

Flipped Classroom versus Lecture-based Instruction in Enhancing the Understanding of Grade 9 Students in Physics

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Abstract. This study investigated the effectiveness of flipped classroom instruction compared to lecture-based instruction in enhancing Grade 9 students' understanding of physics concepts. The limited research on the comparative effectiveness of flipped classroom instruction and lecture-based instruction in K-12 Philippine science education, along with the challenge of teacher-created video production, highlights a gap in understanding their practical implementation and impact. The researcher employed a quasi-experimental design, using a one-stage cluster sampling technique to assign 61 students to experimental and control groups randomly. Both groups demonstrated comparable prior knowledge based on their Third Quarter Science 9 performance, verified through a Mean Performance Score (MPS) analysis and a t-test: Two-Sample Assuming Equal Variances. Data treatment involved using the Mean, t-test for dependent data, and t-test for independent data. The findings revealed that while both instructional methods significantly improved student performance, the flipped classroom approach yielded higher post-test results than lecture-based instruction. The study concluded that flipped classroom instruction is a more effective strategy for fostering active learning and improving comprehension of key physics topics, such as projectile motion, impulse and momentum, linear momentum conservation, and mechanical energy conservation. The research encourages future researchers to replicate this study in other educational settings and expand its scope by exploring additional factors that influence the effectiveness of flipped classroom instruction.

Keywords: Flipped classroom; Lecture-based instruction; Grade 9 Science; Physics; Curriculum development.

1.0 Introduction

Science Education aims to develop scientific literacy among students (Osborne, 2023). Multiple studies have shown a global decline in student interest and achievement in science subjects despite the well-structured science curriculum (Hasni & Potvin, 2015; Kang, 2017; Teppo, 2021). This downward trend is evident in ASEAN countries, Australia, and various Western nations (Leung & Zhu, 2011; Chang, 2015; Muruyama et al., 2013; Hamdan, 2020). It raises alarms about the effectiveness of current educational strategies and calls for urgent interventions.

The recently released 2022 Programme for International Student Assessment (PISA) results further confirm Filipino students' decline in science performance. The results show no significant improvement in science performance compared to 2018 [PISA 2018 Results (Volume I), 2019; PISA 2022 Results (Volume I), 2023]. The

alarming performance has prompted reactions from various stakeholders, including former Education Secretary Sara Duterte, who has called for collective action (Malipot, 2023). Advocacy groups like the Philippine Business Education (PBE) have echoed these concerns, emphasizing that the Philippines' persistent low rankings indicate a systemic education crisis (Malipot, 2023b). At Bais City National Science High School, the shift to Online Distance Learning during the pandemic, followed by the transition to Blended Learning, exposed major challenges. One significant issue was the limited synchronous class time of 1 hour and 20 minutes, held thrice weekly for Science 9. Educators have found this schedule inadequate for covering all learning competencies while maintaining quality instruction. The difficulty in addressing the Most Essential Learning Competencies (MELCs) has persisted, even after reducing competencies by 34% (Education GPS, OECD, 2024).

Researchers have widely studied flipped classroom instruction and lecture-based instruction in higher education. Still, they have limited the comparative analysis of their effectiveness in K-12 settings, particularly in Philippine science education (Hew et al., 2021). Existing research on flipped classrooms often relies on teacher-created videos, which can be time-consuming (Zamorano et al., 2019). The teacher-researcher implemented flipped classroom instruction and lecture-based instruction in Science 9 to address these challenges. This approach focused on teaching physics concepts at Bais City National Science High School during the 2023-2024 school year, utilizing readily available, high-quality instructional materials and a modified flipped classroom model. The teacher-researcher intends to evaluate the effectiveness of flipped classrooms and lecture-based instruction.

2.0 Methodology

2.1 Research Design

This study employed a quasi-experimental design with a pretest-posttest non-equivalent control group approach. This design allows the researcher to investigate the effect of different instructional methods on student performance while acknowledging the practical challenges of achieving random assignments in educational settings. In this study, the researcher manipulated the instructional methods: the experimental group used the flipped classroom model, while the control group received lecture-based instruction. To mitigate the influence of extraneous variables, the researcher maintained consistent conditions across both groups, such as lesson duration, instructional materials, and testing environments. This design aligns with the study's goal of addressing real-world instructional challenges within the classroom context.

2.2 Research Locale

The researcher conducted the study at a public secondary school in Bais City, Negros Oriental, which is known for its emphasis on academic excellence and modern facilities. The school equips students with resources such as laptops, smartphones, LCD screens, and Internet-enabled classrooms to support innovative teaching methods. The average class size is 40 students, and its facilities include computer laboratories adhering to safety and usability standards. The school's infrastructure enabled the seamless implementation of flipped classroom and lecture-based instruction.

2.3 Research Participants

The study involved two Grade 9 sections comprising 61 students. Participants were selected using a one-stage cluster sampling technique, where entire sections were randomly assigned to instructional groups. Section A was assigned to flipped classroom instruction (experimental group), while Section B received lecture-based instruction (control group), ensuring that group allocation was not influenced by prior academic performance. A pretest on relevant science concepts was administered to establish a baseline measure of students' understanding before the intervention. The comparability of the two groups was verified using a t-test: Two-Sample Assuming Equal Variances, which ensured that initial differences in knowledge were statistically insignificant. While grades from the Third Quarter Science 9 curriculum were reviewed, they were not used as a criterion for group selection, minimizing potential selection bias arising from factors such as teaching quality or socioeconomic status. Using random assignment and a standardized pretest helped mitigate biases, ensuring a fair comparison between instructional methods.

2.4 Research Instrument

The instructional tools included teacher-made lesson plans for the flipped classrooms and lecture-based instruction, developed based on the Science 9 curriculum guide and the Essential Learning Competencies

(MELCs) for Quarter 4. Three experts reviewed these plans using the DepEd Bais Learning Resource evaluation tool to ensure alignment with learning objectives and appropriateness for the participants. Instructional materials included DepEd TV videos, refined NegOr learning activity sheets, and resources from Frontlearners. Modified guidelines from Hew (2021) were also adopted, such as limiting video durations to 20 minutes for the flipped classroom approach. The pretest and posttest questionnaires were developed based on a Table of Specifications, with each test comprising 32 multiple-choice items. These were validated by subject matter experts, a statistician, and the researcher's thesis adviser. Reliability testing through Cronbach's Alpha yielded a coefficient of 0.941, confirming the questionnaire's reliability. Items underwent item difficulty and discrimination analysis to ensure their validity and appropriateness.

2.5 Data Gathering Procedure

Data collection was conducted in several phases: Approval Process: Securing permissions from the school administration and the Schools Division Superintendent. The orientation involved conducting sessions for participants and their parents. The validation phase involved refining the research instruments based on feedback from experts. The dry run tested the reliability and feasibility of the research instruments. The pretest was administered to establish baseline performance levels. The researcher implemented the flipped classroom and lecture-based instruction as part of the intervention for the respective groups. The post-test administration measured student performance after the intervention.

2.6 Data Analysis Procedure

The collected data were analyzed using the following statistical tools: a) The weighted mean was used to determine the student's average performance in the pretest and posttest. b) The t-test for dependent samples was used to evaluate the significant difference between each group's pretest and post-test performances. c) The t-test for independent samples was used to compare the post-test performances between the experimental and control groups. Students' proficiency levels were categorized based on criteria set in DepEd Order No. 73, s. 2012, ensuring consistent interpretation of results.

2.7 Ethical Considerations

The study adhered to ethical research standards. Approval was obtained from the Foundation University Research Office's Ethical Committee. Informed consent was secured from both students and their parents. Participants' confidentiality was maintained by anonymizing their identities and refraining from disclosing the school's name. All potential benefits and risks were communicated transparently to the participants and their guardians.

3.0 Results and Discussion

3.1 Pretest Performances of Students

Table 1 presents the overall pre-test performance of students exposed to the instructional approaches—flipped classroom and lecture-based instruction. The pre-test was administered to assess students' prior knowledge of the following topics: projectile motion, impulse and momentum, conservation of linear momentum, and conservation of mechanical energy.

Table 1. Pretest performances of students					
Rating (%)	Verbal Description	Flipped Classroom Instruction (n=28)		Lecture-based Instruction (n=28)	
		f	%	f	%
90 – 100	Outstanding	17	60.7	17	51.5
85 – 89	Very Satisfactory	6	21.4	10	30.3
80 – 84	Satisfactory	5	17.8	5	15.1
75 – 79	Fairly Satisfactory	0	0	1	3.03
	Mean	89.42 (Very Satisfactory)		89.39 (Very Satisfactory)	

The table indicates that, on average, the flipped classroom group scored 89.42%. The lecture-based instruction group scored 89.39%, both classified as "Very Satisfactory." These findings suggest that students in both groups already have fundamental knowledge, skills, and a core understanding of basic concepts. These concepts include projectile motion, impulse and momentum, linear momentum conservation, and mechanical energy conservation (DepEd Order No. 73, s. 2012). The standard deviations of 4.16 for the flipped classroom and 4.25 for lecture-based Instruction suggest that the students' scores are pretty dispersed around the mean. The similar pre-test

performances of both the flipped classroom and lecture-based instruction groups connote that both groups began the study with comparable levels of prior knowledge of physics.

3.2 Posttest Performances of Students

Table 2 shows the overall post-test performance of students who participated in flipped classroom and lecture-based instruction. The results show that, on average, students in the flipped classroom group obtained a 95.04% rating, while those in the lecture-based group obtained 93.03%. These ratings are in the “Outstanding” level. Additionally, the standard deviation (SD) of 2.37 for the flipped classroom group and 2.81 for the lecture-based instruction group indicates that the scores within each group were closely grouped around the mean.

Table 2. *Posttest performances of students*

Rating (%)	Verbal Description	Flipped Classroom Instruction (n=28)		Lecture-based Instruction (n=28)	
		f	%	f	%
90 – 100	Outstanding	28	100	33	100
85 – 89	Very Satisfactory	0	0	0	0
	Mean	95.04 (Very Satisfactory)		93.03 (Very Satisfactory)	

The results clearly show that both groups of students at this level exceed the core requirements regarding knowledge, skills, and understanding of the topics (DepEd Order No. 73, s. 2012).

3.3 Difference Between the Pretest and Posttest Performance

Table 3 compares the pretest and posttest performances of the two groups of students. The mean pretest score for students in the flipped classroom instruction group is 89.42%, while the posttest mean increased to 95.04%, resulting in a mean difference (D) of 5.63. For students in lecture-based groups, the mean pretest score is 89.39%, which also increased to 93.03% in the post-test, resulting in a mean difference (D) of 3.64. The t-test results of 6.54 for the flipped classroom instruction group and 8.82 for the lecture-based instruction group indicate that the improvement in student performances from the pretest to the post-test is statistically significant ($p < .001$). This implies that both instruction methods positively impact students' understanding and retention of Science 9 Physics concepts.

Table 3. *Difference between the pretest and posttest performances of the two groups*

Group	Pretest	Posttest	D	t	p	Decision	Remark
Flipped Classroom Instruction	89.42	95.04	5.63	6.54	<.001	Reject H_{o1}	Significant
Lecture-Based Instruction	89.39	93.03	3.64	8.82	<.001	Reject H_{o1}	Significant

These findings are supported by various studies highlighting the positive impact of flipped classroom methods and lecture-based instruction on students' understanding and retention of Physics concepts. "Widodo et al. (2022) found that flipped classroom instruction promotes active concept analysis and discussion, leading to a deeper understanding of concepts among students. Similarly, Amarilla et al. (2022) confirmed that students in flipped classrooms exhibited higher motivation, self-regulation, and academic performance.

On the other hand, Chiofalo et al. (2022) reported that lecture-based instruction improved student performance in answering conceptual physics questions, highlighting its effectiveness in physics subjects. Additionally, Narula and Singh (2023) claimed that lecture-based instruction using PowerPoint presentations was perceived by students as more effective, enhancing attention, learning effectiveness, and information retention than chalkboard methods.

3.4 Difference Between the Posttest Performance of the Two Groups

Table 4 reveals the posttest performances between students exposed to flipped classroom instruction and those exposed to lecture-based instruction. The data clearly show a statistically significant performance difference of 2.99 points in favor of the flipped classroom group (p -value = 0.004), rejecting the null hypothesis. In other words, both instructional methods significantly improved student performance, with the flipped classroom instruction group showing a higher post-test performance than the lecture-based instruction group. This affirms that flipped classroom instruction is a more effective strategy.

Table 4. *Difference between the post-test performances of the two groups*

Group	d	t	p	Decision	Remark
Flipped Classroom Instruction & Lecture-Based Instruction	2.01	2.99	0.004	Reject H_{02}	Significant

This finding aligns with several studies. McLaughlin et al. (2021) assert that the flipped model promotes greater student engagement and deeper learning. Furthermore, Long et al. (2019) highlight the positive impact of flipped classroom instruction on student learning outcomes, attributing its success to the model's focus on pre-class content engagement and active in-class participation.

On the other hand, Gyimah (2023) emphasized that lecture-based instruction significantly impacts content delivery and concept mastery. Moreover, Hontarenko and Kovalenko (2024) noted that effective lecture-based instruction requires careful planning, appropriate timing, content reduction, engaging examples, and adaptability, with active student involvement and understanding of delivery stages being crucial for enhancing educational outcomes. Yasmin (2019) added that students found lecture-based instruction to be the most effective teaching method for learning the material. This suggests that although the lecture method may be less interactive than flipped classrooms, it still has value for some students in specific contexts.

4.0 Conclusion

The flipped classroom model, which incorporates active learning strategies such as pre-class preparation and in-class problem-solving, has proven more effective than lecture-based instruction in enhancing the understanding of Grade 9 students in Physics. Unlike lecture-based instruction, the flipped classroom empowers students to engage independently with instructional materials outside class, promoting responsibility and improving time management skills. With repeated exposure to video lectures and supplementary resources, students can process information at their own pace, fostering more profound understanding and critical thinking. In-class activities then allow students to apply their knowledge to real-world contexts, strengthening their problem-solving abilities and improving their grasp of challenging Physics concepts such as projectile motion, impulse and momentum, conservation of linear momentum, and conservation of mechanical energy.

For teachers, the flipped classroom model facilitates the design of interactive and innovative lessons that address diverse learning styles. By shifting content delivery outside of class, more time becomes available for individualized and small-group instruction, enabling teachers to provide tailored support to students who need additional guidance. This approach also allows class time for higher-order thinking activities and collaborative learning, enriching the educational experience.

The findings of this study highlight the superiority of the flipped classroom model in improving Grade 9 students' understanding of Physics compared to lecture-based instruction. Future research could explore its long-term effects on learning retention and student performance in other grade levels and subject areas. Studies could also examine its effectiveness among diverse student populations to assess its broader applicability. Additionally, incorporating qualitative approaches like interviews or focus groups could provide deeper insights into student and teacher experiences. Finally, integrating emerging technologies, such as virtual labs and AI-driven personalized learning tools, could further enhance the flipped classroom approach, paving the way for more innovative and impactful teaching strategies in Physics education.

5.0 Contributions of Authors

The authors confirm their equal contribution to every part of this research. All authors reviewed and approved the final version of this paper.

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7.0 Conflict of Interests

This study has no conflict of interest of any sort.

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