DEVELOPMENT AND ACCEPTABILITY OF CONCEPTUALIZED VIDEO LEARNING LESSONS ON BASIC FUNDAMENTAL OPERATIONS USING VISUAL PATTERNS IN NUMERACY EDUCATION

[1]Jhon Lee Rellama, [1]Erica Bagsic, and [1]Jesus Santillan*

Abstract

The effective teaching and learning of mathematics can be enhanced through visual patterns and representations, which are particularly important in the context of blended and remote learning. This study aimed to develop video learning lessons showcasing different problem-solving methods using existing visual patterns and techniques in Numeracy Education, specifically for manipulating basic math operations. The study employed a convergent mixed methods approach, integrating the ADDIE Model to ensure effective instructional design. The developed video learning lessons were highly accepted by five selected experts in the field, with feedback and recommendations provided for further improvement. Based on the significant feedback, the study concluded that visual learning concepts should be incorporated as a strategy in blended and remote learning education, especially in foundational topics of the mathematics curriculum. These findings highlight the importance of incorporating visual learning concepts in online mathematics education to improve learning outcomes.

Keywords: *Visual patterns, interactive learning, instructional design, non-digital games, educational technology*

Corresponding Author: Jesus Santillan, jesussantillan@cnsc.edu.ph

1.0 Introduction

The current coronavirus disease (COVID-19) epidemic has posed significant obstacles and has impacted educational institutions, and no one knows when it will cease. Every country is currently putting in place plans and processes to contain the virus, but the number of illnesses continues to rise. In the educational context, the new normal should be considered in the formulation and execution of the "new normal educational policy" to maintain and offer excellent education despite lockdown and community quarantine (Tria, 2020). The pandemic has affected many core sectors, including the education sector. Students cannot go to school to study and have to practice social distancing by staying at home (Rahayu *et al.*, 2020). Educators communicated with students via online platforms; webinars served as a temporary classroom; parents were summoned for home monitoring; and students were denied social interaction with their peers (Alea *et al.,* 2020). Despite its problems and difficulties, the new normal provided a different environment for students to learn in. Still, the students can keep studying no matter how hard it is.

This pandemic has caused significant disruptions in the education sector worldwide, including in the Philippines. Toquero (2020) highlights the challenges faced by educational institutions in planning, implementing, and assessing learning during the pandemic. A research study conducted in Finland examined the perceptions of students and teachers toward distance learning during the pandemic. The study employed surveys and qualitative content analysis and found that distance education required significant effort and self-management from students. Several subthemes emerged from the students' responses, including motivation problems, difficulty concentrating, fatigue, learning difficulties, longing for interaction, and difficulty asking for help, particularly in math. The teachers also reported positive and negative experiences in various categories, such as interaction with students, evaluation of learning, the workload of teachers and students, student motivation, and technology. While the general tone was positive, the teachers expressed concern that distance learning was missing crucial aspects of regular school life (Niemi & Kousa, 2020). These findings underscore the need for effective and engaging instructional tools to support students' learning during the pandemic. Therefore, this study explored the effectiveness of game-based innovations and math manipulatives as instructional tools to enhance math learning during distance education.

Certain students, particularly in mathematics, find the Philippine educational system challenging. A research study was done by Capuyan *et al.* (2019), where 88 elementary learners from grades 1 to 6 were recommended by their mathematics teachers to engage in remediation as they achieved a final mathematics grade of 78 or below in the previous year. In addition, Dela Cruz *et al.* (2014) examined students' difficulties and level of performance in translating word problems into mathematical symbols through a 20-item problem-solving test involving the four fundament operations, which was given to 204 grade 5 students. Results indicate that 40% of the respondents are below a satisfactory level in translating words. Mathematics becomes more difficult for them, and their numeracy skills become weaker as well since students are confined in the comfort of their homes due to social distancing requirements. According to Rahayu *et al.* (2020), students find it difficult to understand the material delivered through distance learning; they lack confidence and are confused about completing assignments, more particularly math assignments.

On the other hand, in today's new normal education system, digital tools have become essential for sharing knowledge and in the teaching process. Digital learning develops practical teaching strategies for teaching effectiveness (Lin *et al.,* 2017). Also, visual representation is an effective way to teach mathematics since there is no face-to-face interaction. It is a great way to share knowledge, despite being computer-based. According to Yung and Pass (2015), visual representation has been recognized as a powerful learning tool in many learning domains. In addition, Debrenti (2015) claimed that visual representation often helps understand a problem. Using visual representation leads to a better understanding and improves special mathematical reasoning.

A research study conducted by Yung and Pass (2015) noted that learning with visual representations resulted in higher learning performance and lower cognitive load than learning without visual representations. The results suggest that visual representation, which conveys information about numbers and relations among numbers in a simple form, allowed students to focus on essential elements. In addition, arithmetic operations on integers, word problems, multiplication, and division are highly complex. Without visual representation support, mathematics concepts tend to be more difficult in addition and subtraction for elementary school children (Muñez et al., 2013). In elementary mathematics, arithmetic operations on integers are generally learned through solving mathematics word problems (Yung & Pass, 2015).

Video-based learning, including flipped classroom and concept-driven video lessons, can improve students' cognitive and affective

engagement, knowledge integration, and learning outcomes in mathematics courses (Chang *et al.*, 2020; Hsieh *et al.*, 2021; Lai *et al.*, 2016). Also, there is evidence that video-based learning can have positive effects on learning outcomes in mathematics education (Mayer *et al.*, 2003; Shi *et al.*, 2021; Sun *et al.*, 2020). However, there are research gaps in terms of exploring the most effective strategies for incorporating visual patterns and representations in video learning lessons to enhance numeracy skills in blended and remote learning contexts. Thus, further research is needed to address this gap in the literature.

With these, the study's innovation lies in developing video learning lessons that showcase different problem-solving methods using visual patterns and representations in numeracy education. Ultimately, the output of this study aims to enhance the effective teaching and learning of mathematics, particularly in blended and remote learning contexts. The proposed instructional material is unique because it incorporates visual learning concepts as a strategy to improve learning outcomes, specifically in foundational topics of the mathematics curriculum. The design of video lessons is expected to provide an engaging and interactive way for learners to visualize and understand mathematical concepts, leading to improved cognitive and affective engagement, knowledge integration, and learning outcomes. Using visual patterns and representations in video learning lessons is expected to enhance students' ability to absorb and retain knowledge by helping them associate ideas, words, and concepts with images, as discussed in Raiyn's (2016) research.

Thus, this study focused on the development of video learning lessons about solving problems using the four basic mathematical operations, particularly for solving integers, and determined the materials' level of acceptability. The target users of this material are intermediate students. The said material was evaluated by five (5) selected mathematics teachers of Calauag, Quezon. The content of the developed video learning materials was validated in terms of content design, quality, usefulness, and appropriateness. Specifically, sought to (1) determine the different existing patterns and methods for solving integers using the four (4) basic operations at the intermediate level from related published articles and/or other educational learning platforms in mathematics education; (2) determine the level of acceptability of the developed video learning lessons and activity materials based on identified different existing patterns and methods in solving integers as a supplement learning aid to enhance the student's competencies in performing the four (4) basic operations at the intermediate level, in terms of: content design of the material; quality of learning material; usefulness of learning material; and, appropriateness of the content. Finally, modify the proposed supplementary materials based on the comments, suggestions, and recommendations of the selected teacher experts.

2.0 Methodology

This study utilized the convergent mixed-method research design, which combines both qualitative and quantitative research methods (Creswell & Plano Clark, 2018). In this study, the researchers used qualitative research methods through an in-depth analysis of some existing educational video tutorials of some visual pattern techniques to be integrated into the developed video learning lessons: solving the basic fundamental operations. Meanwhile, the researchers used a validated rubric instrument based on the Department of Education's (DepEd) Learning Resource Management and Development System (LRMDS) to quantitatively assess the level of acceptability of the developed video learning lessons. The rubric considered various aspects, such as different existing patterns and methods in solving integers, content design of the material, quality of learning material, usefulness of learning material, and appropriateness of the content (DepEd, 2015).

The ADDIE Model was also integrated into the study as an overarching framework for instructional design. This model comprisesfive phases: Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009). The researchers followed these phases to ensure that the video learning lessons were designed and developed effectively for the enhancement of the learners' numeracy skills. In the analysis phase, the researchers identified the learning needs and goals of the target audience (Merrill, 2018), including the existing patterns and methods for solving integers using the four (4) basic operations at the intermediate level from related published articles and other educational learning platforms in mathematics education (Bickman *et al.,* 1998).

In the design phase, the researchers formulated propositions (Dick *et al.,* 2015) and conducted a review of relevant and significant articles that support the formulated propositions (Creswell, 2014). In the development phase, the researchers created the video learning lessons based on the identified patterns and methods while ensuring that the material is of high quality, useful, and appropriate In the implementation phase, the video learning lessons were tested and evaluated by expert evaluators. Finally, in the evaluation phase, the researchers used the scoring rubric, and statistical procedures were executed to assess the level of acceptability of the developed video learning lessons.

The researchers selected purposively five (5) teacher experts as evaluators using the following criteria: (a) a mathematics teacher, (b) has at least two (2) years of teaching experience in secondary/primary levels, (c) has a master's/doctoral degree (preferably), (d) has at least background knowledge in doing or creating learning materials (Lincoln & Guba, 1985). Table 1 summarizes the profile of the experts who were selected as evaluators of the proposed video materials.

Table 1. Respondents' profile

Expert	Description and Qualifications
A	14 years of teaching mathematics, mathematics coordinator, learning and development coordinator, school paper adviser, district mathematics coordinator-secondary, MAED
B	23 years of teaching mathematics
C	4 years in teaching
D	8 years of teaching mathematics, SHS coordinator, master teacher 1
E	4 years of teaching mathematics

The researchers presented the proposed conceptualized video learning lessons to the evaluators. The qualitative procedures involved presenting the proposed video learning lessons to the evaluators and collecting their feedback and recommendations for the lessons. The data collected was then arranged, linked, and coded according to themes. Specified modifications in terms of content design, quality, usefulness, and appropriateness of the developed material are detailed in later sections of the paper.

During the conduct of the study procedures, the researchers strictly followed duly implemented school policies aligned with the AITF protocols. Finally, for ethical considerations, the researchers wrote a letter requesting permission to conduct a study, asking for the respondents' assistance and an honest answer to questions regarding the study. The researchers also explained to the evaluators the confidentiality measures upheld by this research, including the exclusive use of data for the sole purpose of this study.

3.0 Results and Discussion

Using visual patterns, representation, and lessons will help students better understand the challenging role of mathematics. Visual learning helps pupils develop visual thinking, a learning style in which the learner comprehends and retains knowledge more effectively by linking ideas, words, and concepts with visuals (Raiyn, 2016). These existing patterns and methods can help learners develop their numeracy skills and problem-solving skills. The different existing patterns and methods for solving integers using the four (4) basic operations at the intermediate level were adopted from related published articles and other educational learning platforms in mathematics education.

Table 2 summarizes the adopted techniques in solving the four basic operations from reviewed articles and existing educational video learning materials. These patterns and techniques are designed to increase the abilities and competencies for completing fundamental mathematical operations in various ways. The following are descriptions of the components and characteristics of the developed video lessons:

1. Addition (Add the 10s first Plus Group the 10s). This arithmetic video provides learners with a walk-through of some mental math addition strategies. Students can learn the math underlying adding two-digit numbers, including some methods to help learners add faster.

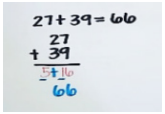
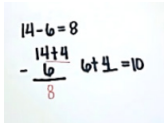
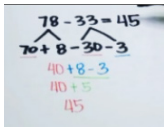
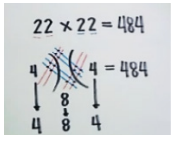
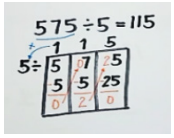
2. Subtraction (Teen Subtraction and Breaking Down Technique). This video lesson features a fast trick that involves subtracting digits from teen values. Another method featured in this video involves the removal of a larger number, called the Breaking Down Technique, which uses the minuend and subtrahend to reduce an amount to a small number.

3. Multiplication (Japanese Multiplication Techniques). This video features techniques known as Japanese Multiplication Techniques. These techniques refer to a line diagram technique that aids in mathematics, involving the substitution of numbers for lines in multiplication. According to Fiqhan, *et al.* (2022), this method teaches children how to calculate multiplication using lines. This is done to make it easier for the learners to understand multiplication and apply it without using the memorization method.

4. Division (Box Method). This video lesson features a method that is perfectly connected with math standards, using the Box Method. This method is quite similar to traditional long division but has the added benefit of organization.

The existing techniques and methods of solving adopted from selected education learning materials i.e., video learning lessons were used as a basis for developing the proposed video learning lessons. Trying out different digits was used as an approach to expand and elaborate the knowledge of the adopted patterns and methods in the video lessons. The researchers also used different methods to test the capacity of these techniques to help learners

Table 2. Adopted patterns and methods of the proposed conceptualized video lessons

Operation	Patterns/Methods		Content Creator/Reference
Addition	Add the 10s first Plus Group the 10s		Youtube Channel of indySOW
Subraction	Subtraction of the Teens breaking		YouTube Channel of PrepNorthwest
	Down Technique		YouTube Channel of the Organic Chemistry Tour
Multiplication	Japanese Multiplication Techniques		Youtube Channel of DaveHax.com
Division	Box Method		YouTube Channel of math with Mr. J.

solve basic operations.

It was found that the video tutorials allow learners to use an array of digits for solving problems. The reason for figuring out the different patterns and ways to solve integers using the four basic operations is to give students more information that will help them improve their math skills. According to Niess and Walker (2005), watching videos gets students involved in more robust debates, which helps them get a better grasp of math concepts because the videos can be used as a starting point for mathematical thinking.

Figure 2 illustrates the process of solving the four basic operations using the existing patterns and methods in the actual video learning lessons of the study.

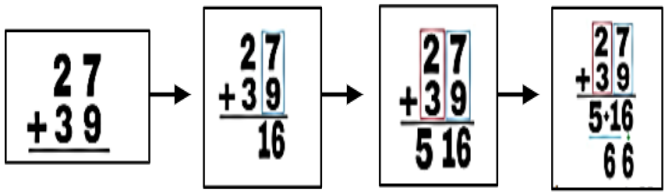


Figure 2. Addition (Add the 10s first plus group the 10s)

Based on the illustration above, begin by adding first the numbers in the one's column: 7 plus 9 equals 16. Then proceed to add the tens column, so 2 plus 3 equals 5. The result shows 516. Next, add the number in the hundreds place to the number in the tens place: 5 plus 1 is 6, then bring down the other 6, and the answer is 66.

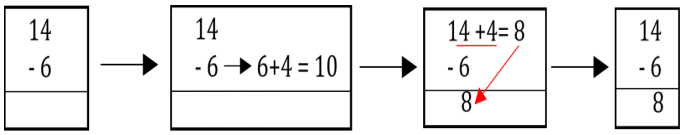


Figure 3a. Subtraction (Teen Subtraction and Breaking Down Technique: Teen Subtraction)

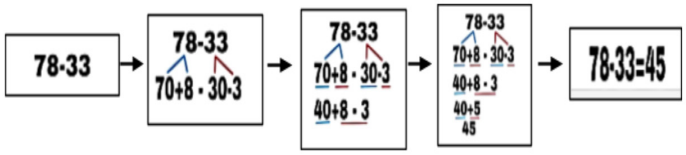


Figure 3b. Subtraction (Teen Subtraction and Breaking Down Technique: Breaking Down Technique)

Begin the Teen Subtraction technique by subtracting 6 from 10, which equals 4. Take that 4 and add it to the minuend in the one's digit value of 14 which is 4. So, 4 plus 4 equals 8. On the other hand, begin the Breaking Down technique by breaking down the minuend and the subtrahend into small numbers similar to the example illustrated in Figure 3. b. Then, apply the negative signs of both numbers (ones to ones, tenths to tenths, hundreds to hundreds). Simplify to get the answer of 45.

Figure 4 illustrates the Japanese multiplication techniques used in the process of solving the four basic operations. Draw sets of parallel lines representing each digit of the first number to be multiplied. (The multiplicand). Count the number of dots to get the answer. Draw sets of parallels, perpendicular to the first sets of parallels, corresponding to each digit of the second number. (The

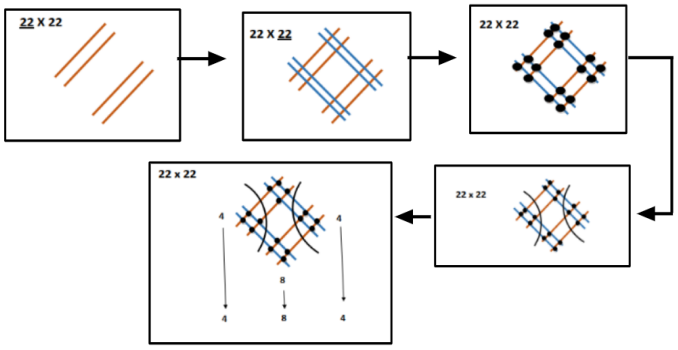


Figure 4. Multiplication (Japanese Multiplication Techniques)

multiplier) Put dots where each line crosses another line. On the left corner, put a curved line through the wide spot with no points. Do the same with the right. Count the points in the right corner, the middle, and the left corner. Write it down and you will have your final answer 484.

Finally, Figure 5 illustrates the solving procedures for division using the Box Method technique.

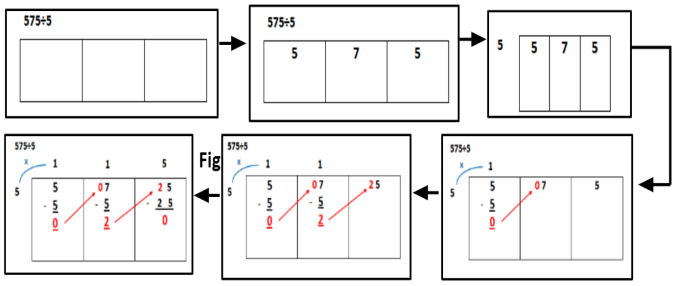


Figure 5. Division (Box Method)

Begin by drawing a rectangle, and split it into three sections corresponding to each digit of the dividend. Put each digit of the dividend in their respective sections. Put the divisor outside of the rectangle on its left side. Divide-Multiply-Subtract-Bring up, then repeat the same process in step 4. Repeat it, and write down those numbers above the rectangle to get the answer 115. With these, the concepts integrated into the video learning lessons in solving basic operations will guide the students because of their simplified patterns. According to Debrenti (2015), visual representations frequently aid in comprehending a topic. Utilizing visual representations facilitates comprehension and enhances special mathematical reasoning.

The developed video lesson in solving the basic operations was evaluated in terms of content design, quality, usefulness, and appropriateness of the content. The evaluators are experts in the field of teaching and developing materials in mathematics and are trained personnel responsible for validating the generated product. Table 3 shows the evaluators' high acceptance of the developed video lessons for performing the four (4) basic operations at the intermediate level, based on the general weighted mean of 3.70.

Based on the result, all indicators of the developed video lesson are Highly Accepted with an overall mean of 3.70 (Highly Accepted). The content design of the material has a computed weighted mean of 3.20 (Highly Accepted), followed by the quality of the learning material and the appropriateness of the content with a computed weighted mean of 3.80 (Highly Accepted). Furthermore, the

Table 3. Level of acceptability of the proposed video lesson (n=5)

Indicators	HA	A	LA	NA	Weighted Mean	Interpretation
Content Design of Learning Material	40%	40%	20%	0%	3.20	Highly Accepted
Quality of Learning Material	80%	20%	0%	0%	3.80	Highly Accepted
Usefulness of Learning Material	100%	0%	0%	0%	4.00	Highly Accepted
Appropriateness of the Contents	80%	20%	0%	0%	3.80	Highly Accepted
				General Weighted Mean:	3.70	Highly Accepted

Legend: Highly Accepted: (3.5-4.0) Accepted; (2.50-3.0) Less Accepted; (1.50-2.00) Not Accepted; (1-1.40)

usefulness of learning materials had a computed weighted mean of 4.00 (Highly Accepted).

Results suggest that the presentations are clear and easy to comprehend. The content design of learning materials (40% Highly Accepted and 40% Accepted) is fairly well documented and organized, and the format is easy to follow. The proposed material also has an excellent sense of design. The video focus is of good quality (80% Highly Accepted): the transitions are smooth and appropriate, and the sound is well suited to the presentation. In terms of the usefulness of learning material (100% Highly Accepted), the video lessons are focused and informative; the content promotes techniques for performing basic operations. Also, the content meets all appropriateness (80% Highly Accepted) requirements and is very creative.

The high level of acceptability can be attributed to the clear and easy-to-comprehend presentations, well-organized and documented content design, appropriate transitions and sound, and focused and informative content that promotes basic operations techniques. The findings suggest that the integration of visual patterns and representations in video learning lessons can enhance the effectiveness of teaching and learning mathematics, particularly in blended and remote learning contexts. The use of these strategies can improve students' cognitive and affective engagement, knowledge integration, and learning outcomes.

Furthermore, the use of the convergent mixed method research design proved to be effective in evaluating the acceptability of video learning lessons. The combination of qualitative and quantitative research methods allowed for a comprehensive evaluation of various aspects of the learning materials, such as content design, quality, usefulness, and appropriateness. Overall, this study highlights the importance of incorporating visual learning concepts in online mathematics education, as it can improve the quality of learning and help address the challenges brought by the pandemic in education.

Following the validation of the learning materials, the selected mathematics teachers were asked for suggestions and recommendations for improving the video lesson. The evaluators' suggestions were taken into account to further improve the content and features of the developed materials. In addition, the comments made by the research committee were also considered. Table 4 summarizes the specified modifications, which were integrated into the developed materials.

The qualitative findings from the study suggest that while the content design of the video lesson was highly accepted, there are still some areas that need improvement. The evaluators recommended that the video tutorial should show the four basic operations in a novel approach, with a brief explanation for each case, more particularly for multiplication and division. Additionally, it was suggested to enhance the readability of the materials by increasing the fonts, including the creation of separate videos and discussions for each operation.

Table 4. Modification of the proposed supplementary materials in solving four basic operations in different ways

Criteria	Modifications
Content Design of Learning Material	Include a brief explanation for each example since it is new to the learners. Maximize spaces by increasing fonts so that the material becomes more readable for the learners.
Quality of Learning Material	Consider reviewing the background voice, and ensure spaces are maximized.
The Usefulness of Learning Material	The video learning lessons will be a great help for the key stage 3 to review the concepts of solving basic operations in different ways manually since they rely on using a calculator. The content is very timely and easy to understand.
Appropriateness of the Contents	Consider creating separate videos and discussion for each operation.

In addition, the positive feedback suggests that the developed video lesson is well-structured and effective for asynchronous training pupils. The use of high-quality resources in the given examples reflects the suitability of the materials for the learners, and the reliance on calculators will be beneficial for Key Stage 3 students in exploring the concept of executing simple manual operations.

Likewise, the study's findings imply that visual pattern techniques in video learning lessons can be an effective tool for enhancing numeracy skills in secondary mathematics education. The recommendation to show the four basic operations in a novel approach can help improve the way pupils learn mathematics through a fresh perspective of approaching these operations. The overall feedback of the evaluators is viewed to be essential modifications that will help improve students' comprehension and retention of the lessons and provide more focused learning and better organization of the material.

Finally, the qualitative findings from the study suggest that incorporating visual patterns and representations in video learning lessons can enhance students' cognitive and affective engagement, knowledge integration, and learning outcomes in mathematics courses. By continuously improving the content design of the learning materials, educators can further enhance the effectiveness of video-based learning for numeracy skills development.

4.0 Conclusion

The four (4) basic mathematical operations are vital and essential to attaining mastery in the next learning contents or higher-level skills in mathematics. Based on the findings of the study, using video learning materials that contain problem-solving patterns and techniques can be useful in blended and remote learning education. Moreover, the concepts of the visual learning process could be included as a strategy in blended and remote learning education, especially in teaching and learning foundation topics in the mathematics curriculum. To further assess the effectiveness of the developed video lessons, it is recommended to utilize the materials and determine their impact on the target users, the students.

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