistical software package SPSS version 23. The results will then be interpreted, accompanied by conclusions and recommendations that can be drawn.

Hypothesis 1:

There is no statistically significant difference at a significance level of 0.05 between the actual performance mean and the hypothetical mean among secondary school mathematics teachers in the Complex Cognitive Processes test, according to the Presseisen model.

The researcher employed a one-sample t-test, and it was found that the calculated value (13.063) is greater than the tabulated value (1.96) at a significance level of 0.05 with degrees of freedom (149). Thus, the null hypothesis is rejected, and the alternative hypothesis is accepted in favor of the actual mean.

Table (1) The paired t-test revealed a significant difference between the actual and hypothetical mean scores of mathematics teachers in the mentalProcesses Test.

Significance	T value		Virtual mean	SD	Real mean	sample
	Tabulated	Calculated				
Significant	1.96	13.063	58.5	10.58211	69.7867	150

The results showed that the research sample individuals possess cognitive processes according to the Presseisen model, indicating an acceptable level of proficiency at 69%. Several reasons contribute to this, including the fact that most accepted students in education colleges are interested in the teaching profession, particularly in the mathematics department, which has a strong and effective impact in the job market. Additionally, the change in mathematics curricula has had a significant effect on the teachers' knowledge development, pushing them towards research, critical thinking, and reasoning more than before.

The second hypothesis states that there is no statistically significant difference at a significance level of 0.05 between the mean scores of male and female teachers who have taken the test.

Table (2) The paired t-test revealed a significant difference between the actual and hypothetical mean scores of mathematics teachers in the mentalProcesses Test according to gender

Significance	T value		Virtual mean	SD	Real mean	sample	gender
	Tabulated	Accounted					
Significant	1.96	2.897	**1.48727**	**11.61594**	72.7377	61	Male teachers
			0.99115	**9.35053**	67.7640	89	Female teachers

The researcher used an independent samples t-test and the computed t-value was higher than the critical value (1.96), indicating that the null hypothesis was rejected and the alternative hypothesis was accepted. This means that there is a statistically significant difference between male and female teachers in their performance. The arithmetic means between them show a clear difference, which can be attributed to the differences in educational and environmental conditions. Additionally, males tend to have a stronger inclination towards leadership roles, enabling them to adapt and work effectively under challenging circumstances, allowing them to confront and solve problems.

Secondly: Conclusions

- Based on the results of this study, the following conclusions can be drawn:
- Secondary mathematics teachers possess an acceptable level of mental processes.
- There are differences between male and female teachers in their possession of mental processes, with male teachers having a higher level.

Thirdly: Recommendations

- Activate the role of scientific libraries and establish gatherings that focus on accessing old and modern sources in the field of mathematics.
- Provide strengthening courses for mathematics teachers to enhance their mathematical knowledge and train them in mathematical thinking skills.

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