

## A NEUROSCIENCE STUDY OF WEAK LEARNERS' THINKING WHILE SOLVING MATHEMATICAL PROBLEMS

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**Abstract:** *Mathematical problem-solving is among the most difficult kinds that mathematics learners encounter. As a result, this issue has attracted lots of researchers over the past 50 years. Mathematical problem solving requires a few steps of comprehension followed by graphical presentations and then the strategies used. Mathematical problem-solving performance has been associated with some general cognitive resources such as working memory, long-term memory, and inhibitory skills. This paper aims to study the neuroscience of weak learners while solving mathematical problems. 3 students of Pra Pendidikan Tinggi March - August 2023 were selected. The students were required to solve mathematical word problems while they were videotaped. Respondents were then interviewed, and the interview session was audiotaped to be transcribed. The transcribed data were then simplified and tabulated together with students' written work and were analyzed to determine the weak learner's perception and problem-solving strategy analysis showed that weak learners were unable to solve mathematical problems due to encoding failure or lack of retrieval cues. This occurs as a result of improper long-term memory storage of the concept.*

**Keywords:** *Neuroscience, Weak Learner, Mathematical Problems.*

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## Introduction

Mathematical problem-solving is among the most difficult tasks for mathematics learners. Lots of researchers have delved into many studies to understand how students deal with the process of problem-solving. Few research findings showed that problem-solving skills have not been successfully taught (Battista 1999; Skinner 1990; Lesh 1981). According to Nor Azlan (1987), mathematics is seen as a static discipline and limited to the process of counting as found in textbooks. The task of the educator has been misunderstood and caused the educator to limit teaching to simply transferring what is available in the textbook with the most efficient method to the student. The student's task is to absorb and memorize.

Teacher's teaching strongly influences the way students learn and subsequently patterns of learning outcomes. In teaching mathematical problem solving, the formula is simply introduced without introducing the basic concept of how the formula is formed. As a result, students are not allowed to develop their mathematical thinking skills. Research done by Marhan et al. (2022) shown that the teachers are still using teacher's centered approach in teaching and learning algebraic problem solving.

TIMSS and PISSA reported that there is a declining trend of Mathematics score in years 2007, 2011, 2015, 2019 from 508 to 474, 465, 461, 440 due to lack of exposure in Mathematical problem solving. Further, it is reported that only about 1% were among the top performers who are able to solve the most complex problems at level 5 and 6. A comparative study of teaching problem solving in Mathematics subject at South Korea has been carried out by Bomi and Abdul Halim (2019) finds out that the South Korean, Ministry of Education have been focusing on problem solving in mathematics much longer than the Malaysian Curriculum, which allows the students to be a very skillful problem solver. This phenomenon also occurs in higher education institutions. This is because the problem of learning mathematics at the higher education level is also very widespread even though the students have been selected to follow various study programs with satisfactory conditions.

Problem problem-solving process is closely related to working memory and long-term memory. Gagne (1975) has put forward a theory on how humans obtain information in the learning process. According to his theory outside stimulation will be received in the nervous system through the human senses. This information will be interpreted in short-term memory storage and sent to long-term memory storage and finally to the activation of a response via the nervous system. The process of problem perception occurs in short-term memory as individuals learn and solve mathematical problems by using existing knowledge gained from long-term memory. The problem that arises is not because the acquired information has been lost but the search for real information among the stored information. Therefore, the role of the educator in making the organization and details of the teaching is very important to ensure that the knowledge received by the students is organized in such an orderly way in long-term memory.

Weak problem solvers' ways of solving problems are studied by researchers. The explanation of their thinking skills while solving mathematics problems can be justified by neuroscience, a science study on brain activation. This study is aiming at the neuroscience of weak learners to give a broad view of the inner brain process of the weak learner.

## Literature Review

Weak learners are students who have problems adapting to the learning process. They are slow to understand concepts, unable to retain information for long and have difficulties in applying their knowledge to various situations. They are also autonomous learners and are very dependent on their lecturers to guide them in their studies. There are a few characteristics of weak learners. Shahrin, H., et al (2006) stated that the characteristics of a weak learner can be divided into cognitive, academic, social, emotional, motivational, and behavior.

Weak students are the individuals who have difficulties in problem solving skills. TIMSS and PISA have recorded that the problem-solving skills of the Malaysian students remains at low level (OECD 2012, Stephen et. al 2016). In the research conducted by (MS Ramim Bibi et. al 2020), it was discovered that students who struggle to grasp mathematical concepts tend to harbor negative perceptions. These individuals express a dislike towards their textbooks and course materials, reporting dissatisfaction and experiencing hesitation within the mathematics classroom environment. According to the research conducted by Nomsa Mabena and her team in 2021, it was observed that weak learners in Mathematics exhibit certain defining characteristics. These include a lack of discipline, challenges in language comprehension, and particular learning attitudes that contribute to their struggles in mastering mathematical concepts.

Weak learners are usually weak in observations including attention, concentration, processing information and memory. They have difficulty understanding what the lecturer is talking about and applying knowledge in a learning situation. They have difficulty in linking existing knowledge to new knowledge and they are weak at following procedures. Weak learners are having difficulty following lectures.

Corder (1981) said that weak learners are said to have a mismatch between their understanding of concepts and the demands of classroom situations. Orton (1984) said that the students do not understand the concept and principle which is taught abstractly and symbolically. This is because they cannot visualize and think logically (Bell,1978). They are said to have a weak concept imagery or difficulty in creating an imaged of gestalt-a -whole (Lindamoodbelle,2012). This weakness causes individuals to get parts such as a few facts or details rather than the whole picture. To clarify the relationship between brain function and the learning process, the crucial role of neurons must be highlighted. Our brain is comprised of 85 billion neurons that are interconnected and related through synapses and carry the information required to perform a variety of functions.

Cognitive function in example, the mental process associated with information consolidation and retention are directly dependent on hippocampus function (Kesner,1998).The hippocampus is the region of the brain responsible for transferring information from short term memory to long term memory which affects spatial navigation.(Ito,2004).at the same time there are cognitive functions such as the ability to connect information, make decision, evaluate and analyze information, these functions are linked to the region in cerebral cortex.(Howard Jones 2014). Evidence from brain imaging studies indicates that frontal lobe areas are involved in working memory and recalling knowledge. Parietal lobe areas are central in calculating the process of numbers (Howard Jones,2014).

In solving mathematical problems, a form of thinking skills known as perception or observation is required. Due to Mohamad Awang (1999), perception is a process of categorizing,

differentiating, interpreting input stimuli received from the environment by using existing knowledge in memory. weak learners perceive the problems by looking at prominent words and directly choose the solutions for the mathematical problems. Due to Prawat (1989), weak learners have limited knowledge of concepts, or the concepts are like chunks of ideas and not related. This is due to how mathematics class was handled in the early years.

It is the current emphasis on inhibitory skills that inspires students to take a “ready time” earlier than responding throughout the mathematics lesson. Furthermore, in problem solving, there are three types of memory involved namely sensory memory, short-term memory, and long-term memory. The stimuli received will be interpreted in the sensory memory. The stimuli go to working memory and portray the input in the form of an image or more structured information based on the previously interpreted meaning. The working memory can be maintained by regular activation. The working memory can also associate the new information with the existing knowledge.

Next, to activate the long-term memory to recognize the problem, an effort and period are needed to search for the information that is being kept among millions of knowledges. Thus, the role of educators is crucial to detail and organize lessons to ensure that the knowledge is being arranged neatly in long-term memory. The implication of the whole process is the interpretation step will be more efficient and faster.

At the same time, Mayer, Larkin and Kadane (1984) identified four types of knowledge which are linguistic and factual, schematic knowledge, strategy knowledge and algorithms in mathematical problem-solving. Students may fail in solving mathematical problems because they lack the linguistic knowledge to relate the relationship between variables. The student should have the schematic knowledge to understand the problem better. The students need to do the training in identifying problems according to category. Students may also fail in solving problems because they never know the appropriate strategy.

### **Methodology**

The objective of this study is to identify the neuroscience of weak learners while solving mathematical problems. Since then, a qualitative study was chosen 3 students from Pra Pendidikan Tinggi Semester March-August 2023 were selected. They were given 2 sets of questions one is from the topic of Arithmetic and another one is from the topic of Algebra. The process of answering is videotaped. Then there was an interview session for each of them. The session was audiotaped. The videotaped answer and the audiotaped transcript were being analyzed and tabulated. The characteristics of the weak learner were defined by the neuroscience explanation from past research. The 3 students were chosen because they are the only weak learners in that particular class which fulfill the characteristics that have been studied.

### **Findings and Discussion**

The aim of this study is to the neuroscience of weak learners in solving mathematical problems – the case of Pra Pengajian Tinggi UiTM Campus Machang. The study is to identify neuroscience or other situations where brain activation occurs. We selected a qualitative study that will definitely show the true story that happens inside the minds of weak learners.

3 out of 23 students were selected in this study, they consisted of 2 boys and one girl. The table below displays the data on the grades they obtained during SPM in Mathematics.

**Table 1: Students' Grade in Mathematics during SPM**

<u>Students</u>	<u>Grades</u>
Respondent (1)	D
Respondent (2)	D
Respondent (3)	E

They were given 2 sets of questions; one is from the topic of Arithmetic, and another is from the topic of Algebra. The process of answering has been recorded well. Then, there was an interview session for each of them. The session also gets audiotaped. The recorded video of the answer and the audio transcript were then analyzed and tabulated. The characteristics of a weak learner's mind were defined by neuroscience explanations from past research.

The first question's objective is to identify the perception of the students on the principle of arithmetic. The first and second respondent's perceptions are not fully from the principle of arithmetic. they have an encoding failure or lack of retrieval cues from their long-term memory. Due to this matter, the students can only remember a few parts of the real concept because it is not stored properly in long-term memory.

Last but not least, the third respondent can respond to the question very well. It is because he referred to the book. He also has problems with encoding failure and a lack of retrieval cues. As a result, he can only achieve a few parts of the concept because it is not fixed in long-term memory.

It can be inferred from respondents' responses that certain students struggle with retrieval cues because the content is not correctly retained in long-term memory.

The second question's goal is to discover how students view the fundamentals of algebra. The perspective of the first respondent does not entirely rest on the algebraic principle. The student seems to only obtain part of the algebra concept. He has an encoding failure or lack of retrieval cues from his long-term memory. Due to this matter, the students can only remember a few parts of the real concept because it is not stored properly in long-term memory.

The second and third respondent's perception is fully related to the principle of algebra. The students can access the principle stored in long-term memory. Due to the fact that the principle is well-organized in their long-term memory.

The second goal is to determine each student's approach to using the arithmetic principle. It can be recognized by the student's response's practical solution. The first response appears to solve the math issue incorrectly. Students appear to infer solutions to the difficulties and connect them to their ideas.

While completing an arithmetic problem, the second respondent appears to give the incorrect response. The problem statement and the posited potential solution appear to be conjectured by the students. While completing the math problem, the second respondent appears to have the right solution. The student took the problem statement and turned it into a physical representation before correlating it to the relevant principles and deciding on the approach to take. The third response appears to have the solution while resolving an arithmetic issue. The student took the problem statement and turned it into an actual thing before linking it to relevant ideas and coming up with a solution.

## Conclusion

Weak learner approaches mathematical issues in their unique way. They concentrate on the keywords and use the formula to solve them right away. This occurs because their cognitive schema is constrained, making it more difficult to access information stored in long-term memory. Neuroscience, a field of study that examines the brain activation that takes place in the minds of weak learners, can explain the mathematical problem-solving of those students. The results demonstrated that weak learners appear to be unable to solve arithmetic issues because they cannot grasp the fraction abilities that are a component of arithmetic concepts. As a result, they are unable to access the notion in their long-term memory due to encoding failure or a lack of retrieval cues. This occurs as a result of improper long-term memory storage of the concept. The same issue also surfaced when they attempted to solve algebraic issues where they did not possess a thorough understanding of the subject. As a result, accessing the notion is difficult due to improper long-term memory storage of the structural schema of algebra. This occurrence can be explained by an earlier study that was conducted, and it will help the community by addressing good, structured pedagogy that will aid in acquiring all of mathematics' fundamental principles.

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