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HEURISTIC APPROACH IN ENHANCING THE PERFORMANCE OF STUDENTS IN GRADE 3 MATHEMATICS

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ABSTRACT

One of the most important and fundamental reasons for learning mathematics is the ability to solve word problems. Exposing students to various problem-solving strategies, such as the heuristic approach, can assist them in becoming expert problem solvers. The primary goal of this study was to determine the effect of a heuristic approach on improving students' problem-solving performance in Grade 3 Mathematics. In accordance with this, the researcher developed the hypothesis that was no significant difference between the pretest and posttest of students who used modular and online learning modes. It also revealed which of the five problem-solving strategies use the best. This study employed a quasi-experimental design with no control group. The researcher purposively selected two sections of Grade 3 students from Gatid Elementary School in the school year 2020-2021 as the two experimental groups; 14 students for online learning approach and 26 students for modular learning approach. Students who took part in the study completed likert-type surveys, content exams, and were interviewed individually. Participants in the online and modular learning approaches were selected based on Likert survey data and interview responses. A questionnaire checklist with a pretest and posttest was used to collect the necessary data from forty Grade 3 students at Gatid Elementary School in the Division of Laguna. Mean, Standard deviation, Parametric t-test and Cohens D were the statistical tools used. When integrating a heuristic approach in teaching problem solving, it was discovered that the learners did not have equal cognitive skills. This provided a medium effect on the improved performance of the students using modular. Furthermore, the heuristic approach had a small effect on the posttest performance of the two student groups.

INDEX TERMS: *Self Discovery, Find, Semantics, Decision making*

1. INTRODUCTION

The ability of a child to perform well in specific Math classes may vary depending on his specific areas of strength and weakness (Hodnett, 2014). So, the problem solvers must think critically and never give up easily; they must devise or implement a new strategy to solve the problem immediately. Learners' perceptions and problem-solving abilities vary.

One of the most intriguing and perplexing skills in Mathematics is word problem solving. Word problems in Math can be tricky and difficult to solve. Despite the fact that it is difficult and perplexing, it greatly aids in the development of the learner's critical thinking skills. Being a critical thinker boosts a learner's competitiveness and helps him/her become a true problem solver.

Math problems with ease is the so-called heuristic approach. Heuristic approach is a method of finding a solution that originates from the ancient Greek word 'eurisko', meaning to 'find', 'search' or 'discover' (Mulder, 2018). It is about using a practical method that does not necessarily need to be perfect.

The primary reason for studying Mathematics, as well as an important tool for assisting students in developing their thinking abilities, is to learn how to solve problems. Non-routine problems should be introduced to students in order to encourage them to use their metacognition abilities and to provide opportunities for them to develop their problem-solving skills.

Mathematical ability is improved by problem solving. It provides students with the tools they need to apply their math skills to both hypothetical and real-world problems. It is enjoyable to solve problems. It enables students to work at their own pace and choose how they will investigate the problem.

Students are frequently expected to be

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successful problem solvers despite the fact that there is no formal method of teaching problem solving to develop their skills. Teaching methods must be developed to assist students in learning mathematical problem solving rather than simply modeling how to solve specific problems. Teachers should also look into teaching strategies that help students learn the necessary skills for solving mathematical problems.

According to Krulik and Rudnick (1996), as cited by Yeo (2012), the use of heuristic approaches can be an effective tool for teaching mathematical problem solving.

1.1 Objectives of the Study

This study determined to determine how heuristic approach in problem solving can enhance problem solving skills and thereby improve the performance of Grade 3 Students in Mathematics.

2. LITERATURE REVIEW

According to Rufi'l (2015), heuristic learning strategy is a process of thinking and making that automatically process in a step by step that provides an explanation after a step has been mastered that should be applied along with all previous steps. Students can use strategy learning heuristics if they understand the composition and structure of cognitive operational processes related to knowledge application. A heuristic learning strategy is a process related to knowledge application. A heuristic learning strategy is a method of putting what you've learned into practice. It is analogous to a student seeing a world problem and automatically calculating the set of problems based on its step-by-step procedures by simply analyzing it.

In this regard, Maheshwari (2016) discussed how heuristic strategies improved students' self-learning abilities through the principle of activity and critical thinking abilities through the principle of logical thinking. He also stated that it can develop students' attitudes toward accepting truth only after verification through the principle of proceeding from the known to the unknown, as well as students' attitudes toward not accepting things on blind faith through the principle of purposeful experience. Thus, the main feature of this method is to ensure that every lesson is presented in front of students in the form of an inquiry, so that some definite things concerning curiosity have come to an end.

Meanwhile, Bristoll (2015) stated that heuristic strategies are not a formal problem solving model, but can be used as an alternative solution to problem solving where a perfect or optimal solution is not guaranteed. She also mentioned that heuristics are informal mental shortcuts that help students improve their problem-solving performance, which is important for survival. As a result, the majority of students use these strategies automatically to solve problems. This strategy is essentially a method of training students' minds on how to analyze a specific problem and find its correct solution; this strategy can be acquired in either a formal or informal manner.

Yalamova (2010), claimed that a heuristic approach to explaining the Black-Scholes option pricing model in undergraduate classes is described. The approach draws upon the method of protocol analysis to encourage students to “think a loud” so that their mental models can be surfaced.

Annie Grove-White (2010), stated that Heuristic approach promotes confidence, openness and trusts such that students speak up more and participate fully contributing to their peers as well as developing their own ability for self-reflection.

Norton-Meier, et al. (2013), pointed out that the heuristic approach is a curriculum innovation that replicates authentic Science investigations by supporting student critical thinking and problem-solving strategies through dialogue, reading and writing.

Hoon (2013), explained that heuristic approach is introduced as a tool to develop students’ mathematical thinking skills. Students who have strong belief of applying heuristic approach show better experience in identifying a mathematical problem.

Problem solving has traditionally been taught as a separate skill in the modern classroom. This study looked into the improvement of performance in mathematical problem solving using various strategies. Students were exposed to non-routine problems that pushed them to improve their problem-solving abilities. As a result, students become expert problem solvers who can use effective techniques to find solutions to problems.

There are numerous definitions of problem solving. Problem solving, according to Gurganous (2017), is the process by which students arrive at a solution to a problem. The process entails students thinking, reasoning, planning, and carrying out a plan to manipulate the initial problem in order to achieve their goal of finding the best solution. Implementing a problem-solving strategy necessitates strategies learned in Math class. It has always been a challenge for educators to devise appropriate strategies for teaching students how to solve problems. According to Erbas, A., and Okur, S. (2012), problem solving in mathematics is a challenging activity in which students deepen their understanding of various mathematical concepts by analyzing and synthesizing their knowledge. It is a process in which a student solves a problem by engaging in a variety of cognitive actions, each of which necessitates some

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knowledge and skills and some of which are not routine. This implies that in order to be successful problem solvers, students must learn how to regulate their own critical thinking skills. The most difficult part of problem solving is analyzing the problem and searching for a solution. This is why teachers teach students techniques and methods for analyzing problems, even though it may appear simple, it is a difficult task for them. Students must be trained to be analytical and logical thinkers through mathematical strategies or techniques in order to achieve a high level of understanding in mathematical concepts. As a result, they will gain a better understanding of mathematics, develop a love for the subject, and become a successful student. That being said, teaching problem solving builds students' self-confidence and self-esteem while also developing their creativity, persistence, and proactive minds, allowing them to make decisions independently and become responsible students in their lives.

Charles R. (2015), agreed that there are various strategies that students use to solve mathematical problems, and there is no single method that always leads to the answer. Students choose one strategy over another because they approach the problem in a different way, and there are numerous solution paths that allow them to reach the answer. The study's researchers encourage students to learn specific problem-solving strategies that will prepare them to achieve their goals in the future and mold them into problem-solving experts. A great problem solver can think of a good plan to solve a problem and determine whether or not it will be effective by analyzing the outcome. As a result, exposing students to various problem-solving strategies that lead to a solution improved their decision-making process.

According to Talpin (2015), students who are critical thinkers and problem solvers are considered 21st century learners. Thus, teachers should shape students' critical thinking abilities and turn them into problem-solving experts by exposing them to various problem-solving strategies. Students will benefit from problem-solving instructional strategies not only today, but also in the future. "If you teach a man to fish, he can fish for a lifetime," one proverb says. Similarly, if you teach a student how to solve a problem, they will be able to do so for the rest of their lives. To accomplish this, the researcher of this study wished to instill in each student the importance of strategies in solving word problems.

The above literatures were related to the present study, in a way that heuristic approach is a technique used to solve word problems that would develop mathematical skills.

Petti (2019) described "Make a picture or diagram" as the most powerful and flexible problem-solving strategy. Most of the time, picturing a problem is the key to helping students understand the problem and identify a solution.

"Drawing a picture", diagram or other type of visual representation is often a good starting point for solving all kinds of word problems. It is an "intermediate step between language-as-text and the symbolic language of mathematics" (Teacher Vision, 2018). By representing units of measurement and other objects visually, students can begin to think about the problem mathematically.

Maslen and Southern (2011), found that by "drawing", the brain's editing is somehow put on hold, thereby permitting one to see more fully and perhaps more realistically which means that by drawing, one learns to see.

Mynlieff, et al. (2014), stressed that there is no consensus in the literature on the definition of "drawing", and many terms (e.g., sketch, diagram, external representation, external model, visualization, illustration, picture) are used differently in different papers. We embrace an inclusive definition of drawing to encourage drawing-to-learn as a parallel endeavor to other pedagogical movements such as writing-to-learn.

Uesaka and Manalo (2011), claimed that "drawings" are a subset of the larger category, diagrams.

The above literatures were related to the present study due to the fact that Draw a Picture is one of the strategies used in problem solving by students.

"Guess and Check" is also a variable of this study. The authors below had their ideas related to the present study.

Novotna, et al, (2014), pointed out that "Guess and Check" is from the family of experimental strategies. Its principle is very simple, "we guess a solution, check it and make a new guess on the basis of the previous result."

The Bureau of Exceptional Education and Student Services (2010), placed that "Guess and Check" is a problem-solving strategy that students can use to solve mathematical problems by guessing the answer and then checking that the guess fits the condition of the problem.

Betany (2015), explained further that solving problems, check is a process that requires logic and an understanding of the question so that it can be done in a way that is organized and time saving. "This is a useful strategy when I'm are given the total and I'm are asked to find the kinds or number of things making up the total or when the questions asked for the value of two or more different kinds of things."

To begin, students should make a guess

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using what they know from the problem. This first guess can be anything at all, so long as it follows the criteria given. Then, once a guess is made, students can begin to make more educated guesses based on how close they are to the correct answer (Bethany, 2015).

Douthat (2012), emphasized that "the strategy for the method guess and check is to guess a solution and then plug the guess back into the problem to see if you get the correct answer. If the answer is too big or too small, make another guess that will get you closer to the goal and continue guessing until you arrive at the correct solution. The process might sound long but often you will find patterns that you can use to make better guesses along the way."

"Guess and Check", is a method of reaching a correct solution or satisfactory result by trying out various means until error is sufficiently reduced or eliminated (Free Dictionary) their students who have not been previously introduced to any method will naturally use "Guess-and-Check"

The above sets of literatures were related to the present study for the reason that Guess and Check is one of the strategies used in problem solving by students.

School Tutoring Academy or STA.com (2014), pointed out that one of the problem-solving strategies that is often used in Math is "looking for a pattern". Often when exploring problems, the student can notice a relationship between numbers. This relationship can help to solve the problem by shortening the number of steps it takes to get to a solution.

Patterns can help students who find Math difficult and uninspiring into understandable and visual (Mango Math, 2018). Helping them see how patterning can help them become better mathematicians.

Fryer, et al. (2016), shared that more longitudinal research has even conducted with longer time intervals and multiple measurements to track down developmental patterns in student learning patterns.

Coertjens, et al. (2013), found out that more advance statistical techniques have even used for data analysis investigating the constituent aspects of learning patterns and development of learning patterns over time.

Vanthournout, et al. (2014), discussed the differences and similarities between learning patterns and approaches to learning. Compared to related concepts, a learning pattern represents a more holistic notion.

According to Zusho (2017), some of concept used in the learning patterns framework was similar to key concepts in SRL models due to their common roots in early metacognition research. However, there are differences
between both models as well.

The above literatures were related to the present study, in a sense that Look for pattern is a strategy in problem solving.

Young (2009), said that a person learns by "trial and error" if he occasionally tries out new strategies, rejecting choices that are erroneous in the sense that they do not lead to higher payoffs.

According to Ridvan Ata (2016), it is by "trial and error", by experimentation that educators scaffold their understanding and engagement with virtual words. As being another motif of educators' involvement with the communities. "I sought to find out their motivation to engaging within virtual worlds other than the class activity requirement."

Cherry (2018), concluded that the "trial and error" approach to problem solving involves trying a number of different solutions and ruling out those that do not work. This approach can be a good option if one has a very limited number of options available

Psychestudy (2016), claimed that approaching "trial and error" strategy as the first method in an attempt to solve any problem can be highly time consuming.

Lui, et al. (2011) suggested that the students who perceived a flow experience state frequently applied trial and error, learning by example and analytical reasoning strategies to learn the computational problem-solving skills.

The above literatures were related to the present study, in a way "Trial and Error" is a strategy of problem solving which is trying different solutions until the problem is solved.

Ramful (2015) defined "working backwards" as a particularly useful method in problem-solving when the end result is known and one has to find the initial quantity.

Grobe (2015) added that "working backward" means that solution steps omitted from the end of the solution, which means that the learners start with solving the last step on their own. the strategy of undoing key elements in the problem in order to find the solution. Students should read the problem carefully and paraphrase if necessary, then solve the problem.

Katz, et al. (2016) stated that "working backwards" is a strategy that work well for this type of problem. It is particularly useful when trying to discover proofs. "Instead of starting from what you know and working toward what you want, start from what you want and ask yourself what you need in order to get there. Highly effective people start with the end in mind."

Nokes and Schum (2010), added that novices have been shown to use general problem-

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solving heuristic, such as means-ends analysis to wok backward from the problem goal. However, strategy use for both experts and novices critically depends on the relationship between prior knowledge and the task. Experts may also use general problem-solving methods and backward working strategies when solving very novel tasks in the domain.

The above sets of literatures were related to the present study, that "Working Backwards" was also one of the strategies in problem solving.

3. METHODOLOGY

The study used a quasi-experimental research design, specifically a pre-test and post-test design with students randomly assigned to be part of the study, to determine the effect of a heuristic approach on improving students' performance in Grade 3 Mathematics in terms of pretest and posttest. According to Thomas (2020), the goal is to establish a link between the independent and dependent variables. By controlling existing groups in analysis, the researcher was able to make use of them. It is frequently used to carry out and assess the efficacy of a treatment. Each group received only one treatment. The researcher chose not to use a controlled group because the primary goal of this study was to determine which strategy would be more effective in problem solving using heuristic approaches.

The study included forty (40) Grade three students who were officially enrolled in Gatid Elementary School for the 2020-2021 school year. The researcher chose at random two sections of Grade 3 students as respondents, totaling forty (40) members, fourteen (14) using online approach and twenty-six (26) using modules.

The respondents for this study were Grade 3 students from Gatid Elementary School in the school year 2020-2021.

The researcher used forty (40) randomly selected Grade 3 students from Gatid Elementary School to obtain the desired sample of Gatid Elementary School students. Twenty-six (26) of the forty (40) students used modules, while the remaining fourteen (14) students used an online learning approach. Simple random sampling was used to ensure an equal distribution of samples in each stratum.

The researcher proposed three research titles. Among the proposed titles, the "Heuristic Approach to Improving Mathematical Performance" was chosen. Following approval of the research title, the researcher submitted an approval sheet of the title to the thesis adviser. The researcher created questionnaires and a checklist that had to be approved by five (5) Math instructors. The study was carried out by the researcher in her advisory class and in another section online class of Grade 3 students at Gatid Elementary School.

To obtain permission to conduct the study at Gatid Elementary School, a letter of request was submitted to the Division Office. The questionnaires were distributed to other teachers and students immediately after approval, with the permission of the District Supervisor and the school principal.

To collect data from teachers and students, a checklist and questionnaires were created. The questionnaires were validated with the help of some experts in the field. The number of copies of the questionnaires was multiplied by the number of respondents. To ensure a high percentage of recovered items, all of the information gathered from the respondents was categorized, totaled, and presented.

The test results assisted the researcher in determining the efficacy of the heuristic approach in improving students' performance in Grade 3 Mathematics. The researcher tabulated, analyzed, and interpreted the data based on the information obtained from the respondents.

In gathering the data needed for this study, the researcher used questionnaires for the respondents' perception on heuristic approach consisting five (5) items and a set of pretest and posttest, consisting fifteen (15) problems, to determine the performance of the respondents in solving problems in Mathematics. The rating scale used to evaluate the response of students in the checklist was as follows:

Rating	Range	Description	Interpretation
5	4.21-5.00	Strongly Agree	Highly Effective
4	3.41-4.20	Agree	Effective
3	2.61-3.40	Moderately Agree	Moderately Effective
2	1.81-2.60	Disagree	Less Effective
1	1.00-1.80	Strongly Disagree	Not Effective

The rating scale used to evaluate the level of performance in the pretest and posttest responses of students.

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Rating	Description
90% and above	Advance
85%-89%	Proficient
80%-84%	Approach Efficiency
75%-79%	Developing
74% and below	Beginning

The test results from the Grade 3 respondents' pretest and posttest were grouped, organized, tabled, and statistically analyzed in the study. The mean, standard deviation, parametric t-test, and cohens d were used to analyze data in this study at the 0.05 level of significance. According to Broto (2011), the arithmetic mean is the average obtained by dividing the sum of two or more quantities by the number of quantities, whereas standard deviation indicates how far apart the individual score values are from the mean value.

The researcher used the mean and standard deviation to determine the level of the heuristic approach in terms of problem solving strategies based on Draw a Picture, Guess and Check, Look for Patterns, Trial and Error, and Working Backwards. Meanwhile, the researcher used the parametric t-test to determine whether there was a significant difference between students' performance in Grade 3 Mathematics on pretest and posttest. Cohens d was used by the researcher to determine the effectiveness of the heuristic approach in improving Grade 3 Mathematics performance. The aforementioned inferential statistics also demonstrated a better treatment in a heuristic approach to improve the level of Grade 3 students in Gatid Elementary School during the school year.

4. RESULTS AND DISCUSSIONS

Table 1 reflects the level of heuristic approach of problem solving using a Draw a Picture strategy. It had an overall mean of 4.69 for modular and 5. 00 for online learning approach. Both had a verbal interpretation of Highly Effective. It appears that the heuristic approached using Draw a Picture strategy was considered to be highly effective in solving word problems in Mathematics.

		Modular			Online		
		Mean	SD	Verbal Interpretation	Mean	SD	Verbal Interpretation
1	Even more, I enjoy using the Draw a picture technique.	4.69	0.47	Highly Effective	5.00	0.00	Highly Effective
2	It was quite beneficial to my response.	4.69	0.55	Highly Effective	5.00	0.00	Highly Effective
3	It is less difficult to implement than other strategies.	4.69	0.62	Highly Effective	5.00	0.00	Highly Effective
	Overall Mean	4.69		Highly Effective	5.00		Highly Effective

Rating	Range	Description	Interpretation
5	4.21 - 5.00	Strongly Agree	Highly Effective
4	3.41 - 4.20	Agree	Effective
3	2.61 - 3.40	Moderately Agree	Moderately Effective
2	1.81 - 2.60	Disagree	Less Effective
1	1.00 - 1.80	Strongly Disagree	Not Effective

The statement, "Even more, I enjoy using the draw a picture technique" (Mean = 5.00, SD = 0.00) provided a strong evidence of this claim.

Dunlosky, et al. (2013), assessed Minute Sketches in Folded Lists as a study method in comparison with a preferred study method, VR, and taught the method to students in an intervention and allowed them to self-assess the effectiveness of the method. Any learning gain that motivates students to use drawing as a learning strategy will create opportunities for development of higher-order skills with drawing that they use for purposes ranging from recall to complex study method.

Unlike the Draw a Picture strategy, Guess and Check strategy was considered effective in problem solving. Its overall mean was 3.62 for modular and 3.86 for online. These averages had the same verbal interpretation of Effective. And based on Table 2, the indicator which reflected the effectiveness of guess and check was "I learned to guess and check (Mean = 3.93, SD = 0.73). This statement is from the response of students under online learning approach.

Morton (2014), investigated middle school African American female perceptions of themselves as learners and students' knowledge of the meaning of ratio, proportionality and how to apply and explain their application of proportionality concepts by examining written problem-solving strategies over a three-year period. The categories of strategies

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included no response, guess and check, additive build up with and without a pictorial representation and multiplicative nature. Participants reported positive dispositions about themselves as Mathematics learners.

Using Look for Pattern strategy in problem solving was highly effective for students under online learning but it was just an effective strategy when considering the response of the students under modular approach.

Table 2. Heuristic Approach using Guess and Check Strategy

		Modular			Online		
		Mean	SD	Verbal Interpretation	Mean	SD	Verbal Interpretation
1	It's fun to try out the guess and check technique.	3.69	1.23	Effective	3.86	0.36	Effective
2	I quickly got the answer with the help of Guess and check.	3.46	1.03	Effective	3.79	0.43	Effective
3	I learned to use Guess and Check.	3.69	0.84	Effective	3.93	0.73	Effective
	Overall Mean	3.62		Effective	3.86		Effective

Rating	Range	Description	Interpretation
5	4.21 - 5.00	Strongly Agree	Highly Effective
4	3.41 - 4.20	Agree	Effective
3	2.61 - 3.40	Moderately Agree	Moderately Effective
2	1.81 - 2.60	Disagree	Less Effective
1	1.00 - 1.80	Strongly Disagree	Not Effective

As reflected in Table 3, this strategy had an overall mean of 4.21 and 3.97, respectively. The students under online learning approach claimed that this strategy was highly effective for its increased retention of information in their minds. But for students under modular learning, it was only an effective strategy in problem solving. The statement considered as the least indicator of the effectiveness of this strategy, "I understood the answer better with the help of the Look for Pattern strategy."

"Looking for Patterns trained the mind to search out and discover the similarities that binded seemingly unrelated information together in a whole. A child who expects things to 'make sense' looks for the sense in things and from this sense develops understanding. A child who does not see patterns often does not expect things to make sense and sees all events as discrete, separate, and unrelated."-Mary Baratta- Lorton (cited on p.112 of About Teaching Mathematics by Marilyn Burns).

In the Trial and Error strategy, both groups of pupils saw this as an effective strategy in problem solving. This was based on the results from Table 4. It had an overall mean 3.64 with a verbal interpretation of Highly Effective and Effective, respectively.

Table 3. Heuristic Approach Using Look for Pattern Strategy

		Modular			Online		
		Mean	SD	Verbal Interpretation	Mean	SD	Verbal Interpretation
1	Using the Look for Pattern strategy is more retained in my mind.	4.19	0.69	Effective	4.79	0.43	Highly Effective
2	With the Look for Pattern Strategy, I was able to respond quickly.	4.15	0.54	Effective	3.93	0.47	Effective
3	I understood the answer better with the help of the Look for Pattern strategy.	3.58	0.90	Effective	3.93	0.47	Effective
	Overall Mean	3.97		Effective	4.21		Highly Effective

Rating	Range	Description	Interpretation
5	4.21 - 5.00	Strongly Agree	Highly Effective
4	3.41 - 4.20	Agree	Effective
3	2.61 - 3.40	Moderately Agree	Moderately Effective
2	1.81 - 2.60	Disagree	Less Effective
1	1.00 - 1.80	Strongly Disagree	Not Effective

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The above-mentioned strategy was effective in solving problems in Mathematics according to the response of students under online and modular learning. This was evident from the statement, "My knowledge increased with the help of Trial and Error strategy."

According to Bandola (2014), Trial and Error, or Trial by error, is a general method of problem solving for fixing things or for obtaining knowledge. Learning does not happen from failure itself but rather from analyzing the failure making a change and trying again.

Table 4. Heuristic Approach Using Trial and Error Strategy

		Modular			Online		
		Mean	SD	Verbal Interpretation	Mean	SD	Verbal Interpretation
1	My knowledge increased with the help of the Trial and error strategy.	3.65	1.06	Effective	3.93	0.62	Effective
2	I understood and answered the question faster with the help of trial and error.	3.62	1.13	Effective	3.14	0.36	Moderately Effective
3	I prefer using the Trial and error strategy.	3.65	1.02	Effective	3.86	0.36	Effective
	Overall Mean	3.64		Effective	3.64		Effective

Rating	Range	Description	Interpretation
5	4.21 - 5.00	Strongly Agree	Highly Effective
4	3.41 - 4.20	Agree	Effective
3	2.61 - 3.40	Moderately Agree	Moderately Effective
2	1.81 - 2.60	Disagree	Less Effective
1	1.00 - 1.80	Strongly Disagree	Not Effective

However, the least indicator of the effectiveness of this strategy was the statement, "I understood and answered the question faster with the help of Trial and Error." In terms of using Working Backwards as a strategy in solving problems in Mathematics, the students under online learning approach claimed that it was highly effective and the same approach was effective according to the students under from modular learning approach. From the results shown in Table 5, it had an overall mean of 5.00 and 4.01 and with a verbal interpretation of Highly Effective and Effective, respectively. The best indicator of this level of effectiveness was the statement, "I quickly figured out the answer with the help of working backwards."

According to Katz, et al. (2016), teachers qualitatively explore how teaching problem solving focusing on the working backwards strategy enhances students' efficacy beliefs to solve problems in Mathematics. Results showed that teaching problem solving focusing on the Working Backwards strategy enhanced student's problem-solving efficacy beliefs, self-regulation and contributed to mathematical thinking performances.

Table 3 reflects the parametric t – test for significant difference between pretest and posttest. Based on the results, there was a significant difference between pretest and posttest of the students using modular learning approach, Student's t = 17.35, p = < .001, and between pretest and posttest of the students using online learning approach, Student's t = 9.72, p = < .001.

Table 5. Difference between Pretest and Posttest

			statistic	Df	p	Mean difference	Cohen's d
POSTTEST MODULAR	PRETEST MODULAR	Student's t	17.35	25	< .001*	4.69	3.4
POSTTEST ONLINE	PRETEST ONLINE	Student's t	9.72	13	< .001*	2.86	2.6

The positive mean difference between the posttest and pretest of both groups showed a significant improvement in the performance of the students in problem solving. This improvement in the posttest scores or in the performance of the students as a whole could be attributed to the different strategies of problem solving. The heuristic approach in terms of Guess and Check, Draw a Picture, Look for Pattern, Trial and Error and Working Backwards provided a medium effect

Table 5 reflects the parametric t – test for significant difference between pretest and posttest. Based on the results, there was a significant difference between pretest and posttest of the students using modular learning approach, Student's t = 17.35, p = < .001, and between pretest and posttest of the students using online learning approach, Student's t = 9.72, p = < .001. heuristic approach had a medium effect on the improved performance of the pupils from both groups. Moreover, there was also a significant

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difference in the pretest of students under modular and online learning approach. On the contrary, there was no significant difference in the posttest of students under modular and online learning approach. The heuristic approach of problem solving had a small effect on this difference. On the improved performance of the students using modular, *Cohen's d* = 3.4, and of the students using online learning approach, Cohen's *d* = 2.6.

The results of the parametric t – test for significant difference in the pretest and posttest of students using modular learning approach and online learning approach were shown in Table 6. Based on the results, the mean score in the pretest on students under online and in the pretest of students from modular and online, varied significantly, Student's t = -2.44, df = 38, p = 0.02. The mean difference which was negative means that the mean score in the pretest of students using online learning was higher than the mean score in the pretest of students using modular learning approach. Further, it signified that the level of cognitive skills of students from the two groups was not the same.

Table 6. Difference in the Pretest and Posttest of Students from Modular and Online Learning Approach

		Statistic	Df	p	Mean difference	Cohen's d
PRETEST	Student's t	-2.44	38	0.02	-2.02	
POSTTEST	Student's t	-0.312	38	0.756	-0.187	-0.104

On the contrary, the results of the posttest were different. The mean score of the posttest of students under the modular and the mean score of the posttest of students under online did not vary significantly, *Student's t* = -0.312, *df* = 38, *p* =0.756. The negative mean difference suggested that the posttest mean score of students using modular approach was lower than the posttest mean score of students using online approach. Moreover, the heuristic approach had a small effect on the posttest performance of the two groups of students, Cohen's d = -1.04. This effect was further reflected by the observed level of effectiveness of the different problem solving strategies.

Table 7. Heuristic Approach Using Working Backwards Strate

		Modular			Online		
		Mean	SD	Verbal Interpretation	Mean	SD	Verbal Interpretation
1	Using the Look for Pattern strategy is more retained in my mind.	4.19	0.69	Effective	4.79	0.43	Highly Effective
2	With the Look for Pattern Strategy, I was able to respond quickly.	4.15	0.54	Effective	3.93	0.47	Effective
3	I understood the answer better with the help of the Look for Pattern strategy.	3.58	0.90	Effective	3.93	0.47	Effective
	Overall Mean	3.97		Effective	4.21		Highly Effective

Rating	Range	Description	Interpretation
5	4.21 - 5.00	Strongly Agree	Highly Effective
4	3.41 - 4.20	Agree	Effective
3	2.61 - 3.40	Moderately Agree	Moderately Effective
2	1.81 - 2.60	Disagree	Less Effective
1	1.00 - 1.80	Strongly Disagree	Not Effective

Table 8 showed the level of performance of the pupils in the pretest and posttest using heuristic approach. The level of performance in the pretest of about 19% of the students under the modular learning approach and about 64% under the online learning approach was above the line of beginning. On the other hand, 100% of the students under the modular using approach and about 93% under the online learning approach had a posttest performance which was above the level of Beginning. It seemed that using Guess and Check, Draw a Picture, Look for Pattern, Trial and Error and Working Backwards influenced the posttest performance of the students from both groups.

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Table 8. **Level of Performance of the Pupils in the Pretest and Posttest Using Heuristic Approach.**

Levels	Modular				Online			
	Pretest		Posttest		Pretest		Posttest	
	f	%	F	%	F	%	F	%
Beginning (74% and below)	21	80.77	0	0.00	5	35.71	1	7.14
Developing (75 - 79%)	1	3.85	3	11.54	3	21.43	0	0.00
Approaching Proficiency (80 84%)	2	7.69	7	26.92	4	28.57	3	21.43
Proficient (85-89%)	1	3.85	7	26.92	0	0.00	5	35.71
Advanced (90% and above)	1	3.85	9	34.62	2	14.29	5	35.71
Total	26	100	26	100	14	100	14	100

5. RESULTS AND DISCUSSIONS

The objective of this study was to determine how heuristic approach in problem solving could enhance problem solving skills and thereby improve the performance of Grade 3 students in Mathematics.

This study followed the pretest – posttest research design and used forty (40) randomly selected Grade 3 students of Gatid Elementary School. Twenty – six (26) students of those forty (40) students were using module and the remaining fourteen (14) students were using online learning approach.

The level of heuristic approach in problem solving was determined using mean and standard deviation while the parametric t – test for dependent and independent samples were used to test for any significant difference between the pretest and posttest of the students. Findings: Level of heuristic approach the heuristic approach of problem solving in terms of Guess and Check, Draw a Picture, Look for Pattern, Trial and Error and Working Backwards varied from effective to highly effective. Level of performance in pretest and posttest, the level of performance in the pretest of about 19% of the students under the modular learning approach and about 64% of the students under the online learning approach was above the level of Beginning performance. On the other hand, 100% of the students under the modular learning approach and about 93% of the students under online learning approach had a posttest performance which was above the level of Beginning performance. Difference between pretest and posttest there was a significant difference between pretest and posttest of students using modular learning approach and between pretest and posttest of students using online learning approach. The heuristic approach had a medium effect on the improved performance of the pupils from both groups. Moreover, there was also a significant difference in the pretest of students under modular and online learning approach. On the contrary, there was no significant difference in the posttest of students under modular and online learning approach. The heuristic approach of problem solving had a small effect on this difference.

6. CONCLUSIONS AND RECOMMENDATIONS

Since there was a significant difference in the pretest and posttest of students using modular and online learning approaches and both pretest of the two groups were statistically not the same therefore, there was a sufficient statistical evidence to not completely reject the null hypothesis of this study.

The following were the recommendations based on the above - mentioned findings:

1. The heuristic approach may be used, guess and check, draw a picture, look for pattern, trial and error and working backwards in problem solving to enhance the performance of pupils in Mathematics.
2. The heuristic approach of problem solving may be utilized in any learning modality. This approach develops independence. It could also improve the performance of the pupils in Mathematics as well as enhance the computational skills of the students.
3. The study may also be used as a guide for teachers to create other instructional materials in which the solution is based on a heuristic approach. It may also assist teachers in conducting action research in their respective classes to deepen the usefulness and effectiveness of the heuristic approach while also looking for the type of strategies.
4. Teachers may encourage students' creative problem-solving approaches by allowing each student to find their own solution rather than simply relying on direct instruction. As a result, students are no longer afraid to solve word problems.
5. More workshop or training sessions on teaching strategies as possible may be provided by the administrator, so that students become familiar and

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comfortable with the various teaching and learning techniques.

6. A future researcher may follow-up study could be conducted to determine what other factors influence student performance when it comes to teaching strategies. It may be preferable to use a larger sampler size.

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