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Enhancing Physics Students' Critical Thinking Skills Using Problem-Based Learning via Vlogs

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Abstract: This study investigated the impact of Problem-Based Learning via Vlogs (PBL-Vlogs) on the critical thinking skills of Grade 10 Physics students at Don Carlos National High School. A quasi-experimental design was employed to assess whether students exposed to PBL-Vlogs would demonstrate significantly greater improvements in critical thinking than those taught using traditional methods. Sixty-eight students were randomly assigned to either an experimental group (PBL-Vlogs) or a control group (non-PBL-Vlogs). Both groups completed a validated pre-test and post-test assessing critical thinking across four domains: interpretation, analysis, evaluation, and inference.

In the pre-test, descriptive statistics revealed that both groups began with low-level critical thinking skills. Following the intervention, the PBL-Vlog group shifted to a moderate level, while the control group remained in the low category. An Analysis of Covariance (ANCOVA), controlling for pre-test scores, was conducted to determine the significance of differences in post-test performance. The results indicated a statistically significant improvement in students' critical thinking skills in the PBL-Vlog group ($F = 15.594$, $p < 0.001$), with a partial eta squared of 0.193, representing a moderate effect size.

The findings support the conclusion that integrating multimedia content in a problem-based framework substantially enhances students' critical thinking abilities in Physics. PBL-Vlogs provided an effective instructional strategy for fostering engagement and developing higher-order thinking skills, as evidenced by the quantitative improvements in student outcomes.

Keywords: *Critical Thinking, Problem-Based Learning, Vlogs, Physics Education, Quasi-Experimental Design, ANCOVA.*

Introduction

Critical thinking is an essential 21st-century skill that enables students to analyze, evaluate, and synthesize information effectively. It allows learners to go beyond rote memorization and engage deeply with content by questioning assumptions, identifying underlying patterns, and applying knowledge to real-life contexts. In science education, particularly physics, critical thinking is fundamental to interpreting data, solving problems, and making informed decisions. However, numerous studies have highlighted that many Filipino students struggle with developing these higher-order thinking skills. According to the 2023 Programme for International Student Assessment (PISA), only 19% of Filipino students met the minimum proficiency level in scientific literacy, a performance well below the OECD average [40]. Similarly, the Philippines ranked among the lowest-performing countries in the Trends in International Mathematics and Science Study (TIMSS), particularly in physics [38]. These gaps have been attributed to insufficient instructional materials, limited teacher training, and a lack of practical learning opportunities [19].

Locally, the 2023 National Achievement Test (NAT) results from Don Carlos National High School revealed that Grade 10 students scored only 32.97% in critical thinking skills, highlighting a significant deficiency in applying analytical and evaluative competencies [17]. Traditional teaching approaches focusing heavily on memorization and passive learning often fail to foster critical thinking. Furthermore, despite efforts in the K to 12 curriculum to emphasize these skills, many teachers still face challenges in effectively implementing and assessing critical thinking in classroom settings [35][45].

There is a pressing need for localized, research-based interventions that address these issues. While previous studies have acknowledged the low level of Filipino students' critical thinking abilities [46], much of the existing literature is based on broad international contexts or lacks specificity regarding practical classroom strategies. A comprehensive review by Lopez (2023) found that while studies on critical thinking ability are common, those exploring students' disposition towards critical thinking in the Philippine context are scarce [33]. Moreover, limited research investigates alternative pedagogical approaches, such as debate, inquiry-based learning, or Problem-Based Learning (PBL), as tools to enhance critical thinking in Filipino learners [28].

Problem-Based Learning (PBL) offers a promising solution by engaging students in real-world problems that require active problem-solving, collaboration, and reflective thinking. PBL encourages learners to construct knowledge through inquiry and experience as a student-centered strategy, rather than passive reception [3][31]. Multimedia integration into PBL, particularly through educational vlogs, has enhanced its effectiveness. Studies have demonstrated that incorporating videos into instruction increases engagement, improves conceptual understanding, and caters to diverse learning styles [12][25]. In the context of physics education in the Philippines, students exposed to video-based simulations performed better in assessments than those taught

through traditional lecture-discussion methods [14]. Additionally, empirical studies show that educational YouTube content can significantly boost students' critical thinking and engagement in science learning [48][49][56].

Despite these advantages, many science teachers still face challenges in using technology and assessing critical thinking. There is often a gap between curriculum goals and classroom realities, especially with the shift toward new learning modalities during and after the pandemic [45]. As such, innovative and contextually grounded teaching strategies are essential to support teachers in cultivating critical thinking among students.

Given these concerns, this study aims to explore the effectiveness of Problem-Based Learning using vlogs (PBL-Vlogs) in enhancing the critical thinking skills of Grade 10 physics students. Specifically, it seeks to determine the level of critical thinking skills among students exposed to PBL-Vlogs compared to those receiving traditional instruction; examine whether there is a significant difference in posttest scores between the two groups while controlling for pretest results.

This research is timely and significant, as it addresses national performance gaps, fills local research voids, and offers an innovative pedagogical model aligned with the goals of the Philippine educational system. The study aims to enhance student engagement and higher-order thinking by integrating multimedia tools with inquiry-driven learning, thereby improving physics education and learner preparedness for future academic and career challenges.

Method (10 Pt)

A quasi-experimental design was employed using a pre-test and post-test control group approach to assess the impact of Problem-Based Learning (PBL) via vlogs on the critical thinking skills of Grade 10 physics students. This phase was conducted during the second quarter of the school year 2024–2025 at Don Carlos National High School in Sinangguyan, Don Carlos, Bukidnon. Before data collection, ethical approval was obtained from the university's Research Ethics Committee (REC), and informed consent was secured from all participants, adhering to ethical research standards in educational contexts [15]. Using simple random sampling, 68 students were selected and randomly assigned to two groups: the PBL-Vlog group (experimental) and the Non-PBL-Vlog group (control). The intervention utilized validated 7E lesson plans, with the experimental group receiving instruction through PBL integrated with educational vlogs. These vlogs presented real-world scenarios aligned with physics concepts such as electromagnetic waves, geometric optics, and electromagnetic induction, encouraging collaborative learning and critical analysis, by multimodal learning theory [35]. In contrast, the control group received instruction via conventional teaching methods, including teacher-led discussions and laboratory-based activities. Pre-tests were administered to establish baseline critical thinking levels, followed by the instructional intervention, and concluded with a post-test to assess learning gains.

To address the first research question—identifying students' baseline critical thinking skills before implementing the PBL-Vlog approach—quantitative analysis was conducted using descriptive statistics. Pre-intervention standardized assessments, constructed according to a Table of Specification (TOS) and targeting the critical thinking indicators of Interpretation, Analysis, Evaluation, and Inference as defined by Facione (1990) [15], were administered to both the experimental (PBL-Vlog) and control (Non-PBL-Vlog) groups. All responses were evaluated using a scoring rubric aligned with these indicators. Student performance for each domain was computed using the formula:

$$\text{Percentage} = (\text{Total Score} / \text{Maximum Possible Score}) \times 100\%,$$

A widely accepted method in educational measurement that ensures consistent and objective scoring [45][46]. These percentage scores were categorized into five proficiency levels—Very Low, Low, Moderate, High, and Very High—using the classification system developed by Herunata et al. (2020) [47], as shown in the table below:

Categories for Determining Students' Critical Thinking Skill Levels

Percentage Range	Category
81% – 100%	Very High
61% – 80%	High
41% – 60%	Moderate
21% – 40%	Low
0% – 20%	Very Low

To address the second research question—whether a statistically significant difference exists in the post-test critical thinking skills between the two groups—Analysis of Covariance (ANCOVA) was applied. This inferential technique allowed for comparing post-test mean scores between the experimental and control groups while using pre-test scores as a covariate to control initial group differences. The quantitative dataset was structured with three primary variables: Group (PBL-Vlog or Non-PBL-Vlog), Pre-test Score (baseline performance), and Post-test Score (performance after the intervention). A p-value threshold of 0.05 was used to determine statistical significance, and effect sizes were calculated using partial eta squared to assess the practical significance of the findings [45]. These procedures followed best practices for evaluating educational interventions in quasi-experimental research designs.

Results And Discussion (10 Pt)

Student's Critical Thinking Skills Level

Non-PBL-Vlog					PBL-Vlog			
n=34					n=34			
Indicators	**Pre-test**			**Category**	**Pre-test**			**Category**
	TS	MaxPS	%		TS	MaxPS	%	
Interpretation	68	170	40.00	Moderate	72	170	42.35	**Moderate**
Analysis	61	238	25.63	Low	48	238	20.17	**Low**
Evaluation	37	170	21.76	Low	39	170	22.94	**Low**
Inference	109	306	35.62	Low	115	306	37.58	**Low**
MEAN	**8.09**				**8.05**			
MPS%	**31.11%**				**30.96%**			
CATEGORY	**Low**				**Low**			

Non-PBL-Vlog					PBL-Vlog			
n=34					n=34			
Indicators	**Posttest**			**Category**	**Posttest**			**Category**
	TS	**MaxPS**	**%**		**TS**	**MaxPS**	**%**	
Interpretation	81	170	47.65	Moderate	77	170	45.29	**Moderate**
Analysis	76	238	31.93	Low	92	238	38.66	**Low**
Evaluation	59	170	34.71	Low	54	170	31.76	**Low**
Inference	153	306	50.00	Moderate	174	306	56.86	**Moderate**
MEAN	9.21				11.68			
MPS%	**35.42%**				**44.92%**			
CATEGORY	**Low**				**Moderate**			

Legend:

Percentage Range	Category
81% – 100%	Very High
61% – 80%	High
41% – 60%	Moderate
21% – 40%	Low
0% – 20%	Very Low

Presents a detailed comparison of pre-test and post-test critical thinking skill levels between the Non-PBL-Vlog and PBL-Vlog groups, each comprising 34 Grade 10 students. Before the intervention, both groups displayed comparable baseline performance. In the Interpretation domain, the Non-PBL-Vlog group scored 68 out of 170 (40.00%), which was classified as Moderate. In contrast, the PBL-Vlog group achieved a slightly higher score of 72 (42.35%), also falling into the Moderate category. For the Analysis domain, the Non-PBL-Vlog group earned 61 out of 238 (25.63%) compared to 48 (20.17%) by the PBL-Vlog group, placing both in the Low category. Similarly, in Evaluation, the Non-PBL-Vlog group scored 37 out of 170 (21.76%) and the PBL-Vlog group 39 (22.94%), indicating low performance. In the Inference domain, the Non-PBL-Vlog group obtained 109 out of 306 (35.62%), whereas the PBL-Vlog group scored 115 (37.58%), with both groups classified as Low. The overall mean scores further corroborate the similarity in baseline performance, with the Non-PBL-Vlog group averaging 8.09 and the PBL-Vlog group 8.05; the corresponding Mean Percentage Scores (MPS) of 31.11% and 30.96% placed both groups under the "Low" category for critical thinking skills according to the classification by Herunata et al. (2020) [27]. These pre-test results confirm that both groups were relatively equivalent in their critical thinking abilities, providing a sound basis for evaluating the subsequent impact of the instructional intervention.

Following the intervention, the post-test results revealed noteworthy differences. In the Interpretation domain, the Non-PBL-Vlog group improved to 81 out of 170 (47.65%), while the PBL-Vlog group scored slightly lower at 77 (45.29%); both remained within the Moderate category. In the Analysis domain, the Non-PBL-Vlog group registered 76 out of 238 (31.93%), still in the Low category, whereas the PBL-Vlog group demonstrated a marked improvement with a score of 92 (38.66%). However, this too was classified as Low. For Evaluation, both groups remained in the Low category, with the Non-PBL-Vlog group scoring 59 out of 170 (34.71%) and the PBL-Vlog group 54 (31.76%). In the Inference domain, both groups advanced into the Moderate category, with the Non-PBL-Vlog group scoring 153 out of 306 (50.00%) and the PBL-Vlog group outperforming with 174 (56.86%). Overall, the Non-PBL-Vlog group's mean score increased to 9.21 with an MPS of 35.42%, while the PBL-Vlog group's mean score rose to 11.68 with an MPS of 44.92%. These changes indicate that the PBL-Vlog group experienced a more substantial improvement, shifting from a Low to a Moderate level of critical thinking, compared to the Non-PBL-Vlog group, which remained in the Low category.

The observed improvement in the PBL-Vlog group suggests that integrating multimedia tools like vlogs can effectively enhance student engagement and foster higher-order thinking skills. Multimedia within PBL provides a more interactive learning experience, enabling students to apply theoretical concepts to real-world scenarios, thus promoting a deeper understanding of the subject matter. In contrast, the Non-PBL-Vlog group, lacking such multimedia integration, did not exhibit comparable cognitive gains. These findings align with previous research; for instance, prior studies at Central Mindanao University, where researchers observed significant improvements in students' critical thinking through computer-assisted instruction and multimedia-supported inquiry approaches [27]. Studies by Ali (2019) [3] and Guo et al. (2014) [26] indicate that videos and vlogs facilitate the visualization and comprehension of complex concepts, thereby increasing engagement and interactive learning. Moreover, the work of Agustin et al. (2020) [1] and Manurung and Siregar (2016) [35] supports the notion that Problem-Based Learning (PBL) enhances critical thinking, problem-solving, and collaborative learning. Collectively, these results underscore the potential of combining PBL with multimedia tools such as vlogs to create a dynamic and effective learning environment that promotes critical thinking skills.

Analysis of Covariance of Critical Thinking Skills of students after the Implementation of Problem-Based Learning via Vlogs

Group	N	MPS	SD			
Non-PBL-Vlog	34	35.42	2.35			
PBL-Vlog	34	44.92	2.96			
Total	68	40.17				

Source	SS	df	MS	f	Sig.	Partial Eta Squared
Group	104.799	1	104.799	15.594	.000**	.193
Pre-test (Covariate)	36.170	1	36.170	5.382	.023*	.076
Error	436.830	65	6.720			
Total	7990.000	68				

The results show that the PBL-Vlog group (experimental group) achieved a significantly higher Mean Percentage Score (MPS) of 44.92% compared to the Non-PBL-Vlog group (35.42%), indicating a notable improvement in critical thinking skills following the intervention. The Analysis of Covariance (ANCOVA) revealed a highly significant effect of the group factor on post-test scores, with an F-value of 15.594 and a p-value of 0.000. Moreover, the pre-test score significantly influenced the post-test results, accounting for 7.6% of the variance. Including pre-test scores as a covariate ensured that baseline differences were controlled, lending more accuracy to the observed outcomes.

The ANCOVA results demonstrate that the PBL-Vlog intervention had a statistically significant impact on students' post-test performance. The partial eta squared value of 0.193 suggests a small to moderate effect size, indicating that the group factor (i.e., use of PBL with vlogs) explained 19.3% of the variance in the post-test scores. This reinforces the conclusion that Problem-Based Learning (PBL), when enhanced with multimedia tools such as vlogs, can substantially improve students' critical thinking abilities.

These findings support integrating interactive and multimedia-rich learning strategies fosters more profound understanding and cognitive development. Video-based content, such as vlogs, helps make complex concepts more accessible, relatable, and engaging, enhancing the learning experience. For educators, this suggests that multimedia in PBL can be a powerful strategy to cultivate higher-order thinking skills among learners.

Furthermore, the significance of the pre-test covariate emphasizes the importance of considering students' baseline knowledge when evaluating the outcomes of instructional interventions. Students with higher initial critical thinking abilities may experience differential improvement compared to those starting from a lower level. This highlights the value of implementing personalized or differentiated instruction in PBL environments to maximize individual learning gains.

These findings align with a growing body of literature affirming the efficacy of PBL integrated with multimedia tools. For example, studies utilizing Process-Oriented Guided Inquiry Learning (POGIL), an inquiry-based approach that promotes critical thinking through structured collaboration, guided questioning, and reflection. Secadron and Tan (2023) [54] found that POGIL significantly enhanced students' critical thinking skills by fostering analytical reasoning and metacognitive awareness. When integrated with multimedia tools like vlogs, this approach further deepens engagement and supports the development of higher-order thinking. Pacheco and Ramos (2021) [52] highlighted the benefits of combining PBL and vlogs in Philippine classrooms, stating it helps overcome pedagogical and technological limitations. Suniasih (2021) [60] demonstrated that animated media and PBL improve scientific literacy and problem-solving capabilities. Santos and Garcia (2023) [51] found that using YouTube and vlogs significantly fosters critical thinking among college students. Similarly, Nikou and Economides (2018) [40] proved that multimedia learning, especially YouTube, can enhance critical thinking skills in higher education settings.

Conclusion

The study examined the impact of Problem-Based Learning via vlogs (PBL-Vlogs) on the critical thinking skills of Grade 10 Physics students. The results showed that the PBL-Vlog group significantly improved their critical thinking skills, progressing to a moderate level, compared to the control group. This suggests that integrating vlogs within a PBL framework can support the development of students' higher-order thinking skills, especially in physics education. The Analysis of Covariance (ANCOVA)

revealed a significant difference in post-test scores between the experimental and control groups, with the PBL-Vlog group achieving significantly higher scores, indicating a substantial impact of the intervention. These findings support the PBL-Vlog strategy's effectiveness in science instruction. Future research should consider longitudinal studies to examine the sustained impact of PBL-Vlogs on critical thinking development over time, expand the sample size, incorporate diverse educational contexts, and explore the application of PBL-Vlogs across other STEM disciplines.

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