Cognitive Representation in Teaching Mathematics on the Students' Interest and Mathematical Skills

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Abstract

This thesis entitled, Cognitive Representation in Teaching Mathematics to the Students' Interest and Mathematical Skills, aimed to determine the effect of cognitive representation in teaching mathematics to the students' interest and their mathematical skills. It follows the sides of determining the level of using cognitive representation in teaching mathematics; students' interest; students' mathematical skills during pre-assessment and post-assessment. Also, the significant difference between the level of students' mathematical skills during pre-assessment and post-assessment. Lastly, the significant effect of using cognitive representation in teaching mathematics to the students' interest and students' mathematical skills.

This study employed the descriptive research method to analyze and interpret the data collected from Grade 8 students at Pedro Guevara Memorial National High School, comprising a total of 121 respondents. Purposive sampling was utilized as the sampling technique. The data were analyzed and interpreted using the mean, standard deviation, t-test, and multiple regression.

The level of cognitive representation in teaching mathematics in terms of enactive and iconic was interpreted as very high while symbolic representation was interpreted as high. With regards to students' interest in it was verbally interpreted as very high. Before the assessment, students' mathematical skills were deemed fairly satisfactory, nevertheless after the assessment, they were classified as very satisfactory. A significant difference was noted between students' mathematical skill levels pre-assessment and post-assessment when employing cognitive representation in teaching mathematics. Furthermore, the study revealed that enactive and iconic representations significantly affect students' interest and mathematical skills.

Based on the findings, it can be concluded that there is a notable difference in students' mathematical skills between the pre-assessment and post-assessment. Additionally, the incorporation of enactive and iconic representations significantly affects both students' interest in the subject and their mathematical skills. Consequently, the hypothesis is rejected. This underscores that cognitive representations contribute to enhancing students' mathematical abilities. And it also has a beneficial effect on students' involvement with the subject matter.

In the formulated conclusions from the findings, it is recommended that teachers integrate a range of cognitive representations into mathematics instruction to cater to diverse learning styles and reinforce student comprehension. Furthermore, future researchers are encouraged to explore the effectiveness of various instructional methods, including cognitive representations, in mathematics education, aiming to discern optimal strategies for improving student learning outcomes.

Keywords: Cognitive Representation; Interest; Mathematical Skills

1. Introduction

One of the main issues discussed in the field of mathematics education is how students are able to possess mathematical abilities at every level of education. The ability to think mathematically becomes guidance for all learners to solve life problems (Sumartini and Priatna, 2018). There are many kinds of mathematics abilities needed to be developed in order to improve the quality of learning achievement, and foster students' mindset to face the challenges of the times. (Putri, et. al, 2017).

Sadly, stress and trauma from the pandemic have made math anxiety worse. This can lead to students giving up on math and simply walking away when faced with work they cannot handle. Schools and teachers do, however, take measures to address this problem, such as creating individualized instruction and giving extra support to children who need it.

In line with this, educators are still innovative and versatile when it comes to how they will deliver the lesson as well as how they will facilitate learning. Aside from this, they also make sure that the interest of the students awakened in the class discussion. As according to Azmidar et. al (2017), students' interest is one of the internal factors that influence students' learning achievement. So, it is essential to know the effective way the students learn nowadays.

Cognitive representation from Jerome Bruner's theory. Which approach has distinguished three types of cognitive representation: enactive, iconic, and symbolic. Enactive is the depiction of knowledge through actions; iconic is the visual summation of images; and symbolic is the use of words and symbols to explain experiences.

All of these approaches can be merged into a single personalized learning strategy. Each learner is an individual with their own set of experiences, knowledge, and perceptions. This can have a significant impact on how they comprehend and assimilate new information. Creating learning experiences that are meaningful for each individual based on their own knowledge and motivate them to seek new solutions can produce amazing results and increase their overall performance.

In the realm of mathematics education, a primary objective is to nurture students' enthusiasm for and proficiency in mathematics. Thus, the researcher had chosen to undertake a study examining cognitive representation in teaching mathematics on the interest and mathematical skills of the students.

1.1 Statement of the Problem

Specifically, it sought to answer the following questions:

1. What is the level of using cognitive representation in teaching MathemaMathematics in terms of:
    1.1 Enactive representation;
    1.2 Iconic representation; and
    1.3 Symbolic representation?
2. What is the level of students' interest in terms of:
    2.1 Task completion;
    2.2 Willingness to participate;
    2.3 Initiative to explore; and
    2.4 Eagerness to learn?
3. What is the level of students' mathematical skills in terms of:
    3.1 Pre-assessment; and
    3.2 Post-assessment?
4. Is there a significant difference between the level of students' mathematical skills during pre-assessment and post-assessment?

5. Does using cognitive representation in teaching Mathematics has a significant effect to the students' interest?
6. Is there a significant effect of using cognitive representation in teaching Mathematics on the students' mathematical skills?

2. Methodology

The descriptive method is used in this study to attain its objective. This descriptive research aims to describe the sample and variables without manipulating any of the variables (Siedlecki, 2020). It determines the effect of the cognitive representation in teaching Mathematics to the students' interest and mathematical skills

This method is used to clearly determine if there is or there is no significant effect of using cognitive representation in improving students' interest and mathematical skills.

3. Results and Discussion

This chapter enumerates the different results and discusses the results that were yielded from the treatment of the data that was gathered in this study. The following tabular presentations and discussions further characterize the significant effect of cognitive representation in teaching Mathematics to the students' mathematical skills and students' interest.

Level of Cognitive Representation in Teaching Mathematics

In this study Cognitive Representation in Teaching Mathematics includes enactive representation, iconic representation and symbolic representation.

It was revealed in the following tables which shows the statement, mean, standard deviation, remarks and verbal interpretation.

Table 1 shows that the weighted mean of 4.34 with a standard deviation of 0.74 indicates that the level of students' Cognitive Representation in teaching Mathematics in terms of Enactive Representation was *Very High*. From this result, it can be inferred that most of the students prefer learning through direct physical interaction with the environment.

Table 1 presents the level of Cognitive Representation in terms of Enactive Representation.

Table 1 *Level of Cognitive Representation in teaching Mathematics in terms of Enactive Representation*

STATEMENT	MEAN	SD	REMARKS
I prefer learning through the use of manipulatives such as replica objects, illustrations etc. for better understanding of mathematical concepts.	4.11	0.85	Agree
I am motivated whenever the teacher initiates activities related to the subject being discussed.	4.43	0.65	Strongly Agree
I like playing games that would stimulates my mind such as triangle pairs, triangle tiles etc.	4.41	0.73	Strongly Agree
I learn better through demonstrations of skills than simply reading books and/or listening to discussions.	4.45	0.72	Strongly Agree
I observed that it is easier to store information by remembering the feel of actions.	4.30	0.74	Strongly Agree
Weighted Mean	***4.34***		

SD	***0.74***
Verbal Interpretation	***Very High***

Table 2 shows that the weighted mean of 4.59 with a standard deviation of 0.54 indicates that the level of Cognitive Representation in teaching Mathematics in terms of Iconic Representation was also *Very High*. This means that most of the students learn well with the use of pictorial images to make actions, objects, and concepts.

Table 2 displays the level of Cognitive Representation in teaching Mathematics in terms of Iconic Representation.

Table 2 *Level of Cognitive Representation in teaching Mathematics in terms of Iconic Representation*

STATEMENT	MEAN	SD	REMARKS
I prefer learning through the use of visual representation such as illustrations, charts, pictures, etc.	4.52	0.56	Strongly Agree
It is easier to focus when the teacher explains ideas and concepts using pictures or illustrations that would awaken my imagination.	4.54	0.58	Strongly Agree
I prefer reading materials with illustrations, charts, pictures, drawings and other illustrations for better understanding of its content.	4.64	0.51	Strongly Agree
I learn better through the form of images than simply reading words and numbers.	4.56	0.50	Strongly Agree
I observed that it is easier to store information visually by remembering mental pictures that support ideas and concepts.	4.68	0.53	Strongly Agree
Weighted Mean	***4.59***		
SD	***0.54***		
Verbal Interpretation	***Very High***		

In table 3, weighted mean of 3.92 with a standard deviation of 0.71 indicates that the level of Cognitive Representation in teaching Mathematics in terms of Symbolic Representation was *High*. The result explains that there were students who still learn in a traditional way. They learn just by representing concepts or ideas using language or abstract symbols.

Table 3 shows the level of Cognitive Representation in teaching Mathematics in terms of Symbolic Representation.

Table 3 *Level of Cognitive Representation in teaching Mathematics in terms of Symbolic Representation*

STATEMENT	MEAN	SD	REMARKS
I prefer learning through the use of symbols such as letters, numbers and other mathematical symbols.	3.68	0.68	Agree
I am able to perform reasoning through my language skills and interpreting linguistic symbols.	3.88	0.83	Agree
I understand mathematical concepts better by just reading books and other references.	3.86	0.66	Agree
I learn better when the teacher presents reading materials such as modules, textbooks, or other references.	4.02	0.75	Agree
I observed that it is easier to store information by remembering the written symbols of what I had already seen or read.	4.18	0.64	Agree
Weighted Mean	***3.92***		
SD	***0.71***		
Verbal Interpretation	***High***		

Level of Students' Interest in terms of Students' Interest

In this study students' interest measures by task completion, willingness to participate, initiative to explore, and eagerness to learn.

It was revealed in the following tables which shows the statement, mean, standard deviation, remarks and verbal interpretation.

Table 4 shows the weighted mean of 4.27 with a standard deviation of 0.59 indicates that the level students' interest in terms of task completion by the use of cognitive representation in teaching Mathematics was *Very High*. The result shows that by the use of different or single cognitive representation in teaching Mathematics has aroused the students' interest specifically when it comes to task completion.

Table 4 illustrates the students' interest in terms of task completion.

Table 4 *Level of Students' Interest in terms of Task Completion*

STATEMENT	MEAN	SD	REMARKS
Through cognitive representation, I was able to generate multiples and creative ideas to accomplish the task.	4.16	0.52	Agree
Through cognitive representation, I was able to find relevance in the tasks assigned to me.	4.45	0.60	Strongly Agree
Through cognitive representation, I was able to stay engaged and interested in completing tasks.	4.43	0.56	Strongly Agree
Through cognitive representation, I was able to express my creativity while completing tasks.	4.14	0.59	Agree
Through cognitive representation, I was able to enjoy the process of completing tasks.	4.19	0.67	Agree
Weighted Mean	***4.27***		
SD		***0.59***	
Verbal Interpretation		***Very High***	

Table 5 discusses the level of students' interest in terms of willingness to participate. The weighted mean of 4.48 with a standard deviation of 0.61 indicates that the level of students' interest in terms of willingness to participate was *Very High*. There was also an impact of using cognitive representation in teaching Mathematics to the willingness of the students to participate in the class discussion.

Table 5 *Level of Students' Interest in terms of Willingness to Participate*

STATEMENT	MEAN	SD	REMARKS
Through cognitive representation, I was able to actively participate in class discussions.	4.26	0.71	Strongly Agree
Through cognitive representation, I was able to frequently ask questions and seek clarification during class.	4.49	0.64	Strongly Agree
Through cognitive representation, I was able to share my thoughts and opinions during class discussions.	4.53	0.58	Strongly Agree
Through cognitive representation, I was able to volunteer for class activities or presentations.	4.55	0.54	Strongly Agree
Through cognitive representation, I was able to feel enthusiast about participating in class activities.	4.58	0.56	Strongly Agree
Weighted Mean	***4.48***		
SD		***0.61***	

Verbal Interpretation	***Very High***

Table 6 shows the level of students' interest in terms of initiative to explore.

The weighted mean of 4.58 with a standard deviation of 0.54 indicates that the level of students' interest in terms of initiative to explore was also *Very High*. The result revealed that with the use of different or even single cognitive representation in teaching Mathematics had also an impact to the initiative of the learners to explore.

Table 6 *Level of Students' Interest in terms of Initiative to Explore*

STATEMENT	MEAN	SD	REMARKS
Through cognitive representation, I was able to feel motivated to explore new information and ideas.	4.56	0.54	Strongly Agree
Through cognitive representation, I was able to find eagerness in exploring topics or ideas that sparked my interest and ignited my desire to learn.	4.52	0.58	Strongly Agree
Through cognitive representation, I was able to seek and discover new techniques in solving problems.	4.62	0.51	Strongly Agree
Through cognitive representation, I was able to experience enjoyment when engaging in exploratory activities during which I could delve into new concepts or ideas.	4.55	0.50	Strongly Agree
Through cognitive representation, I was able to perceive exploration as meaningful because it enabled me to deepen my understanding and broaden my perspectives.	4.65	0.55	Strongly Agree
Weighted Mean	***4.58***		
SD	***0.54***		
Verbal Interpretation	***Very High***		

Table 7 shows the level of students' interest in terms of eagerness to learn. The weighted mean of 4.55 with a standard deviation of 0.56 indicates that the level of students' interest in terms of eagerness to learn was *Very High*. The result revealed that aside from the other indicators that was stated in the previous tables, using cognitive representation in teaching Mathematics has also an impact to the students' interest specifically in their eagerness to learn.

Table 7 *Level of Students' Interest in terms of Eagerness to Learn*

STATEMENT	MEAN	SD	REMARKS
Through cognitive representation, I was able to feel motivated to feel eager to learn because it allowed me to engage with topics and concepts that pique my curiosity and interest.	4.60	0.53	Strongly Agree
Through cognitive representation, I was able to find excitement in learning about Math that resonate with my passions and aspirations.	4.55	0.56	Strongly Agree
Through cognitive representation, I was able to experience joy in the learning process when it involved exploring new ideas or delving deeper into familiar topics.	4.56	0.56	Strongly Agree
Through cognitive representation, I was able to motivated to learn when	4.49	0.58	Strongly

presented with opportunities for hands-on experimentation, discovery, and problem-solving.			Agree
Through cognitive representation, I was able to experience a sense of accomplishment in learning when I overcome challenges, master new skills, and achieve my learning goals.	4.53	0.54	Strongly Agree
Weighted Mean	***4.55***		
SD		***0.56***	
Verbal Interpretation		***Very High***	

Level of Students' Mathematical Skills

In this study using Cognitive Representation in teaching Mathematics, students' performance during pre-assessment and post-assessment were discussed and with accordance to their mathematical skills.

Table 8 presents the level of students' mathematical skills in terms of pre-assessment before using cognitive representation in teaching mathematics.

Table 8 *Level of Students' Mathematical Skills in terms of Pre-assessment*

Raw Score	Frequency (f)	Percentage (%)	Verbal Interpretation
37-45	0	0%	Outstanding
28-36	0	0%	Very Satisfactory
19-27	0	0%	Satisfactory
10-18	106	88%	Fairly Satisfactory
0-9	15	12%	Did Not Meet Expectation
	N = 121	**100%**	
Mean		**13.05**	
SD		**3.08**	
Verbal Interpretation		**Fairly Satisfactory**	

The weighted mean of 13.05 revealed that the level of students' mathematical skills during pre-assessment was interpreted as *Fairly Satisfactory.* It implies that students are really struggling in mathematics and need focus in boosting their interest and developing their skills to further understand the concepts in mathematics.

It was supported by the study of San Juan (2014) which revealed that the problem-solving skills of the students were under fairly satisfactory in the comprehension and computational levels and needs improvement levels. This only show that there is a need for improvement of the students' problem-solving skills.

Table 9 presents the level of students' mathematical skills in terms of post-assessment after using cognitive representation in teaching mathematics.

The weighted mean of 33.82 revealed that the level of students' mathematical skills during post-assessment was interpreted as *Very Satisfactory.*

Table 9 *Level of Students' Mathematical Skills in terms of Post-assessment*

Raw Score	Frequency (f)	Percentage (%)	Verbal Interpretation
37-45	9	8%	Outstanding
28-36	111	93%	Very Satisfactory

19-27	1	1%	Satisfactory
10-18	0	0%	Fairly Satisfactory
0-9	0	0%	Did Not Meet Expectation
	N = 121	**100%**	
Mean		**33.82**	
SD		**1.95**	
Verbal Interpretation		**Very Satisfactory**	

From these results, it can be inferred that through the use of cognitive representation in teaching Mathematics, learners are able to understand the topic being discussed. Students make use of their skills and knowledge learned using different ways of learning in expressing their answers correctly.

In this study, test differences between the level of students' mathematical skills before and after using cognitive representation were discussed.

Test Difference Between the Level of Students' Mathematical Skills during Pre-assessment and Post-assessment

Table 10 presents the test difference in the students' mathematical skills before and after using cognitive representation in teaching mathematics.

Table 10 *Test Difference Between the Level of Students' Mathematical Skills during Pre-assessment and Post-assessment using Cognitive Representation*

Students' Mathematical Skills	Mean	Mean Difference	Computed t-value	Critical t-value	Analysis
Pre-assessment	13.05				
		20.77	163.77	1.98	*Significant*
Post-assessment	33.82				

The table revealed that the computed t-value of 163.77 is greater than the critical t-value of 1.98. Therefore, it can be concluded that there is a significant difference between the level of students' mathematical skills during pre-assessment and post-assessment (before and after) using cognitive representation in teaching Mathematics.

Significant Effect of Cognitive Representation in teaching Mathematics to the Students' Interest

In this study, the significant effects of using cognitive representation in teaching mathematics to the students' interest were discussed.

Table 11 presents the significant effect of using cognitive representation in teaching mathematics to the students' interest.

The table revealed that the cognitive representation in terms of Enactive Representation has significant effect to students' interest in terms of task completion, willingness to participate, initiative to explore and eagerness to learn. This is in accordance with the computed p-values obtained from the tests which are less than the significance alpha of 0.05.

Likewise, cognitive representation in terms of Iconic representation has significant effect to students' interest in terms of task completion, willingness to participate, initiative to explore and eagerness to learn.

This is in accordance with the computed p-values obtained from the tests which are less than the significance alpha of 0.05.

On the other hand, cognitive representation in terms of Symbolic representation has no significant effect to students' interest in terms of task completion, willingness to participate, initiative to explore and eagerness to learn. This is in accordance with the computed p-values obtained from the tests which are greater than the significance alpha of 0.05.

Table 11 *Effect of Cognitive Representation in teaching Mathematics to the Students' Interest*

Cognitive Representation	Students' Interest	α - value	p-value	Analysis
Enactive Representation	Task Completion	0.05	0.04	Significant
	Willingness to Participate		0.01	Significant
	Initiative to Explore		0.04	Significant
	Eagerness to Learn		0.02	Significant
Iconic Representation	Task Completion	0.05	0.01	Significant
	Willingness to Participate		0.00	Significant
	Initiative to Explore		0.00	Significant
	Eagerness to Learn		0.03	Significant
Symbolic Representation	Task Completion	0.05	0.06	Not Significant
	Willingness to Participate		0.47	Not Significant
	Initiative to Explore		0.52	Not Significant
	Eagerness to Learn		0.06	Not Significant

These results indicates that the use of cognitive representation in the teaching of mathematics—more especially, enactive and iconic representation—can stimulate students' interest in task completion, willingness to participate, initiative to explore, and eagerness to learn.

In this study, the significant effects of using cognitive representation in teaching mathematics to the students' mathematical skills were discussed.

Significant Effect of Cognitive Representation in teaching Mathematics to the Students' Mathematical Skills

Table 12 presents the significant effect of using cognitive representation in teaching Mathematics to the students' mathematical skills.

Table 12 *Effect of Using Cognitive Representation to the Students' Mathematical Skills*

Cognitive Representation	Mathematical Skills	α - value	p-value	Analysis
Enactive Representation	Post-assessment (After using cognitive representation)	0.05	0.00	Significant
Iconic Representation			0.00	Significant

Symbolic Representation	0.09	Not Significant

The table revealed that the cognitive representation in terms of Enactive and Iconic representation has significant effect to students' mathematical skills. This is in accordance with the computed p-values obtained from the tests which are less than the significance alpha of 0.05. On the other hand, cognitive representation in terms of Symbolic representation has no significant effect to students' mathematical skills since the p-value obtained in greater than the significance alpha.

It implies that cognitive representation in teaching mathematics (specifically enactive and iconic) has an effect to the students' mathematical skills. Furthermore, by harnessing cognitive representation techniques like enactive and iconic approaches in mathematics education, educators can cultivate a deeper understanding and retention of mathematical concepts among students. This prepares them for a more solid mathematical foundation and lifetime learning by strengthening their mathematical skills as well as encouraging critical thinking and problem-solving ability.

4. Conclusion and Recommendations

Based on the findings above, the following conclusions were hereby drawn:

There is a significant difference on students' mathematical skills during pre-assessment and post-assessment using cognitive representation in teaching mathematics. Thus, the null hypothesis is rejected. This implies that incorporating visual aids, diagrams, and other cognitive strategies into mathematics instruction effectively enhances students' understanding and proficiency. These representations help students visualize concepts, improve retention, and make learning more engaging and accessible.

Furthermore, the utilization of enactive and iconic representation in mathematics instruction yields a significant influence on students' interest, resulting in the rejection of the null hypothesis. This implies that these approaches have a beneficial effect on students' involvement with the subject matter. By incorporating diverse teaching strategies, including enactive methods such as hands-on activities and iconic approaches such as visual aids, educators cater to various learning preferences, thereby augmenting student interest and engagement in mathematics.

Finally, employing enactive and iconic representation in mathematics instruction also exerts a significant effect on students' mathematical skills, resulting in the rejection of the null hypothesis. This underscores that cognitive representations, including iconic and enactive methods, contribute to enhancing students' mathematical abilities. It highlights the importance of employing a diverse range of instructional techniques to effectively facilitate students' acquisition of mathematical knowledge and skills.

In the formulated conclusions from the findings, it was recommended that:

1. Teachers may incorporate a variety of cognitive representations in math teaching to accommodate diverse learning styles and enhance student understanding. To encourage active participation and improve mathematical comprehension, give priority to hands-on activities and visual aids and take advantage of opportunities for ongoing professional development to hone teaching techniques and enhance instructional methodologies.
2. Students may participate actively in hands-on activities and visual aids provided by teachers to deepen understanding and improve mathematical skills. They may embrace the opportunity to explore different cognitive representations to enhance learning experiences and mastery of math concepts.
3. Future researchers may investigate the effectiveness of diverse instructional techniques, including cognitive representations, in mathematics education to identify best practices for enhancing student learning

outcomes. They may examine the long-term effects of cognitive representations on student math skills and interest to inform future educational interventions.

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