Utilization of Multiple Representation Approach on Students' Cognitive and Performance in Science

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Abstract

This study determined whether employing a multiple representation approach on students' cognitive and creative thinking skills in the context of science education were effective among the Grade 4 students of Capitol View Christian School. Specifically, this study will answer the following questions: (1) What is the level of utilization of multiple representation approach; 2) What is the level of students' cognitive skills; (3) What is the level of students' performance; (4) What is the level of Composite table of students' creative thinking skills? (4) Is there a significant difference on the level of student creative thinking skill before and after utilization of multiple representation approach? (5) Does the level of utilization of multiple representation approach have significant effect on students' cognitive skills? (6) Does the level of utilization of multiple representation approach have significant effect on students' creative thinking skills?

The study was conducted to prove that there was a significant difference in the pre-test and post-test among the respondents. The respondents of the study were composed of two (2) sections at Capitol View Christian School to test the effectiveness of The Utilization of Multiple Representation Approach on Students Cognitive and Creative Thinking Skills in Science. In this study, random sampling method was used in choosing the respondents. The researcher made questionnaires validated by different experts from different school. Using a random sampling method, data were collected via validated questionnaires administered to the participants. Analysis of the data indicates a significant improvement in both cognitive and creative thinking skills among students following the implementation of the multiple representation approach. Specifically, there was a notable enhancement in students' perception, memory capacity, logical reasoning, as well as their abilities in analyzing, problem-solving, organizing, and lateral thinking.

Based on the data presented and interpreted in Chapter 4, the overall statistical data revealed that the findings reveal a high level of utilization of multiple representation analysis across various aspects, including task assignment, ICT integration, instructional materials, and model presentation. Additionally, students demonstrated significantly enhanced cognitive skills, such as perception, memory capacity, and logical reasoning, as well as heightened creative thinking skills, including analyzing, problem-solving, organizing, and lateral thinking. Statistical analysis indicates a significant difference in students' creative thinking skills before and after implementing the multiple representation approach, as well as a significant relationship between the utilization of this approach and both cognitive and creative thinking skills. The conclusions drawn suggest that the utilization of multiple representation approaches positively influences students' cognitive and creative thinking skills in science education.

Recommendations are provided for students, educators, schools, and future researchers to leverage these findings to enhance teaching strategies, curriculum development, and educational outcomes. This study serves as a valuable resource for advancing science education practices and promoting deeper student engagement and understanding in the subject.

Keywords: multiple representation; cognitive skills; creative thinking skills

1. Introduction

Education is part of every human's life and a discipline concerned with teaching and learning methods in schools or school-like environments. Educational trends have been changing and continuously transitioning into various tools, materials, activities, and even teaching approaches.

Nowadays learners are more capable and competences to learn through the help of their environment, technology, and the educators that support them to enhance the knowledge they have. In order for students to be able to know and regulate their learning processes, teachers should use essential and appropriate teaching approach.

Besides, quality education of various field and courses are also different with each other. Specifically, in science education, cultivating the students' creativity and innovation, critical thinking and problem solving, collaboration, and communication should be the main focus.

On a current situation, learning science concepts became inert due to the changes of teaching approaches amidst the now normal. Students may bore the brunt of the difficulty brought by the current situation of education. Some students benefited from the increased flexibility they were able to exert around their own learning as a result of the shift to remote instruction, and somehow it is observable that the students are beginning to become more comfortable with using technology through distance learning. For this reason, teachers should be resilient to boost the motivation of the students to go back in the traditional learning that they are used to. However, it must be upgraded into a more competent and flexible teaching approach. Presenting diverse instructional materials, various tools and multiple representation can help the teachers to cultivate the interest of the students to learn their courses.

In connection with this, multiple representation strategies should be utilized in science classroom wherein it consists of orientation, exploration, internalization, and evaluation. It is widely used to build meaning behind subject matter and develop a deeper understanding of properties or ideas connected to the same fact or operation.

In a classroom setting, it is an approach wherein teachers are expected to use different materials in teaching. Teacher can present visuals and at the same time use some other learning tools such as audio, printed, video etc. This kind of multiple representation approach can help the students to gain knowledge on their own phase. It also caters the multiple intelligences of the learners which enable them to be more competent.

Furthermore, student participation can be seen from activities during learning activities. Multiple representation approach can be an effective teaching approach to use wherein it gives the learners an opportunity to excel in different learning field. Students can actively participate in activities such as presentations, asking questions, answering questions, discussions, practicum, the practice of making a product, and writing reports. Teaching and learning process not only focuses on the results obtained, but the learning process can also provide a proper understanding that students can apply in their lives. Learning objectives can be achieved if students understand and comprehend the material obtained during learning.

Mastery of the teachers in the implementation of the different learning materials are also needed to ensure that cognitive knowledge of the students is widely broaden up and establish their creative thinking skills.

This study wants to further explore the utilization of multiple representation approach on students' cognitive and creative thinking skills in science.

1.1 Statement of the Problem

Specifically sought to answer the following questions:

1. What is the level of utilization of multiple representation approach in terms of:
   1.1 task assignment

1.2 ICT integration
1.3 Investigation
1.4 Manipulatives and Non-Manipulatives
1.5 Modeling

2. What is the level of students' cognitive skills in terms of:
   2.1 Perception
   2.2 Memory capacity
   2.3 logical reasoning
   2.4 Cognitive Skills
3. What is the level of students' performance in formative and summative test in terms of:
   3.1 analyzing;
   3.2 problem solving
   3.3 organizing
   3.4 lateral thinking
4. Is there a significant difference on the level of student creative thinking skill before and after utilization of multiple representation approach?
5. Does the level of utilization of multiple representation approach have significant effect on students' cognitive skills?
6. Does the level of utilization of multiple representation approach have significant effect on students' creative thinking skills?

2. Methodology

Descriptive method was used to identify the effects of utilization of multiple representation approach on students' cognitive and creative thinking skills in science.

The researcher will use the quantitative/ descriptive survey method of research. Quantitative methods emphasize objective measurements and the statistical, mathematical, or numerical analysis of data collected through polls, questionnaires, and surveys, or by manipulating pre-existing statistical data using computational techniques. Quantitative research focuses on gathering numerical data and generalizing it across groups of people or to explain a particular phenomenon (Wadsworh, 2017). The method involved range from the survey which described the status quo, the correlation study which investigated the relationship between variables, to developmental studies which seek changes over time (Key, 2017).

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.

Level of Multiple Representation

The following table presents the result of task assignment, ICT integration, investigation, manipulatives and non-manipulatives, and modeling.

Table 1. *Level of utilization of multiple representation analysis in terms of Task assignment*

STATEMENTS	**MEAN**	**SD**	**REMARKS**
Purposeful and relevant to the lesson.	4.64	0.56	Strongly Agree

Considers the learning objectives.	4.60	0.66	Strongly Agree
Focus on the students' interest and allow them to challenge their selves on doing their assignment.	4.42	0.69	Strongly Agree
Conveys a meaningful situation that are connected with the lesson.	4.40	0.68	Strongly Agree
Allow the students to see the purpose for their study and some definite objectives to be achieved.	4.55	0.50	Strongly Agree
Weighted Mean	4.52		
SD	0.25		
Verbal Interpretation	Very Great Extent		

Table 1 illustrates the level of utilization of multiple representation analysis in terms of Task assignment

The Task assignment of the teachers yielded the highest mean score *(M=4.64, SD=0.56)* and is very *purposeful and relevant to the lesson* and was remarked as Strongly Agree. However, with the lowest mean score of *(M=4.40, SD=0.68)* they c*onvey a meaningful situation that are connected with the lesson* and commented as Strongly Agree.

The level of utilization of multiple representation analysis in terms of Task assignment attained a weighted mean score of 4.52 and a standard deviation of 0.25 and was Very Great Extent among the respondents.

The results suggest that teachers have effectively integrated multiple representation analysis into their task assignments, leading to purposeful and relevant learning experiences for students. Additionally, while conveying meaningful situations connected with the lesson received slightly lower scores, it still demonstrated a strong level of effectiveness in enhancing learning outcomes.

In perceptual processing of visual pictures, task-relevant information is selected through top-down activation of cognitive schemata and then visually organized through automated visual routines (Ullman, 2014).

Table 2. *Level of utilization of multiple representation analysis in terms of ICT integration*

STATEMENTS	**MEAN**	**SD**	**REMARKS**
Gauge conceptual understanding and filter information that came from online sites.	4.78	0.46	Strongly Agree
Essentially involve the students into a peer collaborative activity in through the use of various ICT materials.	4.44	0.66	Strongly Agree
Share effective information in different online platforms.	4.51	0.60	Strongly Agree
Utilize technological tools for teaching and presenting the lesson.	4.58	0.60	Strongly Agree
Adopt the right technology that can be use in teaching and innovating instructional materials.	4.29	0.53	Strongly Agree
Weighted Mean	4.52		
SD	0.25		
Verbal Interpretation	Very Great Extent		

Table 2 exemplifies the level of utilization of multiple representation analysis in terms of ICT integration

Gauging conceptual understanding and filter information that came from online sites yielded the highest mean score *(M=4.78, SD=0.46)* for teachers ICT integration. On the other hand, a*dopting the right technology that can be use in teaching and innovating instructional materials*" received the lowest mean score of responses with *(M=4.29, SD=0.53)* yet was remarked as Strongly Agree.

The level of utilization of multiple representation analysis in terms of ICT integration reached a weighted mean score of 4.52 and a standard deviation of 0.25 and was Very Great Extent among the respondents.

The findings imply that incorporating ICT into their lesson plans made effective use of multiple representation in learners' performance. Even though some elements could have had somewhat lower ratings overall, they were nonetheless seen favorably. This suggests that multiple representation analysis can be used to improve teaching and learning with a high degree of success when using ICT technologies.

Table 3. *Level of utilization of multiple representation analysis in terms of Investigation*

STATEMENTS	**MEAN**	**SD**	**REMARKS**
Allow the students to discover their own learning.	4.62	0.49	Strongly Agree
Enable the students to understands their lessons with their own capabilities and skills.	4.67	0.58	Strongly Agree
Help the students to resolve internal problems by giving them chance to find answers on their own questions.	4.38	0.62	Strongly Agree
Develop resiliency in peer competition and self-disappointment by doing activities that enable them to explore on their own.	4.58	0.60	Strongly Agree
Enhance critical thinking by providing assessment that let them predict, discover and explore.	4.58	0.53	Strongly Agree
Weighted Mean	4.57		
SD	0.26		
Verbal Interpretation	Very Grea*t* Extent		

Table 3 demonstrates the level of utilization of multiple representation analysis in terms of Investigation

With the highest mean score *(M=4.67, SD=0.58)* of Investigation, the teacher e*nables the students to understands their lessons with their own capabilities and skills*. With a remarked also of Strongly Agree, the teacher h*elps the students to resolve internal problems by giving them chance to find answers on their own questions* and received the lowest mean score of *(M=4.38, SD=0.62)*.

The level of utilization of multiple representation analysis in terms of Investigation achieved a weighted mean score of 4.57 and a standard deviation of 0.25 and was Very Great Extent among the respondents.

This implies that the findings indicate that educators made effective use of multiple representation analysis in inquiry-based learning activities. It successfully promoted a deep understanding of the subject matter by empowering students to understand lessons with their own abilities and skills and supporting them in solving internal problems through self-inquiry. All things considered; the results show that using multiple representation analysis in investigative teaching methods is highly effective.

Table 4. *Level of utilization of multiple representation analysis in terms of use of Manipulatives and Non-Manipulatives*

STATEMENTS	MEAN	SD	REMARKS
Provide task wherein the students can positively engage in.	4.89	0.31	Strongly Agree
Promote working collaboration within the students.	4.53	0.54	Strongly Agree
Allow the students to explore using their own capabilities in manipulating objects and experiments.	4.67	0.51	Strongly Agree
Allow the students to improve their self-efficacy and self-awareness.	4.62	0.62	Strongly Agree
Enable the students to enhance their ability in understanding abstract concepts.	4.47	0.66	Strongly Agree
Weighted Mean	4.64		
SD	0.21		
Verbal Interpretation	Very Great Extent		

Table 4 shows the level of utilization of multiple representation analysis in terms of use of Manipulatives and Non-Manipulatives

The teachers Strongly Agreed yielding the highest mean score *(M=4.89, SD=0.31)*, the use of Manipulatives and Non-Manipulatives p*rovides task wherein the students can positively engage in*. And they, e*nables the students to enhance their ability in understanding abstract concepts* receiving the lowest mean score of responses with *(M=4.47, SD=0.36)*.

The level of utilization of multiple representation analysis in terms of use of Manipulatives and Non-Manipulatives accomplished a weighted mean score of 4.64 and a standard deviation of 0.21 and was Very Great Extent among the respondents.

The findings imply that while using both manipulatives and non-manipulatives, teachers made good use of multiple representation analysis. Thus, substantially improved student learning experiences by giving interesting assignments and using these resources to help students understand abstract ideas. All things considered, the results show that multiple representation analysis is a highly effective tool for teaching both manipulative and non-manipulative subjects.

Table 5. *Level of utilization of multiple representation analysis in terms of Modeling*

STATEMENTS	MEAN	SD	REMARKS
Involves analyzing of a learner's needs and the characteristics of the target learning audience.	4.75	0.52	Strongly Agree
Select appropriate instructional strategies and resources	4.73	0.53	Strongly Agree
Implement the effectiveness of instruction.	4.44	0.67	Strongly Agree
Designed according to the level of the learners.	4.35	0.64	Strongly Agree
Consist of appropriate technical format and valid content.	4.64	0.49	Strongly Agree
Weighted Mean	4.58		
SD	0.30		
Verbal Interpretation	Very Great Extent		

Table 5 proves the level of utilization of multiple representation analysis in terms of Modeling

From the statements, "*Involves analyzing of a learner's needs and the characteristics of the target learning audience*" yielded the highest mean score *(M=4.75, SD=0.52)* and was remarked as Strongly Agree.

On the other hand, "*Designed according to the level of the learners*" received the lowest mean score of responses with *(M=4.35, SD=0.64)* yet was remarked Strongly Agree.

The level of utilization of multiple representation analysis in terms of Modeling conquered a weighted mean score of 4.58 and a standard deviation of 0.30 and was Very Great Extent among the respondents.

The findings imply that while using modeling, respondents perceive multiple representation analysis as highly valuable and extensively used in modeling practices. The importance of understanding learner needs, adapting teaching materials, and effectively utilizing multiple representation analysis. This approach fosters effective and inclusive learning environments tailored to the diverse needs of students.

Cognitive Skills

The following table presents the result of perception, memory capacity, logical reasoning, and cognitive skills.

Table 6. *Level of students' cognitive skills in terms of Perception*

STATEMENTS	**MEAN**	**SD**	**REMARKS**
Practice active listening and be genuine in the interest of other people.	4.73	0.45	Strongly Agree
Develop empathetic listening skills and become aware of stereotypes and prejudice.	4.49	0.60	Strongly Agree
Engage in self-reflection and develop openness.	4.52	0.59	Strongly Agree
Monitor perceptions of and reactions to others and communication.	4.80	0.45	Strongly Agree
Observe how own behavior can affect other people and be mindful for every actions.	4.56	0.60	Strongly Agree
Weighted Mean	4.64		
SD	0.22		
Verbal Interpretation	Very Great Extent		

Table 6 explains the level of students' cognitive skills in terms of Perception

The Perception of the students yielded the highest mean score *(M=4.80, SD=0.45)* and *monitor perceptions of and reactions to others and communication* and was remarked as Strongly Agree. However, with the lowest mean score of responses with *(M=4.49, SD=0.60)* they *develop empathetic listening skills and become aware of stereotypes and prejudice* and observed as Strongly Agree.

The level of students' cognitive skills in terms of Perception got a weighted mean score of 4.64 and a standard deviation of 0.22 and was Very Great Extent among the respondents.

According to the findings, students demonstrate high cognitive abilities in perception, including keeping an eye on how they perceive and react to other people and to communication, as well as learning how to listen empathetically and being conscious of prejudice and stereotypes. Respondents believe that students are generally very skilled at these cognitive tasks, which suggests that students' perception skills are highly effective.

Table 7. *Level of students' cognitive skills in terms of Memory capacity*

STATEMENTS	**MEAN**	**SD**	**REMARKS**
Integrate various learnings with the present insights gained.	4.84	0.42	Strongly Agree

Recall past lessons and use it on understanding previous lessons.	4.65	0.55	Strongly Agree
Recognize old knowledge and able to integrate it with the new one.	4.75	0.52	Strongly Agree
Easily memorize information, words and/or sentences.	4.65	0.55	Strongly Agree
Develop routines and effective learning habits that can help improving memory.	4.47	0.57	Strongly Agree
Weighted Mean	4.67		
SD	0.26		
Verbal Interpretation	Very Great Extent		

Table 7 illustrates the level of students' cognitive skills in terms of Memory capacity

Integrating various learnings with the present insights gained yielded the highest mean score *(M=4.84, SD=0.42)* for students' Memory capacity. On the other hand, d*eveloping routines and effective learning habits that can help improving memory*" received the lowest mean score of responses with *(M=4.47, SD=0.57)* yet was remarked as Strongly Agree.

The level of students' cognitive skills in terms of Memory capacity attained a weighted mean score of 4.67 and a standard deviation of 0.26 and was Very Great Extent among the respondents.

The findings imply that pupils have great cognitive abilities in memory capacity, especially when it comes to fusing past knowledge with newly acquired knowledge. Respondents strongly agreed that memory improvement requires routines and good learning habits, despite the fact that routines and habits obtained significantly lower scores. Overall, respondents think that pupils are quite good in memory-related cognitive skills, which suggests that their memory capacity is extremely effective.

Table 8. *Level of students' cognitive skills in terms of Logical reasoning*

STATEMENTS	**MEAN**	**SD**	**REMARKS**
See differences between observation and interferences.	4.78	0.46	Strongly Agree
Make logical conclusions by thinking in conditional statements.	4.73	0.53	Strongly Agree
Apply knowledge in real-life situations and real-like environment.	4.62	0.53	Strongly Agree
Recognize the situation and capable of reasoning out with own opinion.	4.53	0.60	Strongly Agree
Formulate answers that are suitable for the questions.	4.62	0.56	Strongly Agree
Weighted Mean	4.65		
SD	0.28		
Verbal Interpretation	Very Great Extent		

Table 8 exemplifies the level of students' cognitive skills in terms of Logical reasoning

With the highest mean score *(M=4.78, SD=0.46)* of Logical reasoning, the students s*ee differences between observation and interferences*. With a remarked also of Strongly Agree, the teacher r*ecognizes the situation and capable of reasoning out with own opinion* and received the lowest mean score of responses with *(M=4.53, SD=0.60)*.

The level of students' cognitive skills in terms of Logical reasoning reached a weighted mean score

of 4.65 and a standard deviation of 0.28 and was Very Great Extent among the respondents.

The data gathered suggest that students exhibit strong cognitive skills in logical reasoning, particularly in seeing differences between observation and inferences. Although recognizing situations and reasoning out with their own opinions received slightly lower scores, respondents still strongly agreed on the proficiency of students in logical reasoning overall. This indicates a high level of effectiveness in students' logical reasoning abilities.

Table 9. *Level of students' creative thinking skills in terms of Analyzing*

STATEMENTS	**MEAN**	**SD**	**REMARKS**
Understand and solve problems using the information available.	4.75	0.44	Strongly Agree
Evaluate information from various sources and identify its differences.	4.60	0.56	Strongly Agree
Identify patterns and trends, and state own perceptions regarding on it.	4.67	0.51	Strongly Agree
Deconstruct information into smaller categories and draw conclusions.	4.64	0.56	Strongly Agree
Make own recommendations and appropriate information about the situations.	4.73	0.45	Strongly Agree
Weighted Mean	4.68		
SD	0.22		
Verbal Interpretation	Very Grea*t* Extent		

Table 9 demonstrates the level of students' creative thinking skills in terms of Analyzing

The Analyzing of the students yielded the highest mean score *(M=4.75, SD=0.44)* and u*nderstand and solve problems using the information available* and was remarked as Strongly Agree. However, with the lowest mean score of *(M=4.60, SD=0.56)* they e*valuate information from various sources and identify its differences* and pronounced as Strongly Agree.

The level of students' creative thinking skills in terms of Analyzing achieved a weighted mean score of 4.68 and a standard deviation of 0.22 and was Very Great Extent among the respondents.

This suggests that students excel in analyzing information to understand and solve problems, while they also demonstrate proficiency in evaluating information from various sources, albeit with slightly more variability. Overall, students' creative thinking skills in analyzing are perceived to be of a very high standard by respondents.

Table 10. *Level of students' creative thinking skills in terms of Problem solving*

STATEMENTS	**MEAN**	**SD**	**REMARKS**
Practice deliberate calm and demonstrate optimism in every problem.	4.73	0.49	Strongly Agree
Visualize the problem and develop positive mindset in solving the situations.	4.58	0.57	Strongly Agree
Solve problems using own understanding.	4.73	0.49	Strongly Agree
Revisit past problems and connect it on the new problems.	4.53	0.57	Strongly Agree
Recognize if there are some mistakes and take actions responsibly.	4.75	0.48	Strongly Agree

Weighted Mean	4.66
SD	0.27
Verbal Interpretation	Very Great Extent

Table 10 shows the level of students' creative thinking skills in terms of Problem solving

Recognizing if there are some mistakes and take actions responsibly" yielded the highest mean score *(M=4.75, SD=0.48)* for students' Problem solving. On the other hand, r*evisiting past problems and connect it on the new problems* received the lowest mean score of responses with *(M=4.53, SD=0.57)* yet was remarked as Strongly Agree.

The level of students' creative thinking skills in terms of Problem solving accomplished a weighted mean score of 4.66 and a standard deviation of 0.27 and was Very Great Extent among the respondents. The results suggests that students exhibit robust problem-solving skills, especially in terms of recognizing errors and assuming responsibility for rectifying them. This indicates a commendable level of self-awareness and accountability among students when encountering challenges or mistakes in problem-solving scenarios.

Table 11. *Level of students' creative thinking skills in terms of Organizing*

STATEMENTS	**MEAN**	**SD**	**REMARKS**
Evaluate own work and determine the room for improvement.	4.64	0.49	Strongly Agree
Establish daily routines which help to improve time management.	4.65	0.58	Strongly Agree
Prioritize things that are more important and give it more focus.	4.38	0.62	Strongly Agree
Divide task according to what is needed the most.	4.58	0.60	Strongly Agree
Manage time and energy for every assignment to effectively achieve goals.	4.58	0.53	Strongly Agree
Weighted Mean	4.57		
SD	0.25		
Verbal Interpretation	Very Great Extent		

Table 11 proves the level of students' creative thinking skills in terms of Organizing

With the highest mean score *(M=4.65, SD=0.58)* of Organizing, the students *established daily routines which help to improve time management*. With a remarked also of Strongly Agree, the students, p*rioritizes things that are more important and give it more focus* and received the lowest mean score of responses with *(M=4.38, SD=0.62)*.

The level of students' creative thinking skills in terms of Organizing conquered a weighted mean score of 4.57 and a standard deviation of 0.25 and was Very Great Extent among the respondents. This indicates that students demonstrate strong creative thinking skills in organizing tasks, particularly in establishing daily routines to improve time management. While prioritizing tasks based on importance and giving them more focus also received a positive rating, there may be some variability in students' ability to do so effectively. However, overall, students' creative thinking skills in organizing are perceived to be of a very high standard by respondents.

Table 12. *Level of students' creative thinking skills in terms of Lateral thinking*

STATEMENTS	**MEAN**	**SD**	**REMARKS**
Aware of the surroundings and the learning	4.67	0.55	Strongly Agree

environment that lived in.			
Expose self in a random situation which enables to go out in a comfort zone.	4.58	0.63	Strongly Agree
Look for different ways to solve problems.	4.38	0.68	Strongly Agree
Be open to different lines of thought.	4.42	0.69	Strongly Agree
Turn a provocative situation into something useful.	4.53	0.54	Strongly Agree
Weighted Mean	4.52		
SD	0.25		
Verbal Interpretation	Very Grea*t* Extent		

Table 12 explains the level of students' creative thinking skills in terms of Lateral thinking

The students Strongly Agreed yielding the highest mean score *(M=4.67, SD=0.55)* the Lateral thinking is *aware of the surroundings and the learning environment that lived in*" And they l*ook for different ways to solve problems* receiving the lowest mean score of responses with *(M=4.38, SD=0.68).*

The level of students' creative thinking skills in terms of Lateral thinking got a weighted mean score of 4.52 and a standard deviation of 0.25 and was Very Great Extent among the respondents.

This explains that students demonstrate strong creative thinking skills in lateral thinking, particularly in their awareness of their surroundings and learning environment. While actively seeking different problem-solving approaches also received positive ratings, there may be some variability in students' ability to do so effectively. However, overall, students' creative thinking skills in lateral thinking are perceived to be of a very high standard by respondents.

Table 13. *Level of student's performance in formative and summative test in terms of analyzing*

Score	Formative test		Summative test		**Descriptive Equivalent**
	f	**%**	**f**	**%**	
9 - 10	0	*0.00*	10	*18.18*	Outstanding
7 - 8	1	*1.82*	32	*58.18*	Very Satisfactory
5 - 6	26	*47.27*	13	*23.64*	Satisfactory
3 - 4	25	*45.46*	0	*0.00*	Fairly Satisfactory
0 - 2	3	*5.45*	0	*0.00*	Did not meet Expectation
Total	**55**	**100**	**55**	**100**	
Weighted Mean	4.33		7.42		
SD					
Verbal Interpretation	1.17		1.21		
	Fairly Satisfactory		*Very Satisfactory*		

Table 13 presents the level of student's performance in formative and summative test in terms of analyzing. For formative test, out of total number of fifty-five respondents *"5 to 6*" received the highest frequency of twenty-six (26) or 47.27% of the total population with descriptive equivalent of *Satisfactory*. While the scores *"7 to 8*" received the lowest frequency of one (1) or 1.82% of the total population with descriptive equivalent of *Very Satisfactory*. With a *(Weighted Mean = 4.33, SD = 1.17)* it shows that the level of student's performance in formative test in terms of analyzing has a descriptive equivalent of *Fairly Satisfactory.*

For summative test, out of total number of fifty-five respondents *"7 to 8*" received the highest frequency of thirty-two (32) or 58.18% of the total population with descriptive equivalent of *Very*

Satisfactory. While the scores *"9 to 10"* received the lowest frequency of ten (10) or 18.18% of the total population with descriptive equivalent of *Outstanding*. With a *(Weighted Mean = 7.42, SD = 1.21)* it shows that the level of student's performance in summative test in terms of analyzing has a descriptive equivalent of *Very Satisfactory.*

This explains that the relationship between formative and summative assessments demonstrates the dynamic nature of student learning. It showcases the effectiveness of educational practices in fostering growth, development, and mastery of analyzing skills over time, ultimately leading to positive learning outcomes.

Table 14. *Level of student's performance in formative and summative test in terms of problem solving*

Score	Formative test		Summative test		**Descriptive Equivalent**
	f	**%**	**f**	**%**	
9 - 10	0	*0.00*	10	*18.18*	Outstanding
7 - 8	0	*0.00*	34	*61.82*	Very Satisfactory
5 - 6	24	*43.64*	11	*20.00*	Satisfactory
3 - 4	30	*54.55*	0	*0.00*	Fairly Satisfactory
0 - 2	1	*1.82*	0	*0.00*	Did not meet Expectation
Total	**55**	**100**	**55**	**100**	
Weighted Mean	4.35		7.44		
SD	0.95		1.08		
Verbal Interpretation	*Fairly Satisfactory*		*Very Satisfactory*		

Table 14 presents the level of student's performance in formative and summative test in terms of problem solving. For formative test, out of total number of fifty-five respondents *"3 to 4"* received the highest frequency of thirty (30) or 54.55% of the total population with descriptive equivalent of *Fairly Satisfactory*. While the scores *"0 to 2"* received the lowest frequency of one (1) or 1.82% of the total population with descriptive equivalent of *Did not meet Expectation*. With a *(Weighted Mean = 4.35, SD = 0.95)* it shows that the level of student's performance in formative test in terms of problem solving has a descriptive equivalent of *Fairly Satisfactory.*

For summative test, out of total number of fifty-five respondents *"7 to 8"* received the highest frequency of thirty-four (34) or 61.82% of the total This indicates an improvement in student performance from the formative to the summative assessment, with the majority of students achieving satisfactory to very satisfactory scores in both tests.

Table 15. *Level of student's performance in formative and summative test in terms of organizing*

Score	Formative test		Summative test		**Descriptive Equivalent**
	f	**%**	**f**	**%**	
9 - 10	0	*0.00*	10	*18.18*	Outstanding
7 - 8	1	*1.82*	27	*49.09*	Very Satisfactory
5 - 6	22	*40.00*	18	*32.73*	Satisfactory
3 - 4	29	*52.73*	0	*0.00*	Fairly Satisfactory
0 - 2	3	*5.45*	0	*0.00*	Did not meet Expectation
Total	**55**	**100**	**55**	**100**	
Weighted Mean	4.18		7.33		

SD	1.11	1.28
Verbal Interpretation	*Fairly Satisfactory*	*Very Satisfactory*

Table 15 presents the level of student's performance in formative and summative test in terms of organizing. For formative test, out of total number of fifty-five respondents *"3 to 4*" received the highest frequency of twenty-nine (29) or 52.73% of the total population with descriptive equivalent of *Fairly Satisfactory*. While the scores *"7 to 8*" received the lowest frequency of one (1) or 1.82% of the total population with descriptive equivalent of *Very Satisfactory*. With a *(Weighted Mean = 4.18, SD = 1.11)* it shows that the level of student's performance in formative test in terms of organizing has a descriptive equivalent of *Fairly Satisfactory.*

For summative test, out of total number of fifty-five respondents *"7 to 8*" received the highest frequency of twenty-seven (27) or 49.09% of the total population with descriptive equivalent of *Very Satisfactory*. While the scores *"9 to 10*" received the lowest frequency of ten (10) or 18.18% of the total population with descriptive equivalent of *Outstanding*. With a *(Weighted Mean = 7.33, SD = 1.08)* it shows that the level of student's performance in summative test in terms of organizing has a descriptive equivalent of *Very Satisfactory.*

This study's evaluation shows that both formative and summative assessments indicate that students generally performed well in terms of organizing skills, with a majority achieving fairly satisfactory to very satisfactory scores. The results suggest a consistent level of performance across assessments, with some students demonstrating exceptional proficiency in the summative test. Overall, the data reflects positively on students' abilities to organize information effectively.

Table 16. *Level of student's performance in formative and summative test in terms of lateral thinking*

Score	Formative test		Summative test		**Descriptive Equivalent**
	f	**%**	**f**	**%**	
9 - 10	0	*0.00*	10	*18.18*	Outstanding
7 - 8	2	*3.64*	33	*60.00*	Very Satisfactory
5 - 6	17	*30.91*	12	*21.82*	Satisfactory
3 - 4	34	*61.82*	0	*0.00*	Fairly Satisfactory
0 - 2	2	*3.64*	0	*0.00*	Did not meet Expectation
Total	**55**	**100**	**55**	**100**	
Weighted Mean	4.16		7.38		
SD	1.15		1.25		
Verbal Interpretation	*Fairly Satisfactory*		*Very Satisfactory*		

Table 16 presents the level of student's performance in formative and summative test in terms of lateral thinking. For formative test, out of total number of fifty-five respondents *"3 to 4*" received the highest frequency of thirty-four (34) or 61.82% of the total population with descriptive equivalent of *Fairly Satisfactory*. While the scores *"7 to 8*" and *"0 to 2*" received the lowest frequency of two (2) or 3.64% of the total population with descriptive equivalent of *Very Satisfactory and Did not meet Expectation*. With a *(Weighted Mean = 4.16, SD = 1.15)* it shows that the level of student's performance in formative test in terms of lateral thinking has a descriptive equivalent of *Fairly Satisfactory.*

For summative test, out of total number of fifty-five respondents *"7 to 8*" received the highest frequency of thirty-three (33) or 60.00% of the total population with descriptive equivalent of *Very Satisfactory*. While the scores *"9 to 10*" received the lowest frequency of ten (10) or 18.18% of the total population with descriptive equivalent of *Outstanding*. With a *(Weighted Mean = 7.38, SD = 1.25)* it shows

that the level of student's performance in summative test in terms of lateral thinking has a descriptive equivalent of *Very Satisfactory.*

Above data indicates a generally positive trend in student performance in both formative and summative assessments concerning lateral thinking skills. While most students demonstrate fairly satisfactory to very satisfactory levels of proficiency, there are also instances of outstanding performance, particularly in the summative assessment. This suggests that students have developed and applied lateral thinking skills effectively, with some showcasing exceptional aptitude in this area.

Table 17. *Test of Difference between the student creative thinking skill before and after utilization of multiple representation approach*

Utilization of multiple representation approach	Before		After		Mean Difference	95% Confidence Interval of Difference		t	df	Sig (2-tailed)
	Mn	**SD**	**Mn**	**SD**		**L**	**U**			
analyzing	4.33	1.17	7.42	1.21	3.09	4.02	6.21	9.36	53	0.000
problem solving	4.35	0.95	7.44	1.08	3.09	4.85	7.57	9.16	53	0.000
organizing	4.18	1.11	7.33	1.28	3.15	3.44	5.69	8.13	53	0.000
lateral thinking	4.16	1.15	7.38	1.25	3.22	3.45	5.43	9.02	53	0.000

*Legend: *Significant at 0.05*

Revealed in Table 17 is the test of difference between the student creative thinking skill before and after utilization of multiple representation approach. Data obtained through a paired t-test indicated that the increase in the scores in *performance* is significant ($p < 0.05$).

This implies that the students performed better after utilization of multiple representation approach. Their level of creative thinking skill has significantly improved from apprentice to proficient level. Findings also indicated that cognitive skills are effective methods in enhancing the creative thinking skill of the students. Using multiple representation approach in enhancing the creative thinking skill improved because they learned according to cognitive skills. The student's ability from remembering level improved to reasoning skills where he/she can analyze, problem solving, organizing and lateral thinking. It could be implied from the results that if the teachers conscientiously use multiple representation approach in teaching science, then critical thinking skills of the students would be enhanced, thus their performance in science be improved.

The results suggest that students' performance improved notably after the utilization of the multiple representation approach. Their creative thinking skills advanced significantly from apprentice to proficient levels. Additionally, the findings highlighted the effectiveness of cognitive skills in enhancing students' creative thinking abilities. By employing the multiple representation approach, students learned according to cognitive skills, transitioning from basic remembering to higher-order thinking abilities such as analysis, problem-solving, organizing, and lateral thinking.

Consequently, this improvement in critical thinking skills may positively impact students' overall performance in science subjects. In essence, integrating multiple representation techniques into teaching methodologies can foster a deeper understanding of scientific concepts and promote the development of advanced cognitive skills, ultimately contributing to improved academic achievement in science.

Table 18. *Single Analysis on the utilization of multiple representation approach on students' cognitive skills*

Perception	**B**	**SE**	**β**	**t**	**p**
Constant	3.67	1.195		3.071*	0.003
Task assignment		0.119	0.298	2.513*	0.015
ICT integration		0.113	-0.01	-0.092	0.927
Investigation		0.116	-0.07	-0.6	0.551
Use of Manipulatives & Non-Manipulatives		0.136	0.256	1.88	0.066
Modeling		0.104	-0.262	-2.507	0.016
R-squared			.21		
Adjusted R-squared			.13		
Standard Error of the Estimate		.204			
F(5, 49)				2.608*	.004
Memory Capacity	**B**	**SE**	**β**	**t**	**p**
Constant	3.545	1.348		2.63*	0.011
Task assignment		0.134	0.566	4.232*	0.000
ICT integration		0.127	0.104	0.821	0.416
Investigation		0.131	-0.084	-0.642	0.524
Use of Manipulatives & Non-Manipulatives		0.154	-0.186	-1.213	0.231
Modeling		0.118	-0.143	-1.214	0.231
R-squared			.313		
Adjusted R-squared			.243		
Standard Error of the Estimate		.231			
F(5, 49)				4.459*	.000
Logical Reasoning	**B**	**SE**	**β**	**t**	**p**
Constant	0.175	1.4		0.125	0.901
Task assignment		0.139	-0.033	-0.238	0.813
ICT integration		0.132	0.523	3.965*	0.000
Investigation		0.136	0.104	0.76	0.451
Use of Manipulatives & Non-Manipulatives		0.159	0.141	0.884	0.381
Modeling		0.122	0.249	2.032*	0.048
R-squared			.331		
Adjusted R-squared			.263		
Standard Error of the Estimate		.239			
F(5, 49)				4.851*	.000

*p < 0.05

The table presents the results of a single analysis examining the effect of students' cognitive skills and utilization of multiple representation approach. The regression model explains 21.00% for Perception, 31.30% for Memory Capacity and 33.10% for Logical Reasoning of the variance in students' cognitive skills (R-squared = 0.21, 0.313, 0.331). *Task assignment* has a significant positive relationship with students' cognitive skills for Perception (β = 0.298, p < 0.001), for Memory Capacity (β = 0.566, p < 0.001), indicating that higher *Task assignment* is associated with lower cognitive skills. On the other hand, *ICT integration and Modeling* has a significant positive relationship with students' cognitive skills as to Logical Reasoning (β = 0.523, β = 0.249 p < 0.001),, indicating that higher *ICT integration and Modeling* is associated with lower cognitive skills.

The F-test of the overall model is significant (F(5, 49) = 2.608, 4.459, 4.851, p < 0.001), indicating that the regression model is a good fit for the data. The standard error of the estimate is 2.04, 2.31, 2.09, reflecting the average deviation between observed and predicted students' cognitive skills.

Table 19. *Multiple Analysis on the utilization of multiple representation approach on students' creative thinking skills*

Students' creative thinking skills	**B**	**SE**	**β**	**t**	**p**
Constant	2.887	.649		4.447*	.000
Task assignment		.064	.114	1.769	.083
ICT integration		.061	-.039	-.634	.529
Investigation		.063	.291	4.604*	.000
Use of Manipulatives & Non-Manipulatives		.074	-.019	-.262	.795
Modeling		.057	.03	.534	.596
R-squared			.389		
Adjusted R-squared			.327		
Standard Error of the Estimate		.111			
F(5, 49)				6.236*	.000

*p < 0.05

The table presents the results of a multiple regression analysis examining the effect of students' creative thinking skills and utilization of multiple representation approach. The regression model explains 38.9% of the variance in students' creative thinking skills (R-squared = 0.389). *Investigation* has a significant positive relationship with students' creative thinking skills ($\beta = 0.291$, $p < 0.001$), indicating that higher *Investigation* is associated with lower creative thinking skills.

The F-test of the overall model is significant ($F(5, 49) = 6.236$, $p < 0.001$), indicating that the regression model is a good fit for the data. The standard error of the estimate is 1.11, reflecting the average deviation between observed and predicted students' creative thinking skills.

From the findings above, we can infer that at 0.05 level of significance, the null hypothesis "*Is there a significant effect of utilization of multiple representation approach to the students' cognitive skills*" is rejected. Thus, the alternative hypothesis should be accepted, which incites that there is a significant effect between them.

The study underscores the importance of both investigation approach and multiple representation techniques in fostering students' creative thinking skills. By encouraging active inquiry and utilizing varied representations of content, educators can effectively promote creativity and enhance students' cognitive abilities.

4. Conclusion and Recommendation

On the basis of the foregoing findings, the following conclusion was drawn.

The study shows that there is a significance level on the students' level of creative thinking skills before and after the utilization of multiple representation approach, thus, rejecting the first null hypothesis.

The study shows the level of utilization of multiple representation approach on students' cognitive skills has significant relationship Thus, the researcher therefore concludes that the research hypotheses stating that the level of utilization of multiple representation approach has no significant effect on students' cognitive skills is rejected. The second hypothesis result the level of utilization of multiple representation approach on students' on creative thinking skills has significant. Thus, the researcher therefore concludes that the research hypotheses stating that the level of utilization of multiple representation approach has no significant effect on students' creative thinking skills is rejected. Thus, the alternative should be accepted which incites that there is a significant relationship between them.

Based on the drawn conclusions resulted to the following recommendations:

1. It is recommended that students actively engage with the findings of this study, as it offers valuable insights into their own learning journey within the realm of science. By understanding their strengths and weaknesses, they can tailor their study approaches accordingly. Furthermore, the identification of suitable learning materials will empower them to optimize their learning processes effectively.
2. This study suggests that educators should seize the opportunity to enhance their teaching strategies, particularly in utilizing multiple representations in science education. By discerning the factors that influence student learning, teachers can refine their instructional methods and foster the development of students' cognitive and creative thinking skills. This study serves as a foundational resource for educators aiming to implement the multiple representation approach in their classrooms.
3. It is recommended that schools recognize the significance of employing multiple representation approaches in teaching practices. Incorporating programs and activities aligned with this approach will foster collaborative and effective learning environments, ultimately benefiting both students and educators. Embracing this methodology can enhance overall educational outcomes and promote a deeper understanding of scientific concepts among students.

References:

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