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Video-Based Teaching and Learning in Mathematics

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Abstract

This study investigates the effectiveness of Video-Based Teaching and Learning (VBTL) strategy in enhancing mathematics performance across diverse subjects. Employing a concurrent embedded mixed-method pretest-posttest approach with a control group and quasi-experimental design, initial assessments revealed comparable pretest math performance levels between control and experimental groups. However, subsequent analysis unveiled substantial differences in posttest math performance. Notably, in Linear Inequalities and System, the experimental group achieved an impressive posttest score of 90%, compared to the control's 53.5%, albeit lacking statistical significance (t-value = -1.479, p-value = 0.374). Conversely, in Function and Relation, the experimental group demonstrated a significant score of 78.938%, compared to the control's 48.23%, confirmed by statistical analysis (t-value = -9.197, p-value < 0.001). Similarly, in Logic and Proof, the experimental group scored notably higher (71.917%) than the control (47.833%), with statistical confirmation (t-value = -3.495, p-value < 0.001). The study confirms that Video-Based Teaching and Learning (VBTL) effectively improves mathematics performance by reducing cognitive load and enhancing comprehension of mathematical concepts through visual aids and interactive elements, thus validating the efficacy of VBTL and contributing to discussions on innovative teaching strategies in mathematics education. These findings contribute to discussions on innovative teaching strategies in mathematics education, emphasizing VBTL's role in reducing cognitive load and enhancing comprehension of mathematical concepts.

Keywords: Video-based teaching and learning (VBTL), Mathematics performance, concurrent embedded mixed-method, Quasi-experimental design

Introduction

This study investigates the effectiveness of Video-Based Teaching and Learning (VBTL) in enhancing students' performance in mathematics, addressing significant challenges faced by Filipino students, as evidenced by poor results in global assessments such as PISA 2018 and 2022, TIMSS 2019, and TOFAS 2023. These assessments revealed consistently low proficiency levels, particularly in fundamental concepts like fractions, algebra, and problem-solving, with most students scoring below global averages.

Focusing on core topics such as linear inequalities and systems, functions and relations, and logic and proof, the study explores how VBTL can deepen students' comprehension of mathematical concepts and improve their overall academic performance. By aligning with the Department of Education's MATATAG Agenda, which emphasizes video-based interventions, this research contributes to the knowledge base for future researchers, offering insights into the impact of videos on engagement and achievement. It serves as a foundation for further exploration in various subjects or educational contexts, advancing instructional practices and promoting innovative approaches to teaching and learning.

Literature Review

Video-Based Learning: Insights and Impact

Video-Based Learning (VBL) has emerged as a transformative approach in mathematics education, enhancing knowledge acquisition through visual representations and self-paced learning. Studies by Yousef et al. (2014), Dodson et al. (2018), and Sablic et al. (2020) highlight VBL's ability to simplify abstract concepts, foster engagement, and cater to diverse learning needs.

Yousef et al. (2014) provided a comprehensive review of VBL research, categorizing its effectiveness, methods, design, and reflection while emphasizing innovations like flipped classrooms and MOOCs. Lalian (2018) demonstrated VBL's positive influence on students' cognitive and affective outcomes, while Mayer's Multimedia Learning theory and Sweller's Cognitive Load Theory offer strategies to optimize its use.

Practical applications, such as Khan Academy and flipped classrooms, show VBL's impact on critical thinking and problem-solving skills, supported by empirical studies from Galatsopoulou et al. (2022) and Smith (2021). Collectively, these findings establish VBL as a powerful tool for inclusive and effective mathematics education.

Video-Based Math Teaching: Insights & Future of VBTL

Recent research highlights the potential of Video-Based Teaching and Learning (VBTL) in enhancing mathematics education, particularly for junior high school students. Scholars have focused on integrating the worked example effect, a cognitive load principle introduced by Sweller (2020) and elaborated by Ayres (2012). This effect emphasizes the value of worked examples—explicit problem descriptions paired with step-by-step solutions—in reducing cognitive load and fostering knowledge construction.

Despite its promise, limited studies have applied the worked example effect to VBTL contexts in junior high mathematics. Prior research by Shroeder et al., Berger & Wilson, and others has explored its broader educational impact but left gaps in understanding its specific role in video-based instruction. Challenges such as the split-attention effect (Tarmizi & Sweller, 1988) and the completion problem effect (van Merriënboer & Krammer, 1987) also highlight the need for innovative instructional design strategies. Effective self-explanation behaviors, as studied by Renkl (1997), along with structural interventions, are key to maximizing learning outcomes.

Materials and Methods

The study employed a concurrent embedded mixed-method design, which involved the simultaneous collection and analysis of both quantitative and qualitative data within a single study. This integration aimed to provide a comprehensive understanding of the research topic (Almeida, 2018). The research design combined elements of quasi-experimental research with mixed methods, particularly a quasi-experimental pretest-posttest control group design conducted within a mega-sized national high school, consisting of 6,000 students and 194 staff members. Two groups were formed: an experimental group and a control group, each with 45 Grade 8 students aged 13-16, selected purposively based on their average grades between 81 and 85 in Grade 7. The experimental group engaged with video-based teaching and learning (VBTL), which included multimedia-rich videos, embedded quizzes, progress monitoring tools, and motivational badges. The control group followed traditional, non-video-based instruction. Quantitative data were collected through pretests and posttests. Both groups completed researcher-made tests to assess their baseline and post-intervention mathematical abilities. This quasi-experimental design with a control group allowed for a clear comparison of the impact of VBTL on student performance relative to traditional teaching methods. The qualitative component involved gathering feedback on student experiences and perceptions through semi-structured interviews and observations, providing additional insights into the effectiveness of the intervention. The concurrent collection and analysis of both types of data—quantitative performance assessments and qualitative feedback—enabled a triangulated approach. This approach allowed for a more nuanced understanding of the impact of VBTL on mathematics learning outcomes, as well as how students perceived the different teaching methods.

Results and Discussion

Table 1. Comparative Analysis of the Pretest Mathematics Performance Between the Control and Experimental Group by Competencies.

Linear Inequalities and Systems								
Competencies	**Control Group**			**Experimental Group**				
	Mean	PS	Description	Mean	PS	Description	T-Value	P-Value
Differentiates linear inequalities in two variables from linear equations in two variables.	0.29	29	DME	0.16	16	DME	1.163	0.443
Illustrates and graphs linear inequalities in two variables.	0.18	18	DME	0.18	18	DME		
Average		**23.5**	**DME**		**17**	**DME**		

Functions and Relations

Competencies	Control Group			Experimental Group				
	Mean	PS	Description	Mean	PS	Description	T-Value	P-Value
Determines dependent and independent variables.	2.36	39.33	DME	2.91	48.5	DME	-0.614	0.567
Finds the domain and range of a function.	2.31	38.5	DME	1.93	32.17	DME		
Graphs and illustrates a linear function and its (a) domain; (b) range; (c) table of values; (d) intercepts; and (e) slope.	0.22	22	DME	0.49	50	DME		
Solves problems involving linear functions.	1.33	33.25	DME	0.87	21.75	DME		
Average		**33.27**	**DME**		**38.105**	**DME**		

Logic and Proof

Competencies	Control Group			Experimental Group				
	Mean	PS	Description	Mean	PS	Description	T-Value	P-Value
Determines the relationship between the hypothesis and the conclusion of an if-then statement.	1.2	20	DME	1.11	18.5	DME	1.82	0.104
Transforms a statement into an equivalent if-then statement.	2.29	38.17	DME	2.44	40.67	DME		
Determines the inverse, converse, and contrapositive of an if-then statement.	1.89	31.5	DME	2.11	35.17	DME		
Illustrates the equivalences of: (a) the statement and its contrapositive; and (b) the converse and inverse of a statement.	0.36	36	DME	0.16	16	DME		
Uses inductive or deductive reasoning in an argument.	0.36	36	DME	0.13	13	DME		
Writes a proof (both direct and indirect).	0.4	40	DME	0.4	18	DME		
Average		**33.611**	**DME**		**23.556**	**DME**		

Significant at $\alpha < 0.05$
Note:
Hypothetical Mean 30
Source: DepEd Order No.8 series 2015 (Policy Guidelines on Classroom Assessment for the K-12 Basic Education Program)

Percentage Scores	**Description Level**
90 – 100	Outstanding (O)
85-89	Very Satisfactory (VS)
80-84	Satisfactory (S)
75-79	Fairly Satisfactory (FS)
Below 75	Did not meet Expectations (DME)

In the initial assessment of pre-test scores across Linear Inequalities and System, Function and Relation, and Logic and Proof, both the control and experimental groups exhibited levels classified as "Did Not Meet Expectation" (DME). Specifically, the control group scored 23.5% in Linear Inequalities and System, while the experimental group scored slightly lower at 17%. However, this difference was not statistically significant, with a t-value of 1.163 and a p-value of 0.443. Similarly, in Function and Relation, the control group scored 33.27%, slightly lower than the experimental group's score of 38.105%. Again, this difference was not statistically significant, indicated by a t-value of -0.614 and a p-value of 0.567. In Logic and Proof, the control group scored 33.611%, slightly higher than the experimental group's score of 23.556%. Although the difference was notable, it was not statistically significant, with a t-value of 1.82 and a p-value of 0.104. These findings suggest that both groups commenced the study with comparable levels of understanding across all three topics, indicating a balanced starting point for subsequent analyses of intervention effectiveness.

In the pretest of students' performance based on the pretest, the table 2 is presented below.

Table 2. Summary of Comparative Analysis of the Pretest Performance

	Mean	**SD**	**Effect Size**	**PS**	**Description**	**T-Value**	**P-Value**
Control Group	17.09	4.25	3.04	34	DME	0.425	0.672
Experimental Group	16.64	5.69	2.35	33	DME		

The table illustrates the pre-test mathematics performance of students in both the control and experimental groups. The control group scored a mean of 17.09 with a standard deviation of 4.25, resulting in an effect size of 3.04 and a percentage score of 34, categorizing their performance as "Does not Meet Expectations (DME)." Similarly, the experimental group scored a mean of 16.64 with a standard deviation of 5.69, an effect size of 2.35, and a percentage score of 33, also categorized as "Does not Meet Expectations (DME)." These classifications align with DepEd Order No.8 series 2015, which defines scores below 75 as "Did not meet Expectations (DME)." The "Does not Meet Expectations (DME)" categorization indicates that both groups' performance fell below the expected level, suggesting that students scored below the standard set by the grading system. Possible reasons for this could include gaps in understanding, lack of prior knowledge, or difficulty with the assessed concepts.

Table 3 displays the summary of post-test performance of both the control and experimental groups, alongside their respective standard deviations and verbal descriptions. The data were analyzed using the Statistics Kingdom calculator. The hypothetical mean for this analysis was set at 30 because DepEd is using 60% criterion reference grading system.

Table 3. Summary of Posttest Mathematics Performance of Students in the Control and Experimental Group

	Mean	**SD**	**D**	**PS**	**Description**	**Range**	**Adjusted Mean (SS/Error/MS)**	**F-Value**	**P-Value**
Control Group	22.24	6.89	1.13	44	DME	48.91-77.21	(4912.28) (3144.33) (4912.3)	32.76	<0.001
Experimental Group	37.27	5.33	1.36	75	FS	47.94-78.84			

The table summarizes the post-test mathematics performance of the control and experimental groups, including mean scores, standard deviations (SD), effect sizes (d), percentage scores (PS), range, F-value, and p-value, with a hypothetical mean of 30 to align with the 60% DepEd grading system.

The control group had a mean of 22.24 (SD = 6.89), effect size of 1.13, and was categorized as "Did not meet Expectations (DME)," with a significant T-value of -11.574. The experimental group had a mean of 37.27 (SD = 5.33), effect size of 1.36, and was categorized as "Fairly Satisfactory (FS)," with a p-value of <0.001, indicating a significant difference from the hypothetical mean.

These results highlight the effectiveness of the experimental intervention. Table 4 also presents ANCOVA results, showing significant differences in math performance across topics, with an f-value of 32.76 and a p-value of <0.001. The adjusted means for both groups suggest that the VBTL approach was more effective than traditional methods.

Table 4 presents a comparative analysis of the posttest mathematics performance between the control and experimental groups by competencies. The table illustrates the competencies and mean posttest scores for each group, providing valuable insights into the proficiency levels before the intervention.

Table 4. Comparative Analysis of the Posttest Mathematics Performance Between the Control and Experimental Groups by Competencies

Competencies	**Control Group**			**Experimental Group**				
	Mean	PS	Description	Mean	**PS**	**Description**	**T-Value**	**P-Value**
Linear Inequalities and Systems								
Differentiates linear inequalities in two variables from linear equations in two variables.	0.78	78	FS	0.87	87	VS	-1.479	0.277
Illustrates and graphs linear inequalities in two variables.	0.29	29	DME	0.93	93	VS		
Average		**53.5**	**DME**		**90**	**VS**		
Functions and Relations								
Competencies	**Control Group**			**Experimental Group**				
	Mean	PS	Description	Mean	PS	Description	T-Value	P-Value
Determines dependent and independent variables.	3.13	52.17	DME	4.47	75	FS	-9.197	<0.001
Finds the domain and range of a function.	2.91	48.5	DME	4.53	75.5	FS		
Graphs and illustrates a linear function and its (a) domain; (b) range; (c) table of values; (d) intercepts; and (e) slope.	0.49	49	DME	0.87	87	VS		
Solves problems involving linear functions.	1.73	43.25	DME	3.13	78.25	FS		
Average		**48.23**	**DME**		**78.94**	**FS**		
Logic and Proof								

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Competencies	**Control Group**			**Experimental Group**				
	Mean	PS	Description	Mean	PS	Description	T-Value	P-Value
Determines the relationship between the hypothesis and the conclusion of an if-then statement.	2.07	34.5	DME	4.49	74.83	FS		
Transforms a statement into an equivalent if-then statement.	2.78	46.33	DME	4.02	67	DME	-3.495	<0.001
Determines the inverse, converse, and contrapositive of an if-then statement.	2.11	35.17	DME	4.36	72.67	DME		
Illustrates the equivalences of: (a) the statement and its contrapositive; and (b) the converse and inverse of a statement.	0.67	67	DME	0.78	78	FS		
Uses inductive or deductive reasoning in an argument.	0.64	64	DME	0.82	82	S		
Writes a proof (both direct and indirect).	0.4	40	DME	0.57	57	DME		
Average		**47.83**	**DME**		**71.9**	**DME**		

Table 5 compares posttest mathematics performance between the control and experimental groups across three topics: Linear Inequalities and System, Function and Relation, and Logic and Proof.

In Linear Inequalities and System, the control group scored 53.5%, while the experimental group scored 90%. However, the t-value of -1.479 and p-value of 0.374 suggest no statistically significant difference. In Function and Relation, the control group scored 48.23%, while the experimental group scored 78.94%. The t-value of -9.197 and p-value <0.001 indicate a significant difference. Similarly, in Logic and Proof, the control group scored 47.83%, and the experimental group scored 71.92%, with a t-value of -3.495 and p-value <0.001, confirming statistical significance.

Overall, the experimental group outperformed the control group in all three topics, with significant improvements in Function and Relation and Logic and Proof, but not in Linear Inequalities and System. This suggests that the intervention was more effective in certain areas.

Table 6 presents a comparative analysis between the pre-test and post-test scores of two groups, a control group and an experimental group, in a study evaluating the effectiveness of a teaching approach.

Table 6. *Comparative Analysis Between Pretest and Posttest of both Two Groups by Competencies.*

Linear Inequalities and Systems								
Competencies		**Control Group**			**Experimental Group**			
		Mean	PS	Description	Mean	PS	Description	
Differentiates linear inequalities in two variables from linear equations in two variables.	Pretest	0.29	29	DME	0.16	16	DME	

	Post	0.78	78	FS	0.87	87	VS
Illustrates and graphs linear inequalities in two variables.	Pretest	0.18	18	DME	0.18	18	DME
	Post	0.29	29	DME	0.93	93	VS
Average	Pretest		23.5	DME		17	DME
	Post		53.5	DME		90	VS
SD	Pretest		7.78			1.41	
	Post		34.68			4.24	
Effect Size		1.12			25.81		
T-Value		1.579			36.5		
P-Value		0.359			0.017		

Functions and Relations

Competencies		**Control Group**			**Experimental Group**		
		Mean	PS	Description	Mean	PS	Description
Determines dependent and independent variables.	Pretest	2.36	39.33	DME	2.91	48.5	DME
	Posttest	3.13	52.17	DME	4.47	75	FS
Finds the domain and range of a function.	Pretest	2.31	38.5	DME	1.93	32.17	DME
	Posttest	2.91	48.5	DME	4.53	75.5	FS
Graphs and illustrates a linear function and its (a) domain; (b) range; (c) table of values; (d) intercepts; and (e) slope.	Pretest	0.22	22	DME	0.49	50	DME
	Posttest	0.49	49	DME	0.87	87	VS
Solves problems involving linear functions.	Pretest	1.33	33.25	DME	0.87	21.75	DME
	Posttest	1.73	43.25	DME	3.13	78.25	FS
Average	Pretest		33.27	DME		38.11	DME
	Posttest		47.83	DME		71.92	DME
SD	Pretest	7.98			13.57		
	Posttest	3.70			5.56		
Effect Size		1.84			3.26		
T-Value		3.677			6.512		
P-Value		0.0348			0.007		

Logic and Proof

Competencies		**Control Group**			**Experimental Group**		
		Mean	PS	Description	Mean	PS	Description
Determines the relationship between the hypothesis and the conclusion of an if-then statement.	Pretest	1.2	20	DME	1.11	18.5	DME
	Posttest	2.07	34.5	DME	4.49	74.83	FS
Transforms a statement into an equivalent if-then statement.	Pretest	2.29	38.17	DME	2.44	40.67	DME
	Posttest	2.78	46.33	DME	4.02	67	DME
Determines the inverse, converse, and contrapositive of an if-then statement.	Pretest	1.89	31.5	DME	2.11	35.17	DME
	Posttest	2.11	35.17	DME	4.36	72.67	DME
Illustrates the equivalences of: (a) the statement and its contrapositive; and (b) the converse and inverse of a statement.	Pretest	0.36	36	DME	0.16	16	DME

	Posttest	0.67	67	DME	0.78	78	FS
Uses inductive or deductive reasoning in an argument.	Pretest	0.36	36	DME	0.13	13	DME
	Posttest	0.64	64	DME	0.82	82	S
Writes a proof (both direct and indirect).	Pretest	0.4	40	DME	0.4	18	DME
	Posttest	0.4	40	DME	0.57	57	DME
Average	Pretest		33.61	DME		23.56	DME
	Posttest		47.83	DME		71.92	DME
SD	Pretest	7.25			10.43		
	Posttest	14.36			8.88		
Effect Size		1.11			2.93		
T-Value		2.72			7.17		
P-Value		0.04			<0.001		

Table 6 shows significant differences between the control and experimental groups in Linear Inequalities and Systems, Functions and Relations, and Logic and Proof. In Linear Inequalities and Systems, the experimental group had a much larger effect size (25.81 vs. 1.12), higher t-value (36.5 vs. 1.579), and significant p-value (0.017), indicating a strong impact. For Functions and Relations, the experimental group also outperformed the control group with a higher effect size (3.26 vs. 1.84), t-value (6.512 vs. 3.677), and a lower p-value (0.007), confirming its effectiveness. In Logic and Proof, the experimental group showed a higher effect size (2.93 vs. 1.11), t-value (7.17 vs. 2.72), and significant p-value (<0.001 vs. 0.04), further highlighting the treatment's effectiveness.

Overall, the experimental treatment demonstrated significant improvements in all three topics, with large effect sizes, high t-values, and statistically significant p-values, supporting its efficacy in enhancing mathematical performance across these domains.

Table 7 provides a detailed comparison of the performance improvement between the control and experimental groups in a research study. It distinguishes between pre-test and post-test data, displaying average scores for each group and the mean gain between the two test points. Additionally, it presents the statistical significance of these differences through the effect size, t-Value and p-value in rows in each set of competencies.

Table 7. *Comparative Analysis of the Gain Between Control and Experimental Groups per Competencies*

Linear Inequalities and Systems					
Competencies		**Control Group**		**Experimental Group**	
		Mean	**Mean Gain** (SD Difference)	Mean	**Mean Gain** (SD Difference)
Differentiates linear inequalities in two variables from linear equations in two variables.	Pretest	29		16	
	Post	78		87	
Illustrates and graphs linear inequalities in two variables.	Pretest	18		18	
	Post	29		93	
Average	Pretest	23.5	**30**	17	**73**
	Post	53.5		90	
SD	Pretest	7.78	**26.9**	1.41	**2.83**
	Post	34.68		4.24	
Effect Size	**2.25**				
T-Value	**-10.66**				
P-Value	**<0.001**				
Functions and Relations					

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Competencies		**Control Group**		**Experimental Group**	
		Mean	**Mean Gain** (SD Difference)	Mean	**Mean Gain** (SD Difference)
Determines dependent and independent variables.	Pretest	39.33		48.5	
	Posttest	52.17		75	
Finds the domain and range of a function.	Pretest	38.5		32.17	
	Posttest	48.5		75.5	
Graphs and illustrates a linear function and its (a) domain; (b) range; (c) table of values; (d) intercepts; and (e) slope.	Pretest	22		50	
	Posttest	49		87	
Solves problems involving linear functions.	Pretest	33.25		21.75	
	Posttest	43.25		78.25	
Average	Pretest	33.27	**14.56**	38.11	**33.81**
	Posttest	47.83		71.92	
SD	Pretest	7.98	**-4.28**	13.57	**-8.01**
	Posttest	3.7		5.56	
Effect Size	**3**				
T-Value	**-14.22**				
P-Value	**<0.001**				

Logic and Proof					
Competencies		**Control Group**		**Experimental Group**	
		PS	Mean Gain	PS	Main Gain
Determines the relationship between the hypothesis and the conclusion of an if-then statement.	Pretest	20		18.5	
	Posttest	34.5		74.83	
Transforms a statement into an equivalent if-then statement.	Pretest	38.17		40.67	
	Posttest	46.33		67	
Determines the inverse, converse, and contrapositive of an if-then statement.	Pretest	31.5		35.17	
	Posttest	35.17		72.67	
Illustrates the equivalences of: (a) the statement and its contrapositive; and (b) the converse and inverse of a statement.	Pretest	36		16	
	Posttest	67		78	

Uses inductive or deductive reasoning in an argument.	Pretest	36		13	
	Posttest	64		82	
Writes a proof (both direct and indirect).	Pretest	40		18	
	Posttest	40		57	
Average	Pretest	33.61	**14.22**	23.56	**48.36**
	Posttest	47.83		71.92	
SD	Pretest	7.25	**7.11**	10.43	**-1.55**
	Posttest	14.36		8.88	
Effect Size	**6.63**				
T-Value	**-31.47**				
P-Value	**<0.001**				

The experimental group showed significantly higher mean gains across all competencies compared to the control group: 73 vs. 30 in linear inequalities and systems, 33.81 vs. 14.56 in functions and relations, and 48.36 vs. 14.22 in logic and proof. These differences were supported by large effect sizes (2.25, 3, and 6.63), t-values (-10.66, -14.22, -31.47), and p-values (<0.001), indicating strong statistical significance. Overall, the results demonstrate the effectiveness of VBTL in significantly enhancing participants' mathematical skills.

Table 8 provides a summary comparison of the performance improvement between the control and experimental groups in a research study. It distinguishes between pre-test and post-test data, displaying average scores for each group and the mean gain between the two test points. Additionally, it presents the statistical significance of these differences through the T-Value and P-Value columns.

Table 8. *Summary of Comparative Analysis of the Gain Between Control and Experimental Groups*

	Test	**Mean (SD)**	**Mean Gain (SD)**	**T-Value**	**P-Value**
Control Group	**Pre-test**	17.09 (4.25)	5.15 (2.2377)	-4.57	<0.001
	Posttest	22.24 (6.89)			
Experimental Group	**Pre-test**	16.64 (5.69)	20.63 (2.55)		
	Posttest	37.27 (5.33)			

The table compares the pre-test and post-test performance of the control and experimental groups in mathematics. The control group had a mean pre-test score of 17.09 (SD = 4.25) and a post-test mean of 22.24 (SD = 6.89), yielding a mean gain of 5.15. A significant difference was observed, with a t-value of -4.57 and a p-value < 0.001. The experimental group began with a slightly lower pre-test mean score of 16.64 (SD = 5.69) but showed a substantial post-test improvement to 37.27 (SD = 5.33), resulting in a mean gain of 20.63. This difference was also statistically significant, with a p-value < 0.001. The experimental group's larger mean gain highlights the effectiveness of the intervention, likely the Video-Based Teaching and Learning approach, in enhancing mathematics performance. Similarly, a 2024 study by Latif and Titikusumawati from the Islamic University of Salatiga demonstrated significant learning improvements using PhET Interactive Simulation videos, further validating video-based pedagogy as an effective instructional strategy.

Thematic Analysis

This research explores students' perspectives on video-based teaching and learning in mathematics, with a focus on three key themes. The analysis process, based on Clarke and Braun's (2006) thematic analysis approach, involved identifying patterns of meaning across the dataset to develop these themes.

Theme No. 1: Engagement and Clarity

The "Engagement and Clarity" theme emphasizes two key aspects students value in educational videos: interest and ease of understanding. Engagement involves videos being interesting and helpful, with practice exercises, examples, and quizzes enhancing learning. Clarity means videos are straightforward and easy to follow, with effective explanations and demonstrations. Students 1, 2, and 3 highlight the importance of these aspects, noting that interactive elements like quizzes boost engagement and clear explanations aid understanding. This suggests that videos combining clarity and interactivity are more effective for learning.

> .***S1:*** *Practice exercises and examples – It's effective because I understand when it is example in video and practice it. (Practice exercises and examples - It's effective because I understand better when there are examples in the video that I can practice*.)
> ***S2:*** *Practice exercises and examples in the videos (Embedded Quiz) – Mas daghan pako makat-onan jud kung mag answer ko ig human tanaw sa video (Practice exercises and examples in the videos (Embedded Quiz) - I can learn more when I answer questions after watching the video.)*
> ***S3:*** *Practice exercises and examples in the videos (Embedded Quiz) Because Math Video Quiz is help me to unlock my skill. (Practice exercises and examples in the videos (Embedded Quiz) - Math Video Quiz helps me improve my skills.)*

Students 4 and 5 emphasizes the importance of clarity in explanations and demonstrations in video-based learning. They find that clear explanations and demonstrations from the teacher are more effective for their understanding. This highlights the significance of clear and concise instructional delivery in videos for student comprehension.

> ***S4:*** *Clarity of explanation and demonstrations – It's more effective because I understand it more when the teacher explains and demonstrates it. (Clarity of explanation and demonstrations - It's more effective because I understand better when the teacher explains and demonstrates.)*
>
> ***S5:*** *Clarity of explanations and demonstration – Og nay explanations makabalo kog ayo (Clarity of explanations and demonstration - If there are clear explanations, I understand well.)*

Students' feedback emphasizing the importance of clear explanations and demonstrations corresponds with research on effective video-based teaching. Gou et al. (2014) and Galatsopoulou et al. (2022) suggest that clear explanations and visible demonstrations in videos improve student engagement and understanding. This highlights the need to incorporate clear instructional practices in video-based teaching to enhance student learning outcomes.

The studies by Gou et al. (2014) and Galatsopoulou et al. (2022) support the idea that engagement and clarity are crucial in video-based teaching. Gou et al. (2014) found that shorter videos, presenter visibility, and a style similar to Khan Academy videos enhance engagement. This aligns with the practice of creating brief videos, as shorter durations are more engaging.

Furthermore, Galatsopoulou et al. (2022) discovered that videos can boost student motivation and engagement in various active learning scenarios. They observed that students, particularly those familiar with digital tools, enjoy using audiovisual materials in their learning.

Theme No. 2: Impact and Satisfaction

The "Impact and Satisfaction" theme evaluates how students perceive video-based math teaching, their satisfaction with it, and the effects of features like badges and progress cards on engagement and learning. Understanding these insights helps educators refine video-based interventions to better support students' needs and improve learning outcomes. Let's now explore students' specific feedback on the impact and satisfaction of this approach

> ***S6:*** *Badges – I also need this para ma exchange sa akong points and medyo mo taas ang grado and possible ma proud nako akong parents in that way. (badges – I need badges to exchange for points and to possibly make my parents proud by improving*

my grades.)
S7: *Badges & Progress Monitoring Card – I need these because its good for my grade but its hard to get one of it (Badges & Progress Monitoring Card – I need these because they are good for my grades, but they are hard to earn)*
S8: *Moderately – Badges enhance my learning motivation quickly.*
S9: *Very much – Yes, maka interaesado kay kung mo tan aw og maminaw. (Very much – Yes, it makes me interested because I learn more when I watch and listen.)*
The following feedback pertains to the satisfaction level of students using video-based teaching and learning (VBTL) as a resource for learning mathematics.
S10: *Very much – Kay naa didto tanan (video) ang meaning onya naka improve siya naku kay naay video, naa pay mo tudlo (Very much – Because all the meanings (of the video) are there, so I have improved because there are videos, and someone to teach.)*
S11: *Satisfied - Because if wala mi kasabot sa lesson amora i rewatch. (Satisfied - Because if we don't understand the lesson, we can rewatch.)*
S12: *Satisfied – Satisfied ko sir kay maka learn ko through video at the same Time maka learn sab ko through discussion sa blackboard. (Satisfied – I am satisfied because I can learn through videos and also learn through discussions on the blackboard.)*
S13: *Very much – kay naa didto tanan ang mga meaning unya naka improve Pod siya nako kay naa nay video naapay mo tudlo. (Very much – Because all the meanings are there, and I have improved because there are videos as well as a teacher who teaches inside the classroom)*

Morino et al. (2019) found that teacher-produced video content significantly improved student satisfaction, particularly regarding the teacher's perceived effectiveness. Students exposed to these videos reported a 5.8% increase in the teacher's effectiveness rating. Additionally, the study showed a moderate impact on grades, with the experimental group achieving an average grade of 85.6%, compared to 82.4% in the control group, reflecting a 3.2% improvement.

Theme No. 3: Preferences and Challenges

Implementing video-based math teaching requires understanding students' preferences and challenges. The "Preferences and Challenges" theme explores whether students prefer traditional teaching or video learning and highlights issues like video quality or lack of internet access. Teachers can improve video lessons by using clear visuals, ensuring high-quality videos, providing offline materials, or offering alternative resources for students without internet. Addressing these needs makes video-based learning more effective and enjoyable. Now, let's examine what students say about their preferences and challenges in video-based math learning

S14: *Traditional classroom instruction is more effective, like we can see it clearly if we can use chalk because the board is big, compare to video it is small and far. (Prefers traditional classroom instruction due to the clarity of the big chalkboard compared to the small and distant video screen.)*
S15: *Mas effective ang video-based teaching and learning kay ma discuss sa personal and ma discuss pod sa video (Finds video-based teaching and learning more effective because it allows for personal discussions and discussions within the video.)*
S16: *Very confident – na kay before mga grade 7 ko I hate math kay among Among subject teacher di mo discuss (Very confident – Because before, when I was in grade 7, I hated math because our subject teacher didn't explain well.)*
S17: *Not at all – cuz sometimes naa koy masabtan sa video and sometimes Naa sad koi di masabtan like maglibog ko sa pag explain ni sir or discuss. (Not at all – Sometimes I understand the video, and sometimes I don't. Sometimes I get confused with the explanations in the video or during the discussion.)*
S18: *Hinay ang audio ang video kay blurry (Audio in the video is slow, and the video is blurry.)*
S19: *Boring mag linkod lang pirmi (It's boring to just sit and watch all the time.)*
S20: *Dili ka review kay walay internet pang search sa video (Unable to review because there's no internet to search for videos.)*

Weinberg & Thomas (2018) emphasized the variability in student engagement with instructional videos, stemming from differences in background knowledge and sense-making practices. While this variability can be leveraged to enhance the effectiveness of videos for diverse students, it also presents a challenge in ensuring the material meets all students' needs. Their study further suggests that students' learning from videos is influenced by the types of questions posed afterward, challenging the idea of learning as a static process.

Conclusion

The study confirms that Video-Based Teaching and Learning (VBTL) effectively improves mathematics performance by reducing cognitive load and enhancing comprehension of mathematical concepts through visual aids and interactive elements, thus validating the efficacy of VBTL and contributing to discussions on innovative teaching strategies in mathematics education.

To optimize the effectiveness of video-based teaching and learning (VBTL) in mathematics education, the following recommendations are proposed:

1. Teachers may meticulously design multifaceted video-based teaching plans, emphasizing clear explanations and ensuring accuracy of content delivery.
2. Students are encouraged to actively engage with video materials, seeking personalized support as needed and providing constructive feedback to enhance the learning experience.
3. Future research endeavors may explore the integration of diverse content delivery methods within VBTL frameworks to further enhance student engagement and improve overall learning outcomes.
4. As a recommendation for future research, the proposed title "Enhancing Video-Based Mathematics Instruction Through Interactive Features: A Comparative Study on Student Engagement and Learning Outcomes" aligns with the aim of investigating innovative approaches to video-based instruction and their impact on student engagement and learning outcomes in mathematics education.

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