UtilitasMathematica

ISSN 0315-3681 Volume 122, 2025

DEVELOPMENT OF POLYA'S TECHNIQUE-BASED VIDEO TUTORIALS FOR STUDENTS' PROCEDURAL FLUENCY IN COLLEGE ALGEBRA

Joel C. Patiño Jr.[1]

[1] Instructor III, College of Teacher Education, Cotabato State University, Cotabato City, Philippines

[1]joeljr@cotsu.edu.ph

ORCID iD: 0009-0005-0953-0651

Corresponding Author: Joel Completano Patiño Jr.

ABSTRACT

This study aimed to develop Polya's video tutorials for improving students' procedural fluency in college algebra. The four concepts of problem-solving introduced by George Polya, namely understanding the problem, devising a plan, carrying out the plan and looking back, form the foundation of the video tutorials. The first semester of the academic year 2023–2024 was the covered time of the study with one hundred College of Teacher Education students majoring in mathematics at Cotabato State University as respondents. Descriptive research design using a survey method was utilized. Based on the results, the majority of respondents believed Polya's technique-based video tutorials were very good in terms of layout, content, and usefulness. The video's layout or design is suitable for learners, and the video's engaging content places a strong emphasis on the four problem-solving principles. Additionally, video tutorials are unquestionably crucial for learning mathematics because they provide an alternative source of information for efficient problem-solving. Personalized tutorials can be very beneficial for both instructional learning and self-learning to help students learn various mathematical problems.

Keywords: *Polya's technique, personalized tutorials, procedural fluency, descriptive, Philippines*

Introduction

Mathematics is not an easy subject to learn. Even before the pandemic, it was highly unlikely to succeed in math classes. Due to the abstract nature of mathematics, students, particularly those with low achievement levels, quickly lose interest in the subject **[1]**. In truth, practice is the only way to pick up new skills **[2]**. The law of exercise, which emphasizes that the things that are repeated the most are the best remembered, and that students acquire information more effectively and retain it for a longer period of time when they engage in meaningful practice and repetition, are both stated in Edward Thorndike's (1898) theory of connectionism.

A substantial quantity of video content is now incorporated into higher education. It often serves as a primary medium for content dissemination in online courses, is integrated into conventional courses, and underpins various blended courses **[3]**. Meanwhile, solving problems is a part of everyday life. Individuals frequently deal with

problems and come up with solutions for them. Different procedures or steps are taken in order to solve a specific problem.

The four phases or areas of problem-solving that Polya (1957) outlined in his book "How to Solve It" have subsequently come to be accepted as the standard framework for problem-solving. Polya stated that one of the main duties of the teacher is to discourage his students from forming the impression that mathematical problems are unrelated to one another or to any other subject. The teacher should motivate the students to envision scenarios in which they could utilize the procedure or implement whatever result they have obtained. It is true that after you have mastered various problem-solving skills, such as metacognition and critical thinking, you can apply these skills not just in the field of mathematics but also in other disciplines like language, the arts, and science.

Blended learning has been used to teach subjects or courses since face-to-face instruction gave way to distance learning, particularly in public schools and universities. Problem-solving in Mathematics is undoubtedly one of the hardest subjects to teach and learn. For this reason, the researcher set out to create individualized video tutorials that would act as an alternative approach of teaching problem-solving skills. In particular, the created video lessons whose format, content, and utility were verified through descriptive analysis. The results of the study are highly advantageous to both learners and teachers since instructional videos contribute to the enhancement of student engagement, which in turn helps boost achievement.

Objectives of the Study

This study sought to develop video tutorials in College Algebra based on the four principles of George Polya, namely understanding the problem, devising a plan, carrying out the plan, and checking the answer. Also, it aimed to determine the extent of quality of the developed Polya's technique-based video tutorials based on the format or layout, content, and usefulness.

Materials and Methods

The collected data has undergone to descriptive analysis. The sample mean (2.1) and sample standard deviation (2.2) were used to validate the format, content, and usefulness of the created video tutorials. The mathematical formulas used were as follows:

$$\bar{x} = \frac{\sum_{i=1}^{n}(x_i)}{n} \qquad (2.1)$$

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}} \qquad (2.2)$$

There were twenty video tutorials covering topics related to the least-learned competency in problem solving, specifically how to solve mathematical problems involving motion, age, number and work. Three (3) characteristics of a very good instructional video comprised the modified questionnaire **[4]**. Further, both the video and the questionnaire were evaluated by experts in research and education.

Regarding the data collection procedure, the researcher requested approval to conduct the study from the Cotabato State University (CSU) administration, specifically

the dean of the College of Teacher Education (CTEd). Following this, a sample of one hundred CSU-CTEd students was granted access to the twenty (20) Polya's technique-based video tutorials. After the respondents' five weeks of exposure to the created video tutorials, a survey was promptly conducted to verify the video tutorials' format, content, and usefulness.

Results and Discussion

Table 1
Extent of Quality of Polya's Technique-Based Video Tutorials in terms of Format or Layout (n = 100)

Statement	$\bar{x}$	s	Description
1. The layout of the video tutorial is arranged in a logical and sequential order.	4.84	0.395	Very Good
2. The font size and font style of the video tutorial is readable.	4.82	0.435	Very Good
3. The video tutorial has a balanced, clear and compelling audio.	4.79	0.433	Very Good
4. The mathematical symbols used in the video tutorial are accurate and well-defined.	4.91	0.351	Very Good
5. Illustrations and captions are properly laid out for easy reference.	4.80	0.449	Very Good
Overall	**4.83**	**0.413**	**Very Good**

Legend:

Range of Means	*Description*
4.20 – 5.00	*Very Good*
3.40 – 4.19	*Good*
2.60 – 3.39	*Acceptable*
1.80 – 2.59	*Poor*
1.00 – 1.79	*Very Poor*

As shown in Table 1, majority of the respondents perceived the extent of quality of the Polya's technique-based video tutorials as very good in terms of format or layout as indicated by the overall mean of 4.83 and standard deviation of 0.413. This finding suggests that the video design or arrangement is of high quality, and it is appropriate to the learners of problem-solving. Videos facilitate in-depth learning by combining different learning resources, including sound, motion, and images **[5]**.

Particularly, statement 4 got the highest mean which indicates that the mathematical symbols used in the video tutorials are accurate and well-defined. The result of the study implies that no mathematical errors were found in the video tutorials. As emphasized in the study conducted by **[6]**, students are more likely to accept video-based instruction or video-assisted learning when there are no technical issues, such as issues with audio and video quality.

Table 2

Extent of Quality of Polya's Technique-Based Video Tutorials in terms of Content (n = 100)

Statement	$\bar{x}$	s	Description
1. The learning activities helped me understand fully the topic.	4.83	0.428	Very Good
2. The video tutorial highlighted the use of Polya's four principles in problem-solving.	4.90	0.302	Very Good

3. The presentation of the lesson as well as the suggested task stimulate interest in learning.	4.82	0.386	Very Good
4. I find it easier to study mathematical problems using these video tutorials.	4.78	0.524	Very Good
5. I understand clearly the concepts and solutions in each topic.	4.75	0.520	Very Good
Overall	**4.82**	**0.432**	**Very Good**

Legend:

Range of Means	*Description*
4.20 – 5.00	*Very Good*
3.40 – 4.19	*Good*
2.60 – 3.39	*Acceptable*
1.80 – 2.59	*Poor*
1.00 – 1.79	*Very Poor*

As reflected in Table 2, most of the respondents perceived the extent of quality of the Polya's technique-based video tutorials as very good in terms of content as indicated by the overall mean of 4.82 and standard deviation of 0.432. This finding implies that the video content is also of high quality, and it is engaging to the learners of problem-solving. By developing or packaging educational videos in a manner that conveys to the learners that the content is intended for them, it becomes possible to raise the level of student engagement with the content **[3]**.

Particularly, statement 2 got the highest mean which indicates that the video tutorial highlighted the use of Polya's four principles in problem-solving. The result of the study suggests that the content of the video provides emphasis on the process of problem-solving specifically understanding the problem, planning or devising a strategy, solving or executing the plan and checking the answer or looking back. As cited by **[7]**, students' level of rationality and their ability to solve mathematical problems can both be enhanced by Polya's four stages. In light of this, learning planning is essential as it can enhance problem-solving skills. One of the seven principles for designing and developing video lessons is learning by example. This concept posits that learning occurs when students actively construct their own knowledge by interpreting their experiences. Consequently, experiences that support the construction of knowledge should be a part of instruction. Giving examples helps students learn because it gives them a picture of experiences they may not have had **[8]**.

Table 3

Extent of Quality of Polya's Technique-Based Video Tutorials in terms of Usefulness (n = 100)

Statement	$\bar{x}$	s	**Description**
1. The video tutorials will motivate learners to study problem-solving in College Algebra.	4.74	0.525	Very Good
2. The video tutorials will help learners master the topics at their own pace.	4.80	0.449	Very Good
3. The video tutorials will allow learners to use their time more efficiently.	4.80	0.492	Very Good
4. The video tutorials will develop the learners' analytical thinking and reasoning skills in solving mathematical problems.	4.78	0.524	Very Good
5. The video tutorials will serve as an alternative material to effectively learn word problems in mathematics.	4.91	0.321	Very Good
Overall	**4.81**	**0.462**	**Very Good**

Legend:

Range of Means	*Description*
4.20 – 5.00	*Very Good*
3.40 – 4.19	*Good*
2.60 – 3.39	*Acceptable*
1.80 – 2.59	*Poor*
1.00 – 1.79	*Very Poor*

As presented in Table 3, majority of the respondents perceived the extent of quality of the Polya's technique-based video tutorials as very good in terms of usefulness as indicated by the overall mean of 4.81 and standard deviation of 0.462. This finding suggests that the video tutorial is truly important in mathematics learning. Students can raise their performance levels with the help of video lessons. Students will perform better when video lessons are incorporated into their math classes **[9]**.

Particularly, statement 5 got the highest mean which indicates that the video tutorials will serve as an alternative material to effectively learn word problems in mathematics. The result of the study implies that problem-solving in College Algebra can be easily understood using step-by-step video tutorials. According to **[10]**, audiovisual media will become increasingly significant in higher education because creative, process-oriented, and active learning methods will become more valued. When student commitment, active learning, and cognitive load are considered, videos serve as an effective teaching tool **[3]**.

Conclusion and Recommendations

This study concludes that the developed Polya's technique-based video tutorials were perceived as high quality in terms of format or layout, content and usefulness. Validation-wise, the video's layout and design suit the learners, and its content is interesting and places a strong focus on the four problem-solving principles. Additionally, video tutorials are incredibly helpful for learning mathematics because they provide different resources for efficient problem-solving. Personalized tutorials can be very helpful for both instructional and self-learning in helping students learn various mathematical problems.

This study recommends that the results should be disseminated by way of faculty and student development. On top of that, it recommends more research, mainly on the effectiveness of Polya's technique-based video tutorials in enhancing students' procedural fluency in college algebra. In such a way, the use of customized video materials will help the students become proficient problem solvers. Furthermore, it is recommended that all instructors teaching courses related to algebra incorporate the four Polya principles, particularly with regard to the problem-solving aspects.

References

[1] Yeh, C.; Cheng, H.; Chen, Z.; Liao, C. & Chan, T. (2019). Enhancing achievement and interest in mathematics learning through Math-Island. Research and Practice in Technology Enhanced Learning, 14(5). https://doi.org/10.1186/s41039-019-0100-9

[2] Long, M. (2016). The importance of practice – and our reluctance to do it. https://www.harvardbusiness.org/the-importance-of-practice-and-our-reluctance-

to-do-it/

[3] Brame, C. (2016). Effective educational videos: Principles and guidelines for maximizing student learning from video content. CBE–Life Sciences Education, 15(4). https://doi.org/10.1187/cbe.16-03-0125

[4] Torrefranca, E. (2017). Development and validation of instructional modules on rational expressions and variations. The Normal Lights, 11(1), 43-73. http://dx.doi.org/10.56278/tnl.v11i1.375

[5] Kosterelioglu, I. (2016). Student views on learning environment enriched by video clips. Universal Journal of Educational Research, 4(2), 359-369. 10.13189/ujer.2016.040207

[6] Galatsopoulou, F.; Kenterelidou, C.; Kotsakis, R. and Matsiola, M. (2022). Examining students' perceptions towards video-assisted active learning scenarios in journalism and communication courses, 12(1), 74. https://doi.org/10.3390/educsci12020074

[7] In'am, A. (2014). Implementation of the Polya method in solving Euclidean geometry problems. International Education Studies, 7(7), 149. https://dx.doi.org/10.5539/ies.v7n7p149

[8] Ou, C.; Joyner, D. & Goel, A. (2019). Designing and developing video lessons for online learning: A seven-principle model. Online Learning, 23(2), 82-104. https://files.eric.ed.gov/fulltext/EJ1218394.pdf

[9] Jeremias, J. & Carretero, G. (2022). Effectiveness of video lessons in improving the performance of the students in mathematics 8. United International Journal for Research & Technology, 3(11), 2582-6832. https://uijrt.com/articles/v3/i11/UIJRTV3I11001

[10] Kohler, S. & Dietrich, T. (2021). Potentials and limitations of educational videos on YouTube for science communication. Frontiers in Communication, 6(1). http://doi.org/10.3389/fcomm.2021.581302