

UC³ Model for Primary Grades Problem Solving

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ABSTRACT

This study aimed to determine the effectiveness of Polya's UC³ model in improving the problem-solving skills and attitude and perception towards problem-solving of grade 2 students. Quantitative data were gathered through a two-group pre-posttest quasi-experimental design, and qualitative data were gathered through focused group discussion from 54 grade two students through convenient sampling. The Paired T-test and T-test for independent samples results revealed that UC³ model has increased students' problem-solving skills to Satisfactory level with a significant pair difference and mean gain as compared to conventional method. It has also increased students' attitude and perception with a significant mean gain in growth mindset and interest. Based on the findings, it is concluded that the utilization of the UC³ Model in teaching problem solving is effective in improving students' skills and attitude and perception towards problem solving of grade 2 students. It further recommends for provision of programs and workshops by administrations, integration of UC³ in classroom instruction by the teachers, and further validation of findings by other researchers.

INTRODUCTION

Problem solving is at the heart of mastering mathematics (Drury, 2014). It has become the core of the mathematical framework in many countries such as the top Asian countries like Singapore, Japan, and South Korea based on the OECD's global test - PISA Program for International Student Assessment (PISA) 2018 results.

In the Philippines, the twin goals in the basic education of mathematics in the K-12 curriculum are critical thinking and problem solving (K-12 Curriculum guide, 2012). These are 21st skills that every student must acquire and master to be ready to solve real-world problems. However, the National Achievement Test or NAT performance of Grade 6 students has been declining steadily in the last years with a Department of Education descriptive level "low mastery" while the Grade 10 students' remained steady at "low mastery" (Albano, 2019). As explained by DepEd Underseretary for Curriculum and Instruction Lorna Daig Dino, the probable contributory factor to the students' low mean percentage score was the change in the design of the 2017 NAT from the previously competency-based assessment framework to now testing problem solving, information literacy and critical thinking which are 21st century skills. It is also shows in the PISA results that Philippines ranked as 2nd lowest in Mathematics out of the 79 participating countries (Schleicher, 2018). This is despite the implementation of the K-12 curriculum that aims to provide quality education to every Filipino that can compete in a global context.

In the private school where the researcher teaches, the standardized test results for Math showed a developing to approaching proficiency with 20% - 59% problem- solving performance level among students in the elementary level (based on the Global Resources for Assessment Curriculum and Evaluation or GRACE 2019 results). It has been observed that when students were given word problems on a specific lesson with only single operation (e.g. addition of whole numbers), they would tend to look for the given numbers immediately then perform the operation being focused, instead of reading, analyzing, and understanding the problems first. This is why when given word problems that involved mixed operations, most of them manifest difficulty and will then ask questions such as, "Teacher, how do I do this?" or "Teacher, what operation should I use?". These struggles become worse as multi-step word problems were introduced in the higher grades. They then complain that Math is difficult. Because of this, Mathematics teachers are also pushed continue to explore on different approaches such as the UC3 (Understand, Choose, Carry-out, and Check) in problem-solving.

The research aimed to assess the effectiveness of the UC3 Model in enhancing problem-solving skills, attitude, and perception of grade 2 students. Specifically, it sought to address the following: 1) students' level of problem-solving skills before and after the intervention exposed to conventional method and exposed to UC3 model; 2) whether or not there is a significant difference in the students' problem-solving skills before and after their respective interventions; 3) whether or not there is a significant difference in the mean gain between both groups in their problem-solving skills; 4) the students' attitude

and perception towards problem solving before and after the intervention in both groups; 5) whether or not there is a significant difference in the students' attitude and perception towards problem solving before and after their respective intervention; 6) whether or not there is a significant difference in the mean gain between both groups in their attitude and perception towards problem solving; 7) the highlights and lowlights of using UC3 model in problem solving as perceived by the students; and 8) relevant proposal can be made to improve the problem-solving skills based on the results of the study.

THEORETICAL REVIEW

Polya's UC³ Model

According to Zheng and Gupta (2020), cognitive load significantly affects students' ability to solve mathematical problems. Problem-solving tasks involve various cognitive activities, such as mobilization, organization, isolation, and combination, which pass through working memory. This heavy cognitive processing often leads to working memory overload and limited schema acquisition, hindering effective problem-solving and resulting in the utilization of the means-ends approach (Carifio, 2015; Powell, 2011).

Polya's four-phase problem-solving heuristic, which includes understanding the problem, devising a plan, carrying out the plan, and checking the solution, provides an effective problem-solving framework (Gurat, 2018). The UC3 Model, based on Polya's heuristic, is used in this study to help students address their low performance by identifying the root causes of their difficulties. It recognizes that problem-solving skills require organization, structure, and mastery of sub-skills (Riccomini et al., 2016). To develop these skills, the sub-skills of problem-solving must be deconstructed and taught individually, similar to teaching sub-skills in other domains (Almond, 2019).

Several studies have investigated the challenges in problem-solving. Angateeah (2017) found that errors occur at different stages of Polya's heuristic, with high achievers exhibiting overconfidence and careless computational errors, while low achievers struggle with visualization, solution planning, and problem paraphrasing. The ability to understand the problem and interpret it into symbolic form is a recurring difficulty (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010; Novriani & Surya, 2017). Incebacak and Ersoy (2016) noted that students struggle with unfamiliar problems and have difficulty analyzing and translating problems into mathematical sentences. Developing strategies to check answers and fostering deep mathematical understanding are crucial for successful problem-solving (Angateeah, 2017; Siemon, 2016). By addressing these challenges, problem-solving becomes a cycle of learning, leading to improved performance and metacognitive evaluations (Britz, 2019).

Implementing Polya's model has shown positive outcomes in improving students' mathematical problem-solving abilities (Gopinath & Lertlit, 2016; Lasak, 2017; Daulay et al., 2019). The Common Core State Standards for Mathematics emphasizes understanding problems and persevering in solving them as essential mathematical practices (National Governors Association

Center for Best Practices, Council of Chief State School Officers, 2010). Equipping students with problem-solving tools positively influences their attitudes and perseverance when faced with challenges.

Attitude and Perception towards Problem Solving

Math skills particularly problem-solving skill has been observed to be a source of anxiety to many of our Math students. According to Wismath et. al., (2014) two of the predictive factors of persistence and effort in problem solving are confidence and self-efficacy. When students learn and successfully do problem-solving tasks, confidence and self-belief will be developed. This will then pave way to a positive mindset and a 'can-do' attitude. In relation to the Cognitive load theory as explained by Heick (2019) on the limitations of the human cognitive processing, Kayulga (2011) found out that excessive cognitive load certainly influences affective states by causing frustration. With this, students may develop negative attitude and may be discouraged learn further. Leading and guiding the students to successfully solve problems will help them develop positive attitude and perception towards learning mathematics. Kayulga further mentioned in his studies that there is a close relationship between affective and cognitive states associated with the operation of working memory.

A study conducted by Mahmood et. al. (2011) showed that the overall attitude of students in problem solving tasks overall contributes mathematics achievement. Based on the findings, perseverance, confidence, and willingness to are essential to achieve success in problem solving.

UC³ Model Primary Grades Problem Solving

Teachers must recognize that developing problem-solving skills takes time, sustained attention, and the creation of a problem-solving culture in the classroom. It should be integrated into the long-term instructional goals in mathematics across grade levels and incorporated into every topic and lesson (Cai & Lester, 2010).

The National Council of Teachers of Mathematics (NCTM, 2013) and the National Association for the Education of Young Children (NAEYC, 2002) both agree that young children should have opportunities to enhance their reasoning processes and problem-solving skills through curriculum and teaching practices. Problem-solving serves as the foundation for a child's learning, helping them develop initiative and the ability to evaluate actions and consequences (Britz, 2019; *Developing Problem Solving Skills in Children of Kumon*, UK, 2020). Therefore, teaching problem-solving should begin at an early age.

Research by Palmér et al. (2018) suggests that problem-solving tasks can be introduced in early mathematics education, as young children are capable of appreciating the challenge and creativity involved. In this study, the UC³ model will be implemented with grade 2 students, as they are beginning to read independently and are sensitive to text structure (Willams, 2005; Kodan, 2017).

The researcher believes that grade 2 pupils can effectively utilize the UC3 model on their own.

These ideas strengthen the researcher's belief in the importance of teaching problem-solving and critical thinking skills. Effective instructional design plays a crucial role in fostering creative problem solvers. Therefore, this study aims to examine the effectiveness of the UC3 model for problem solving in Grade 2.

METHODOLOGY

This study employed a quantitative method using two-group pre-posttest quasi-experimental design. Randomization of research respondents/participants was not possible, so a quasi-experimental design was used. Respondents were already grouped accordingly. A focus group discussion was done to elicit the highlights and lowlights of using UC3 model in problem solving.

Research Participants

The participants were the second-grade students who were selected through convenience sampling. Regrouping was not possible since it was already established, and the students were in 2 sections with 27 students per class using heterogeneous grouping. There were 54 pupils with 30 boys and 24 girls with ages that range from 7-8 years old.

Research Environment

The locale of this study is in one of the prominent private schools in Cebu that offers basic education programs from Early Education to Senior High School. The Grade School Department has a total population of approximately 1,150 pupils in all six elementary levels. There were six to seven sections per grade level with approximately 25-35 pupils in each classroom. The Grade School Department is headed by a principal and 2 assistant principals and is composed of 71 faculty and staff. The institution has been accredited with Level 3 Status by PAASCU (Philippine Accreditation Association of Schools, Colleges, and Universities).

Research Instruments

A teacher-made test on problem solving using four operations-addition, subtraction, multiplication and division on length and mass- was used to determine the performance level of the grade 2 students. The test was coupled with a rubric to score the problem-solving skills. A survey on Attitude and Perception on Problem Solving (APPS) adapted from the Mathematics Attitudes and Perceptions Survey - an instrument that is used to assess the views and dispositions among Math students by Code, W. et al (2016) was used to determine students' attitude and perceptions about problem-solving among mathematics students. The students responded to each question using a 5-point Likert format: "Strongly Disagree", "Disagree", "Neutral", "Agree", and "Strongly Agree". The results were identified as highly positive (4.20-5:00),

positive (3:40-4:19), neither positive nor negative (2:60-3:39), negative (1.80-2.59) and highly negative (1.00-1.79). (Refer to appendix H, on page 43 for the scoring procedure of APPS.)

Data-gathering Procedure
Pre-implementation Phase

Upon the approval of the ethics committee, a letter of permission was sent to the school president. The research committee of the school has reviewed the proposal, and the consent and assent letters. When the permit to conduct research was secured, parental consent was given to the parents of the respondents. The students were given an orientation on how the research would be done. A consent and agreement to participate in the research of the students were sought. When the students have signed the agreement, they were given a pretest on problem solving. They were also given the Attitudes and Perceptions on Problem Solving (APPS) survey after taking the test. The survey was answered with the teacher's guidance to ensure that the items are understood and properly answered.

Implementation Phase

Both groups were given the same lessons, sets of activities, worksheets and tests on length, mass, and capacity. However, for problem-solving, one group served as the control group and were exposed to Conventional Method of Problem Solving. The other group was the experimental group, and they were exposed to the UC3 Model in solving math problems. Refer to Appendix J, page 55 for lesson sample. 25 contact periods with series of problem-solving activity were intended for this phase.

Post-implementation Phase

The two groups took a posttest on problem-solving and the APPS to determine if there was a significant change on the level of performance and attitude on problem-solving of both groups. An interview on the highlights and lowlights of the study on the students' point of view was conducted through focused group discussion. Then, a thematic analysis on the response was done. Data analysis followed. A proposal was made based on the results.

RESULTS AND DISCUSSION

Table 1 shows the descriptive statistics of students' problem-solving skills before and after the exposure to Conventional Method and UC³ Model.

Table 1. Descriptive Statistics of the Problem-Solving Skills of the Students exposed to Conventional Method and UC³ Model of Problem-Solving, n = 27

Students Exposed to Conventional Method of Problem Solving	Mean (SD)	Transmuted Grade	Description
Before the exposure	12.52 (7.39)	67	Did not meet expectations
After the exposure	22.26 (6.53)	73	Did not meet expectations
Students Exposed to UC ³ Model of Problem Solving	Mean (SD)	Transmuted Grade	Description
Before the exposure	12.44 (5.01)	67	Did not meet expectations
After the exposure	28.11 (7.90)	81	Satisfactory

Based on DO no. 8, s 2015

Grade	Description
90 – 100	Outstanding
85 – 89	Very Satisfactory
80 – 84	Satisfactory
75 – 79	Fairly Satisfactory
Below 75	Did Not Meet Expectations

Based on the results, the Grade 2 students under the conventional group obtained a pretest mean score of 12.52 (SD = 7.39) which is equal to a grade of 67 when transmuted using the 60% passing rate. Based on DO no. 8, s 2015, it falls under the Did Not Meet Expectations level. It can be implied that the problem-solving performance of the students did not meet the minimum standard set by DepEd prior to the intervention. But the mean score increased to 22.26 (SD = 6.53) after exposure to the conventional method which is equal to a grade of 73 when transmuted using the 60% passing rate. However, this still falls under the Did Not Meet Expectation level. Despite the exposure to the Conventional Method of problem solving, the performance was still lagging behind the minimum standard.

On the other hand, the other group of Grade 2 students under the UC³ model obtained a pretest mean score of 12.44 (SD = 5.01) which is equal to a grade of 67 when transmuted using the 60% passing rate. Based on the DO no. 8, s 2015, it falls under the Did Not Meet Expectations level which means that the performance of the students in terms of problem solving did not meet the minimum standards prior to the intervention. However, after the exposure to the UC³ model, the mean score has increased to 28.11 (SD = 7.90), which is equal to a grade of 81 when transmuted using the 60% passing rate and falls under the Satisfactory level. This implies that probably the intervention has helped the students improve their problem-solving skills. Satisfactory level of performance would mean that the expected acceptable level of performance of the students in

terms of problem solving was met after the intervention. It has been observed that most of the students' problem-solving outputs showed drawings and/or illustrations to visualize the problem, computations and solutions were mostly correctly done and most answers are also written in complete sentences and/or with labels.

The Significance of the Difference of the Pretest and Posttest

A comparative analysis to identify whether or not there is a significant difference in students' level of problem-solving skills before and after exposure to Conventional Method and UC3 Model is shown in Table 2.

Table 2. Comparative Analysis of the Levels of Problem-Solving Skills Before and After the Interventions, n_{total} = 54

Groups	n	Statistics		Paired Difference Mean (SD)	T-Value	P-Value
		Pretest Mean (SD)	Posttest Mean (SD)			
Students Exposed to Conventional Method	27	12.52 (6.53)	22.26 (7.39)	9.74 (6.73)	7.522**	0.000
Students Exposed to UC ³ Method	27	12.44 (5.01)	28.11 (7.90)	15.67 (6.51)	12.504**	0.000

Note: Values presented in Mean (Standard Deviation); * Significant at 0.05 and ** Highly Significant at 0.05

As shown in the data, the students exposed to the conventional method obtained a mean gain of 9.74 (Sd = 6.73), with a t value of 7.522, and a P-value of less than 0.05 of the students' scores which revealed that there is a significant difference of means between pretest and posttest, which implies that statistically, the conventional method of problem solving has helped the students improve their problem-solving skills. This improvement can be attributed to the students' daily exposure to problem-solving tasks. As Kadir et al., (2016) mentioned in their study that by having authentic problems to be solved, students are more involved in the process of learning and thus improving their problem-solving abilities. Moreover, in the study conducted by Hoaglund (2008), it was found out that doing daily problem solving would result to an improved mathematical communication and reasoning thus helping students become better problem solvers. However, despite the significant improvement shown, the students' performance still falls under Did Not Meet Expectations level, which would mean that exposure to Conventional Method is not enough to help the students reach the 60% standard set by DepEd. It was observed that even after exposure to the conventional method of problem solving, only very few students go through the process of visualizing the problems. Though many of the problems are answered in sentences forms, correct labels are sometimes not reflected.

On the other hand, the paired difference of the pretest and posttest results of the students exposed to the UC3 Model intervention is 15.67 (Sd = 6.51), with a t-value of 12.504, and a P-value of less than 0.05. This result revealed that there is a significant difference of means between pretest and posttest, and that is, students' performance has significantly improved when exposed to UC3 Model

of problem-solving. This implies that probably, the UC3 Model has helped improve students' problem-solving skills from Did Not Meet Expectation to Satisfactory level. This implication shows consistency with Daulay and Ruhaimah's (2019) observation results of students' capabilities to solve world problems, as well as their test results which falls under the Good Enough to Very Good category after employing Polya's method of problem solving. This improvement can be attributed not only to students daily problem-solving activities but more so to the organized and systematic structure of UC3 Model that served as a guide and a scaffold for students on how to start and how to go about the problem. Wulandari et. al. (2019) and Yusha'u (2020) in their study found out that a structured and systematic problem-solving model helps students improve their problem-solving ability. Wulandari and her colleagues found out that the problem-solving model greatly increased the aspects of students' understanding the problems and planning the solutions. In the study of Lasak, P. (2017), it was also concluded that Polya's problem solving does not only develop logical thinking but it's four step process helps students keep in mind the common-sense nature of math and mathematical problem and further mentioned that students who utilized this method of problem solving learned the math processes associated with communication, representation, modeling, and reasoning.

Though agreeably, both the Conventional Method and UC3 Model can help improve students' problem-solving skills as shown in the spike of results between the pretest and posttest for both interventions. However, conventional method can only be efficient for routine problems. In their study on Students' Mathematical Problem-Solving Abilities, Nasution et al (2018) emphasized that in order to solve non-routine problems, it is not enough for students to imitate how to solve problems that have been known, but the must to make additional efforts and develop good problem-solving strategy. Moreover, Tambunan, (2019) in his study mentioned that a problem-solving approach makes it easier for students to solve difficult problems and it has an impact on the students' ability and academic achievement. On the other hand, Youssef-Shalala et al (2014) interestingly concluded that a problem-solving strategy was helpful for beginners but not for students who had access to domain-specific knowledge. Nevertheless, the above-mentioned studies proved that having a problem-solving strategy, which in this study- the UC3 Model, yields a high improvement in students' problem-solving skills. The results of the study of Albay (2019) also showed an enhancement of students' performance in Math through problem solving approach.

Mean Gain Problem Solving Skills

Table 3 presents the mean gain of the problem-solving skills of the Grade 2 pupils between the two methods of problem solving

Table 3. Comparative Analysis of the Problem-Solving Skills Mean Gain between two Exposures

Groups	n	Statistics			Gain Difference	T-Value	P-Value
		Pretest Mean (SD)	Posttest Mean (SD)	Gain Mean (SD)			
Students Exposed to Conventional Method	27	12.52 (6.53)	22.26 (7.39)	9.74 (6.73)	5.93	0.924*	0.002
Students Exposed to UC ³ Method	27	12.44 (5.01)	28.11(7.90)	15.67(6.51)			

Note: Values presented in Mean (Standard Deviation); * Significant at 0.05 and ** Highly Significant at 0.05

As the data revealed, the students exposed to Conventional Method of problem solving has a mean gain of 9.74 (Sd = 6.73 while the students exposed to the UC³ Model intervention a mean gain of 15.67 (Sd = 6.51). Thus, there is a gain difference of 5.93 between the two groups. The t value obtained was 0.924 and has a P value of less than 0.05, which means that there is a significant difference between the mean gains of the two groups, and that the mean gain is significantly higher in the group of students exposed to UC³ Model. Thus, the UC³ Model intervention is considered to be better as compared to Conventional Method of problem-solving. That is, Grade 2 students are improving better in problem solving when exposed to the UC³ Model than those exposed to conventional method. This is in consonance with the results of the studies of Atagoda Olaniyan et.al (2015), Gopinath et al. (2016), Okafor (2019), and Phuntsho et al. (2019) who found out that the performance of the students who were exposed to Polya's problem solving technique was better than those exposed to the conventional problem-solving technique.

For many decades, research have been made about the benefits of teaching through problem-solving. However, as cited by Ayers et.al. (2012), substantial research into Cognitive Load Theory has demonstrated that learning through problem solving, which by nature entails high cognitive load, is an inefficient way to learn and that it can be detrimental for students who, for the first time are still learning new concepts and procedures. Chinnappan, M., & Chandler, P. (2010) mentioned that teachers need to be aware of the cognitive load associated with any mathematical task and that some tasks may need to be segmented into sub-tasks in order to control intrinsic load. In this study, the UC³ Model, emerges to be an effective tool to help our young learners deal with this so-called cognitive overload. Scusa (2019), in her research on Five Processes of Mathematical Thinking, found out that modeling the process and the thinking were vital to help students learn problem-solving. Scuca emphasized the importance of getting the students to think of the process and not just of the answer or results when doing problem-solving tasks. Evidently, the steps of Polya's UC³ Model provided a much more well-defined and well-guided scaffolding of the entire problem-solving process for the students than the Conventional Method. It's very first step, Understand, scaffolds the students

towards understanding the very problem by breaking it into pieces. The 2nd step, Choosing a Plan, challenges the students to critically and creatively come up with own model or illustration in order to solve the problem. Andrew Baker (as cited by Priester, 2014) shared in an essay that while critical thinking analyzes information and roots out the true nature and facets of problems, what drives progress in problem solving is creativity. The 3rd step, Carry out, provides an avenue to apply the mathematical concepts in varied ways, and the 4th, Check, requires self-assessment of their answers. Abazov (2016) mentioned that the final touch in the problem-solving process is the developing a step-by-step execution plan and acting effectively and decisively and also highlighting the importance of mastering the skills of monitoring and evaluating the whole implementation process. This step-by-step process provides what Scusa described as 'visual reminders' to help the students light their journey towards problem-solving.

Students Attitude and Perception Towards Problem Solving

The Attitude and Perception towards Problem Solving survey (APPS) is categorized according to the following: Growth Mindset, Real World, Confidence, Interest, Persistence, Sense Making and Nature of Answers (Code et al, 2016). Table 4 shows the descriptive statistics of students' attitude and perception towards problem solving before and after exposure to UC³ Model.

The attitude and perception towards problem solving of the Grade 2 students exposed to the UC³ Model of problem-solving pretest and posttest results showed Positive level on Growth Mindset and Real Word categories. A positive growth mindset would mean that the students' belief that that problem-solving skills can be acquired and improved through conscious practice and effort and that it is not just something that is innate only to some was already well-established. A positive result on the real word category would mean that the students already have established a perception that it is important to learn problem solving and that this skill can be applied in real life situations (Code et al, 2016). On the other hand, the categories on Confidence, Interest, Perception, Sense Making and Nature of Answers had pretest results of Neither Positive nor Negative and the results shifted to Positive in the posttest.

In the Confidence category, prior to the intervention, the mean was 3.16 (SD =0.80) which was in the Neither Positive nor Negative level. This would mean that the students' confidence and perception on their ability to successfully engage in problem solving was not yet well-established and thus affecting their willingness and effort to engage with problem-solving task especially when encountering difficulties and challenges (Code et al, 2016). After the intervention, the mean was 3.43 (0.83) which is now in the Positive level. This result may imply that the UC³ Model of problem solving probably have helped the students attain an average level of confidence which means that they are now more confident on their ability to solve problems successfully.

Table 4. Attitude and Perception towards Problem-solving Survey Results of Students exposed to the UC³ Model

Categories	Students exposed to UC ³ Model of Problem Solving		
		Mean (SD)	Description
GROWTH MINDSET	Before the exposure	3.43 (0.94)	Positive
	After the exposure	4.09 (0.58)	Positive
REAL WORLD	Before the exposure	3.69 (0.75)	Positive
	After the exposure	3.73 (0.75)	Positive
CONFIDENCE	Before the exposure	3.16 (0.80)	Neither positive nor negative
	After the exposure	3.43 (0.83)	Positive
INTEREST	Before the exposure	3.30 (0.88)	Neither positive nor negative
	After the exposure	4.04 (0.83)	Positive
PERSISTENCE	Before the exposure	3.36 (0.81)	Neither positive nor negative
	After the exposure	3.91 (0.73)	Positive
SENSE MAKING	Before the exposure	3.20 (0.58)	Neither positive nor negative
	After the exposure	3.93 (0.72)	Positive
NATURE OF ANSWERS	Before the exposure	3.02 (0.61)	Neither positive nor negative
	After the exposure	3.88 (0.56)	Positive
AVERAGE MEAN	Before the exposure	3.30 (0.35)	Neither positive nor negative
	After the exposure	3.87 (0.43)	Positive
Ranges	Description		
4.20-5.00	Highly Positive		
3.40-4.19	Positive		
2.60-3.39	Neither positive nor negative		
1.80-2.59	Negative		
1.00-1.79	Highly Negative		

In the Interest category, data shows that before the intervention, the mean was 3.30 (SD = 0.88) which was in the Neither Positive nor Negative. This means that the students do not necessarily have established interest and willingness to engage in solving problems (Code et al, 2016). After the exposure, the mean increased to 4.04 (SD = 0.83) and now falls under Positive level. This would imply that probably, the UC³ Model of problem solving have helped the students attain an average level of interest which means that they are now more willing to do and be engaged in problem solving tasks.

In the Persistence category, data shows that before the intervention, the mean score was 3.36 (SD = 0.81) which falls under Neither Positive nor Negative attitude. This means that the students do not necessarily have established persistence when encountering setbacks in problem solving yet (Code et al, 2016). After the intervention, the mean increased to 3.91 (SD = 0.73) and falls under Positive attitude. This result may imply that the UC³ Model of problem solving might have helped the students attain an average level of persistence in problem-solving tasks which means that students have now learned not to give up easily when doing problem-solving tasks even when confronted difficulties and challenges.

In the Sense Making category, data shows that before the intervention, the mean was 3.20 (SD = 0.58) which falls under Neither Positive nor Negative level. This can be implied that the students do not necessarily have the ability to make sense of the problem yet and that their ability to see ideas in the text and to relate it to existing knowledge is not yet well-established. They may rely on memorizing key words and clues (Code et al, 2016). After the intervention, the mean increased to 3.93 (SD = 0.72) which falls under Positive level. This would imply that the UC³ Model of problem solving might have helped the students have attain an average level of sense making ability and to a certain degree do not just rely on memorizing clues worlds and solutions to solve the problem.

In the Nature of Answers category, data shows that before the intervention, the mean score was 3.02 (SD = 0.61) which falls under Neither Positive nor Negative level. This can be implied that the students have not established the importance of understanding the process of solving a problem. After the intervention, the mean increased to 3.88 (SD = 0.56) with which now falls under Positive level. This would imply that the UC³ Model of problem solving probably have helped improve the students view on the nature of obtaining answers and they now understand that it is as important as obtaining the correct. This means that to a certain degree, the students can now see the importance of understanding the process of solving the problem and that problems can be solved through various ways.

The Significance of the Difference of the Students' Attitude and Perception Towards Problem Solving

A comparative analysis is drawn in Table 5 to reveal difference in mean gains of the two interventions. It is revealed that the students exposed to Conventional Method of problem solving has a mean gain of 0.24 (Sd = 0.27) while the students exposed to the UC³ Model intervention a mean gain of 0.56 (Sd = 0.38). Thus, there is a gain difference of 0.32 between the two groups. The t-value obtained was 3.633 and has a P value of less than 0.001. This means that there is a significant difference between the mean gains of the two groups. Based on the mean gains, it can be said that the mean gain is significantly higher in the group of students exposed to UC³ Model. Thus, the UC³ Model intervention is considered to be better as compared to Conventional Method. That is, Grade 2 students were improving

Table 5. Comparative Analysis of the Problem-Solving Skills Mean between the Two Exposures

Categories	Groups	Values			Gain Difference	T-Value	P-Value
		Mean (SD) Before the Intervention	Mean (SD) After the Intervention	Mean Gain			
GROWTH MINDSET	Students Exposed to Conventional method of	3.90 (0.53)	3.91 (0.54)	0.01 (0.65)	0.66	-2.990	0.004*
	Students Exposed to UC ³ Model	3.43 (0.94)	4.09 (0.58)	0.67 (0.94)			
REAL WORLD	Students Exposed to Conventional method of	3.77 (0.51)	3.77 (0.63)	0.00 (0.65)	0.04	-0.167	0.434
	Students Exposed to UC ³ Model	3.69 (0.75)	3.73 (0.75)	0.04 (0.96)			
CONFIDENCE	Students Exposed to Conventional method of	3.12 (0.59)	3.29 (0.80)	0.17 (0.81)	0.10	-0.441	0.330
	Students Exposed to UC ³ Model	3.16 (0.80)	3.43 (0.83)	0.27 (0.88)			
INTEREST	Students Exposed to Conventional method of	3.84 (0.80)	4.00 (0.84)	0.16 (0.91)	0.58	-2.315	0.012*
	Students Exposed to UC ³ Model	3.30 (0.88)	4.04 (0.83)	0.74 (0.94)			
PERSISTENCE	Students Exposed to Conventional method of	3.32 (0.75)	3.67 (0.78)	0.34 (0.85)	0.20	-0.812	0.210
	Students Exposed to UC ³ Model	3.36 (0.81)	3.91 (0.73)	0.55 (0.99)			
SENSE MAKING	Students Exposed to Conventional method of	3.46 (0.58)	3.87 (0.68)	0.41 (0.80)	0.32	-1.370	0.088
	Students Exposed to UC ³ Model	3.20 (0.58)	3.93 (0.72)	0.73 (0.90)			
NATURE OF ANSWERS	Students Exposed to Conventional method of	3.20 (0.45)	3.81 (0.48)	0.62 (0.67)	0.24	-1.425	0.080
	Students Exposed to UC ³ Model	3.02 (0.61)	3.88 (0.56)	0.86 (0.57)			
AVERAGE MEAN	Students Exposed to Conventional method of	3.52 (0.22)	3.76 (0.32)	0.24 (0.27)	0.32	-3.633	0.000*
	Students Exposed to UC ³ Model	3.31 (0.35)	3.87 (0.43)	0.56 (0.38)			

Note. Values presented in Mean (Standard Deviation); * Significant at 0.05

Students' attitude and perception towards problem solving problem solving when exposed to the UC³ Model than those exposed to Conventional Method.

Based on the data, both categories - growth mindset and interest, showed that mean difference of the UC³ Model group is significantly higher than that of the Conventional group. These values suggest that the mean gain is statistically higher in UC³ Model than the conventional Method. This would imply that the UC³ Model has helped improve students' growth mindset and interest better than the conventional method. The significant improvement in students' attitude and perception under the UC³ Model can be attributed to the significant improvement on the students' problems-solving skills and achievement and significant improvement in the students' growth mindset and interest of the students exposed to the UC³ Model. While one can argue that attitude and perception can affect academic achievement or vice versa, it was found out in the study of Peteros et. al (2019) that there is a significant relationship on Math achievement and students' attitude. It was concluded in their study that students'

academic achievement is greatly affected by students' attitude towards the subject.

The results are in consonance with the studied of Blackwell (2007), Burnette et al. (2013) and Yeager et al., (2016) who found out that achievement is affected by students' mindset. It was concluded in their study that students' performances were better for those who have growth mindset. Blackwell (2007) and Burnette (2013) mentioned that to foster greater resilience, it is important to have a growth mindset as it influences reactions to setbacks, increase resilience as students with growth mindset interpret challenges as opportunities to lean and to improve their ability. Moreover, Burnette (2020) found out in their study that interventions to improve growth mindset can increase students' desire to learn and interest. Having said these, the impact of the UC³ Model on students' growth mindset and interest as two of its determining factors have definitely enhanced the students of attitude and perception towards problem-solving. This further confirms the study of Mahmood et. al. (2011) in the contribution of the overall attitude of the students in problem solving to math achievement.

Highlights and Lowlights of UC³ Model in Problem Solving

From the focused group discussion conducted with the 27 students who were exposed to the UC³ model of problem-solving, there surfaced five highlights and two lowlights as perceived and shared by the participants.

Highlights

The UC³ Model aids comprehension and cognitive development. The UC³ Model template served as students' guide to solve the problems correctly - step by step and that they are forced to answer every question and write in every answer in the step of the template and thus helping them understand what the problem is all about. Craig (2016) in his study described the effectiveness of writing about the problem-solving processes which potentially results to students' deeper engagement and understanding the problem thus adequately describing the solution processes. As shared by a student, "It (the UC³ Template) always asks me to understand the problem and have a plan, and always check my answer. I have to do all the steps and I should not miss any to write the answer correctly." Another student added, "Making models and illustrating and drawing gives me ideas and helps me understand it (the problem) more."

The UC³ Model promotes fun-learning and develops creativity. Students pointed out that they enjoyed the part of the problem-solving activity where they get to draw and illustrate. Creativity is evident and can be observed in students' outputs. Below are pictures of different creative models done by three different student participants in representing the same problem to solve for distance.

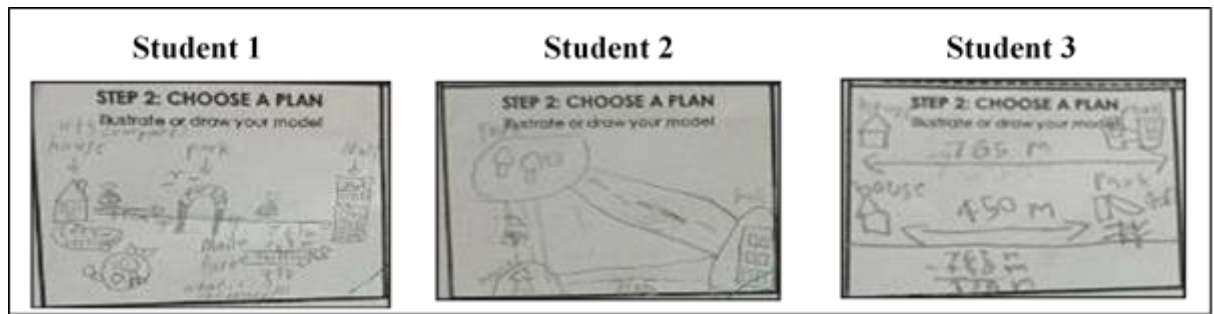


Figure 1. Students' Responses on the Word Problem on Distance

The UC³ Model promotes a student-centered learning and develops flexibility in solving Math problems. To solve Math problems accurately and efficiently, students need to learn multiple strategies as well as how to choose among them (Wong, 2008). As shown in the figure 4 below, four students use different methods of solving the same problem:

Word Problem (on Mass):

Father bought 10 coffee sticks. Each coffee stick has a mass of 10 grams. What is the total mass of the coffee sticks he bought?

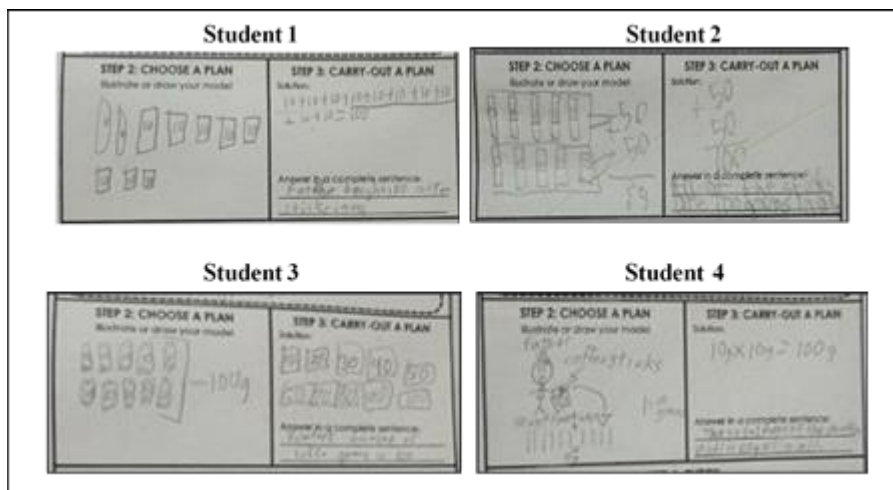


Figure 4. Students' Responses on the Word Problem on Mass

Without teacher's prompts, the students were able to use repeated addition, partial sum, skip counting, and multiplication in solving this problem. When these outputs were presented to the class, it made them realize that problems can be solved in many ways. During the presentation of the answers, some students shared how his/her ways are different or similar to one another. One student said, "My drawing looks the same as his (the presenter). I solved it differently but still I have the same answer." Another student added, "My drawing looks the same as his (the presenter) and I got the same answer. However, I solved it differently."

The UC³ Model promotes self-assessment in learning. The UC³ template serves as a reminder for pupils reminded of the importance of checking their own answers. "Checking always reminds me to review and put labels and peso

signs. I always forget this (label) before, but it always reminds me now to answer in a complete sentence. Always!", a student said. Although a few students admitted that they still neglect the checking part of UC³ model because it would require time, many still conscientiously go through the 4th step for the purpose of self-assessment. According to Sharma et al (2016), self-assessment develops students' critical skills to analyze their own work, improve students' interest and motivation levels thus helping them improve learning and academic performance. It is in this light where the UC³ model gives emphasis on self-assessment among students Craig (2016).

The UC³ Model develops positive attitude at looking at mistakes as opportunities to learn. Admittedly, the use of UC³ Model does not guarantee that the students will yield correct answers every time they do problem solving activities. However, the students showed a more positive attitude when given points for the parts that are correctly done and a more positive view in looking at their mistakes as opportunities to learn. "Oh, I forgot the label that is why only got 3 points.", "Now I know my mistake, I added it wrongly", "Ah! I almost got it, but I subtracted $0-9 = 9$. I am too careless". the pupils commented. As Hattie et al (2007) highlighted the importance of providing the students with specific information about what was right or wrong in their output, and what exactly they did well or what needs improvement. Students were able to understand root cause of their difficulty in doing problem solving task may it be (1) lack of comprehension, (2) number sense and sense making, (3) computation or (4) checking/completion of answers, and thus become opportunities to learn from and at the same time, teachers can easily help them with. Moreover, advanced students can be given advanced/multiple step problems to further hone their skills.

Lowlights

The UC³ Model caters only to a few learning styles. Although the UC³ model develops creativity in learning among students, it highlighted more on visual learning style on top of verbal and logical-mathematical. This is the common concern by a number of students who do not like drawing or illustrating. In step 2 of the UC³ model: CHOOSING A PLAN, it has been observed students have a common misconception that drawing/ illustrating is the only way to do this step. Some comments from the students include, "It is difficult to draw and it takes time to draw, I don't like to draw that's why it's difficult for me." "I need to draw and write so many and the space, it's too small for me." It is therefore a continuous quest among teachers as to how we can emphasize other ways of CHOOSING A PLAN such as making a list, guess and check, looking for a pattern, acting it out are among the suggested things that can be done in this step. Teaching the use of Singapore bar models' side by side with this UC³ model can be another way to address this limitation.

The UC³ Model requires too much time. To a significant number of student participants expressed that when the UC³ model first was introduced, the process is "tiresome", and "too long". Tendency is that they are tempted to do

shortcuts or even neglected the other steps because of their fear of not being able to solve the word problem on time since it requires them to go through the four steps. Although, some said that it became easier as they continue to do it every day.

CONCLUSIONS AND RECOMMENDATIONS

The utilization of the UC³ Model in teaching problem solving is effective in improving students' skills and attitude and perception towards problem solving of grade 2 students. The UC³ Model proved to be a more potent tool, compared to the conventional method of problem solving, in improving the problem-solving skills as well as the demonstrated positive attitude of the students towards problem-solving tasks.

Based on the abovementioned findings and conclusion, the study recommends that a) UC³ -based problem-solving drills to be integrated intentionally in Math classes; and b) Math teachers to be given with workshops and trainings to better implement the UC³ model and develop own workbook as means of improving the problem-solving of the students. It further recommends for future researchers to explore the use of UC³ model in early education, to conduct a comparative analysis between UC³ Model and other non- conventional method of problem solving in the primary grade levels, and to conduct similar studies in other schools such as public schools and the UC³ workbook may be utilized in schools to validate the content and procedure of the use of the workbook.

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