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Visual Representations in Teaching Mathematics

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ABSTRACT

Visual representations are used in mathematics to help students solve problems or understand abstract ideas. Most of the students hate Mathematics because it's hard for them to solve problems. In order for students to start loving Mathematics, teachers should find ways to make their lessons easier, simpler, and at the same time creative for their students. The study aimed to determine the extent of utilization of visual representations in teaching mathematics, such as diagrams, computer graphics, and physical models, in relation to the students' beliefs, views, and preference level in solving problems. This study utilized the descriptive method with the aid of the survey questionnaire instrument for data gathering. *The mathematics instructors often utilized the visual representations as to diagrams, computer graphics, and physical models and it was significantly correlated to the students' views, beliefs, and preference level in solving math problems.* Mainstream use of other visual representations to determine its effectiveness on students' academic performance.

Keywords: *Visual representations, Diagrams, computer graphics and Physical model*

1. Introduction

Students can access abstract mathematical concepts effectively through visual representations. It's important to be able to abstract the main aspects of a situation in order to successfully use models and diagrams in mathematical thinking. Some aspects of reality are modeled and illustrated in diagrams. A large portion of the abstracting happens throughout the diagram or model creation phase. As a result, when a young child sketches a stick figure of a person or a rectangle representing a window, they are abstracting from a far more complex reality. Making a model or diagram to depict a mathematical issue by a student involves an analogous abstraction process. Students must use abstraction techniques when interpreting models and diagrams that the teacher uses to explain various ideas.

Students have historically struggled with learning how to solve mathematical problems, and mathematical development has long placed a strong emphasis on this subject. Successful problem solvers invest more time in the analysis of an issue and look for all possible solutions. Carden and Cline (2015) assert that encouraging visual imagery/visualization as a problem-solving technique would be beneficial for all students, even those who do not find word problems difficult. The likelihood that successful students will continue to succeed as they encounter more challenging challenges will improve with the use of visualization techniques. Children should learn these techniques at a young age and should practice them often.

The primary reason why mathematics is taught in schools from elementary to college is because it is crucial to our daily life. Because it's challenging for them to answer issues, the majority of kids detest mathematics. Teachers should look for ways to make their classes simpler, easier, and more engaging for their pupils in order to get them to love mathematics. The use of visual representation is one method that can be utilized to teach mathematics. It is any method for producing pictures, diagrams, or animations to convey a point. Since the beginning of time, people have used visualization to convey both abstract and concrete ideas ("Visualization (graphics)," 2023).

To be able to work on unique issues needing an adaptation of well-known solution methods as well as solve well-known problems, mathematical solution techniques are a crucial requirement. (Sean Whiteley, 2011). When discussing visual representation in mathematics, you can be referring to representing information in your head with an image or to representing information on a page with a diagram or chart. Fortunately, academics have concentrated on assisting pupils in strengthening their internal and exterior visual representation. (e.g., Zhang et al., 2012). In order to enhance student learning in mathematics for all sorts of issues, it is crucial for students to develop both internal and external visual representation strategies.

In order to help pupils understand how to solve challenging problems more easily, it is crucial to incorporate visual aids when teaching mathematics. Visual representation comprises diagrams, computer images, and physical models that will boost the students' ability to think critically, solve problems, and show an interest in the course.Since they can help highlight important information and omit information that is not necessary for solving a problem, diagrams are beneficial for kids with learning impairments. This can make fixing problems easier. (Kolloffel et al., 2009).Diagrams are visual displays that use the important information in mathematical problems such as tree diagram, Venn diagram, and etc. They are typically used to **demonstrate how the important information is related,** and can be used to organize information as well as to compute the answer to a problem. A common type of diagram might be a drawing that a student creates to represent the objects within a word problem.

A technique for digitally synthesizing and altering visual content is computer graphics. Even while the phrase is frequently used to describe the study of three-dimensional computer graphics, it also includes image processing and two-dimensional graphics. It is a form of computer programming that uses images to be drawn on computer screens. It entails calculations, data production, and manipulation. In other words, computer graphics can be thought of as a tool for creating and modifying images. A physical model is a scaled-down or

enlarged physical representation of an item. Physical models provide visualization of information about the thing they represent through close examination of the model.

More encouraging findings were obtained in a more recent meta-analysis by Gersten et al. (2009). The use of visual representations considerably benefited children, according to one study, which focused on arithmetic instruction for students with learning difficulties. The present study, therefore, contributes to the body of knowledge on this pedagogical method to teaching mathematics because of the mixed nature of these results and the dearth of empirical studies especially examining the use of visual representations in the primary school context.

This study determined the extent of utilization of visual representations by the instructors and its relationship to the student's views, beliefs and preference level in solving mathematics problems. It also affects the students on how they can picture out the differences and relationships of data, and give them simpler way in understanding the topic. The use of this technique, they will know on how to solve abstract problems in an easier way. Specifically, it sought to answer the following questions:

1. What is the extent of utilization of visual representations used by the instructor in solving mathematics problem in terms of:
    a. Diagrams,
    b. Computer graphics, and
    c. Physical model?
2. What is the students' views about whether their instructors use on visual representations sufficiently and clearly in solving verbal mathematical problems?
3. What is the students' views on how visual representations will be formed in solving verbal mathematical problems?
4. What is the students' beliefs in the usefulness of the use of visual representations in the process of solving verbal problems?
5. What is the students' preference levels for visual representations formed by the instructors for solving mathematical problem?
6. Is there a significant correlation between the instructor's extent of utilization of visual representations and the students' views, beliefs and preference level in solving mathematics problem?

2. RESEARCH METHOD

This study utilized the descriptive method with the aid of the survey questionnaire instrument for data gathering in the instructors' extent of utilization of the visual representations and to the students' views, beliefs and preference level in solving mathematical problems. The researchers used the non- probability sampling technique, specifically the purposive sampling, which was applied to those who were able to take, in consideration to their availability at the time that the data gathering procedure was conducted. There were only 9 math instructors and 30 mathematics students. The instrument used in this study was the adapted questionnaire from the study of Gursel Guler and Alper Citas,2011, "The Visual representation usage levels of math teachers and students in solving verbal problems.

The goal of this study was to enhance and strengthen students' problem-solving skills, their capacity to communicate with teachers and other students, and their conceptual knowledge. The significance of these techniques is that they can make abstract concepts more understandable and enhance students' interest and motivation to learn.

The degree to which visual aids were used in math instruction depended on how engaged the students were with the material. They can come across methods that can sharpen their critical thinking, make it easier for them to understand mathematical ideas, and inspire a passion of mathematics.

Weighted mean was used to determine the extent of utilization of visual representations used by the mathematics instructors and the following range and description were used:

Scale	Mean Range	Qualitative Description
5	4.21 – 5.00	always utilized
4	3.41 – 4.20	often utilized
3	2.61 – 3.40	sometimes utilized
2	1.81 – 2.60	seldom utilized
1	1.00 – 1.80	never utilized

In determining the students' beliefs, views and preference level in solving math problems the following range were used:

Scale	Mean Range	Qualitative Description
5	4.21 – 5.00	always
4	3.41 – 4.20	often
3	2.61 – 3.40	sometimes
2	1.81 – 2.60	seldom
1	1.00 – 1.80	never

Chi-square was used to determine the significant correlation of the extent of utilization of visual representation in teaching mathematics to the students' views, beliefs and preference level in solving mathematical problem.

3. Results and Discussions

Table 2 Extent of Utilization of Visual Representation in Teaching Mathematics as to "Diagrams"

Diagrams	Weighted mean	Qualitative Description
1. Presents lessons in a form of diagrams.	3.33	Seldom Utilized
2. Utilizes diagrams in giving seat works or exercises.	3.47	Often Utilized
3. Includes diagrams in giving a quiz.	3.44	Often Utilized

4. Use diagrams in giving a quarterly examination.	3.39	Seldom Utilized
Grand Total	3.41	Often Utilized

The extent of utilization of visual representation as to “diagrams” in teaching mathematics obtained the grand total weighted mean value of 3.41 with a verbal description of “often utilized”. This indicates that the diagrams are often used by math instructors in presenting the lessons, giving assignments, seat works, exercises and quarterly examinations. Diagrams are useful for students with learning difficulties, according to Kolloffel et al. (2009), as they can help highlight important information and omit information that is not relevant for solving a problem. This makes it easier to solve problems.

Table 2 Extent of Utilization of Visual Representation in Teaching Mathematics as to “Computer graphics”

Computer graphics	Weighted mean	Qualitative Description
1. Uses computer in discussing the lesson.	3.63	Often Utilized
2. Let the students to execute the lesson in the computer.	3.39	Sometimes Utilized
3. Applying computer in solving problems.	3.49	Often Utilized
4. Uses computer in giving exercises & assignments.	3.34	Sometimes Utilized
Grand Total	**3.46**	**Often Utilized**

The extent of utilization of “computer graphics” as visual representation in teaching mathematics obtained the grand total weighted mean value of 3.46 with a verbal description of “often utilized”. This means that the math instructors often utilized the computer graphics in teaching. The power of computers and other technology, when utilized properly, can "evoke dream in the minds of visionary educators who saw endless potential for altering traditional notions of teaching and learning" is stated by Johnson (2003). (p. 2).

Table 3 Extent of Utilization of Visual Representation in Teaching Mathematics as to “Physical Model”

Physical Model	Weighted mean	Qualitative Description
1. Uses the mathematical device in discussing the subject matter.	3.41	Often Utilized
2. Uses image to presents a lesson.	3.44	Often Utilized

3. Discusses the lessons by allowing the students to identify the accurate mathematical tools that can be applied.	3.43	Often Utilized
4. Presents lessons by using the real objects.	3.5	Often Utilized
5. Uses figures in presenting a topic.	3.33	Often Utilized
Grand Total	**3.42**	**Often Utilized**

The extent of utilization of “physical models” by the math instructors obtained the grand total weighted mean value of 3.42, which describes as “often utilized”. This implies that mostly the math instructors are using physical models in teaching the subject. Higher-level math and scientific courses increasingly require visualization and spatial reasoning techniques to solve issues, making visual representation a crucial skill. (Zhang,et. al, 2012). Additionally, it is only another tactic that students might employ when determining the optimal solution to a mathematical problem. When teaching, teachers should create explicit linkages between real-world problems and their mathematical equivalents in order to help students develop their ability to "model with mathematics."

Table 4 Students’ views about whether their instructors use visual representations sufficiently and clearly in solving verbal mathematical problems

Statements	Weighted Mean	Verbal Description
1. I can focus on the images, figures and the graphics which my instructor’s use in the classroom while solving mathematical problems.	4.46	Always
2. My instructor uses images, figures and graphics while explaining how to solve mathematical problems	4.54	Often
3.The images, figures and the graphics, which are used by our instructor for understanding the solution of mathematical problems, help me to solve problems.	4.8	Always
Total	**4.6**	**Always**

The students’ views about whether their instructors use visual representations sufficiently and clearly in solving verbal mathematical problems obtained the weighted mean of 3.94 which describes as “often”. This implies that the students think that using visual representations in problem solving is a good way of learning and that it increases the learning success. Because more advanced math and scientific courses depend on visualization and spatial reasoning to solve issues, visual representation is a crucial skill. (Zhang,et. al, 2012). It is merely another tactic that students might employ when determining the most effective solution to a mathematical issue. Making links between real-world circumstances and their mathematical equivalents during education is important for teachers who want to help students develop their ability to "model with mathematics."

Table 5 Students' views on how visual representations will be formed in solving verbal mathematical problems.

Statements	Weighted Mean	Verbal Description
1. It is easy for me how to create images, figures and graphics in mathematical problem solving.	4.33	Always
2. Using images, figures and graphics in solving mathematical problems is boring for me.	4.6	Always
3. It is difficult for me to create an image, figure or graphic in solving mathematical problems.	4.58	Always
4. I can identify which kind of image, figure or graphic that I should utilize in solving various mathematical problems.	3.83	Often
Total	**4.33**	**Always**

The students' views on how visual representations will be formed in solving verbal mathematical problems obtained the grand total weighted mean of 4.33 which describes as "always". It indicates that teaching method that is directed to create this kind of visual representations in the process of problem solving is important for students. This supports the idea that visual representations can be the most important instrument for any kind of problem in all fields of mathematics including the situations, which do not require geometric evidence. Diagrams are effective for students with learning disabilities as they can help **highlight essential information and leave out information that is not necessary** for solving a problem. This can simplify the problem-solving process (Kolloffel et al., 2009).

Table 6 Students' beliefs in the usefulness of the use of visual representations in the process of solving verbal problems.

Statements	Weighted Mean	Verbal Description
1. I utilize images, figures and graphics in solving mathematical problems.	4.53	Always
2. I use the images, figures and the graphics given in books in solving similar mathematical problems.	3.67	Often
3. I think that using figures, images and graphics is useful for an efficient mathematical problem solving.	4.27	Always
4. I think that using figures, images and graphics in solving mathematical problems is a good way to learn.	3.96	Often
5. I think that using figures, images and graphics can be useful in understanding how mathematical problems can be solved.	3.17	Sometimes
Total	**3.92**	**Often**

The students' beliefs in the usefulness of the use of visual representations in the process of solving verbal problems obtained the grand total weighted mean of 3.92, which describes as "often". This rate shows that the students have a strong belief that using visual representation in problem solving would be beneficial. This implies that the use of visual representations is frequently more successful and the students have positive beliefs about the use of visual representations in solving verbal mathematical problems. A more recent meta-analysis by Gersten et al. (2009) found more positive results. This study looked specifically at mathematics instruction for students with learning disabilities and found that the use of visual representations significantly benefitted students. Due to the mixed nature of these results and the lack of empirical studies specifically looking at the use of visual representations in the primary school context, the present study therefore contributes to the research on this pedagogical approach to teaching mathematics.

Table 7 The preference levels of the students for visual representations formed by the instructors for solving mathematical problem

Statements	Weighted Mean	Verbal Description
1. In solving problems, I try to use the diagrams, images, figures and graphics, which are created by my teachers in problem solving in math.	3.82	Often
2. In order to solve mathematical problems, I use the method that my teacher uses in the same way for the other similar questions.	3.74	Often
3. In solving problems, I am directed on how to answer through the use of the diagrams, images, figures and graphics.	4.83	Always
Total	**4.13**	**Often**

The preference level of the students obtained the grand weighted mean of 4.13, which describes as "often". This rate shows that the students used the visual representations, which were formed by their teachers in problem solving in the solution of similar mathematical problems. It further implies on how they affected the solving strategies in use the visual representations in mathematical problems.

Table 8 Relationship between the Extent of Utilization of Visual Representation in Teaching Mathematics to the Students' views, beliefs and preference level in solving mathematical problem.

Variables	x^2-computed	p-value	Decision
Extent of Utilization of Visual Representation in Teaching Mathematics to the Students' views, beliefs and preference level in solving mathematical problem	0.454	0.013	Accept Ha

The p-value obtained is 0.013 which exceeded the 0.05 level of significance, this led to the rejection of the null hypothesis. This implies that there is a significant relationship between the extent of utilization of visual representations in teaching mathematics to the students' views, beliefs and preference level in solving mathematical problem. Visual representations have an important role in the making of the problem and in leading to the problem-solving method and it affects cognitive structures *Debrenti,* 2015.In other words, forming visual representations in making sense of the problem can be a key factor. According to this premise, the use of visual representation at the comprehension stage of the problem can be effective in the solving of the problem.

This demonstrates that the students are aware of the construction methods for pictures, figures, and graphics used in verbal problem solving. Although creating pictorial representations can cause problem solvers to focus on unimportant details, formal representations can play a more active role in problem solving. Since the formal representations better explain the spatial relationships, it increases the success at problem solving.According to Zang et. Al, 2012, states that the importance of visual representation can be seen in the growing usage of visualization and spatial thinking in higher-level math and scientific courses. Additionally, it is only another tactic that students might employ when determining the optimal solution to a mathematical problem.

Findings

1. Based on the results of the study, the extent of Utilization of Diagrams, computer graphics, and physical model as visual representations were often utilized.

2. There is a significant relationship between the extent of utilization of visual representations in teaching mathematics to the students' views, beliefs, and preference level in solving math problems.

5. Conclusion

The following conclusions were drawn from the findings of the study.

The mathematics instructors often utilize the visual representations as to diagrams, computer graphics, and physical models and it was significantly correlated to the students' views, beliefs, and preference level in solving math problems.

6. Recommendation

Based on the findings and conclusions, the following recommendations are hereby offered:

1. Mathematics instructors need to mainstream use of other visual representations to determine its effectiveness on students' academic performance

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