



Flipped classroom: Synchronizing academic achievement, holistic engagement, and teaching excellence

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ABSTRACT

Article History

Received: 15 May 2026

Revised: 6 July 2026

Accepted: 3 August 2026

Published: 14 October 2026

Keywords

Academic performance

Blended learning

Flipped classroom

Student engagement

Teacher evaluation.

The research investigates the impact of the flipped classroom model in enhancing student engagement and academic performance in learning earth science, as well as a comparison of teacher evaluation with that of the traditional model. Recognizing the persistently low performance in international standardized assessments such as the Trends in International Mathematics and Science Study (TIMSS), the Programme for International Student Assessment (PISA), and the National Achievement Test (NAT), this study advocates for innovative teaching approaches that align with technological advancements and diverse learning styles. The flipped classroom model, characterized by prerecorded video lectures accessed outside the classroom, is advocated to improve student motivation and academic understanding. The quasi-experimental study, involving forty-nine undergraduate students taking up earth science, was divided into traditional and flipped classroom groups. All students were then exposed to pre- and posttests in earth science; pre- and postsurveys on engagement across cognitive, behavioral, and affective domains; and were tasked to accomplish standardized teacher evaluations. Results indicate significant improvement in academic achievement for both groups, with the flipped classroom group attaining a superior performance level. Furthermore, the flipped classroom significantly increased student engagement across all domains, unlike the traditional classroom, which only enhanced cognitive engagement. Teacher evaluations remained outstanding and comparable across both methods. All of these suggest that while traditional teaching remains effective, the flipped classroom presents a persuasive pedagogical framework that fosters higher levels of engagement across all domains and academic success. Recommendations include curriculum adjustments and professional development to effectively implement flipped classrooms, thereby supporting academic growth in science learning.

Contribution/Originality: This study shows the novelty of the flipped classroom model by proving its superior capacity to enhance earth science academic achievement and multidimensional student engagement. It also contributes significant evidence that, while a flipped environment elevates engagement, it maintains outstanding teacher evaluation comparable to traditional teaching.

1. INTRODUCTION

The dismal performance of students of the Philippines in international and even national assessments has been well-documented. The Trends in International Mathematics and Science Study (TIMSS), for example, has put the Philippine educational system in the spotlight, but arguably not in a positive way. As told by the (Congressional Policy and Budget Research Department 2024), the 2003 results put the Philippines at the bottom of the list for science (4th from last) and mathematics (5th from last). This is a slight improvement in the 1999 TIMSS result that

ranked the country's performance 2nd from last for both subjects. Nevertheless, these results may be the reason why the country never participated in the TIMSS for many years until 2019. This time, Filipino learners ranked last among the participating countries.

The disappointing results are also confirmed by the Programme for International Student Assessment (PISA), which placed the Philippines at the bottom, that is, ranked 78th out of 78 countries in 2018 and ranked 77th out of 81 countries in 2022. These results seem to compound the problem even in view of the complete integration of the K-12 Program into the nation's basic education system. Moreover, the results of the National Achievement Test (NAT) in 2018 show diminished levels of proficiency, specifically in science and mathematics (Hernando-Malipot, 2019).

The blame should not be shouldered by the educational system alone. Indeed, students may not be the learners our present educational infrastructure was designed for (Prensky, 2001). We could attribute this to the ever-evolving pace at which technology evolves. Teachers should be able to catch this. As proclaimed by Baer (2013), technology is now at the point where educators can meet students' learning needs and capture the powerful imagination within all students. There is a call, then, to modify the learning environment for the students.

One modification is the blended learning environment, which showcases the flipped classroom. This is an educational model that reverses the role of school and home (EDUCAUSE, 2012). There is no fixed model for flipping a classroom, but it works by exposing students to video lectures that can be accessed away from the school, followed by activities done inside the classroom.

The rise of the flipped classroom model has been well-documented, including its benefits. Among them would be that the flipped learning approach significantly increases student engagement (Bond, 2020). In this sense, learners can always revisit, review, and scrutinize discussions. The pace, time, and location for the lecture are personalized for the students at their own convenience. Second, valuable and meaningful discussions can transpire during class time, focusing on areas that are very difficult to understand. Focus is also on questions that are lingering and may or may not be covered during the learning sessions. Third, the learning environment provides more feedback from both the students and the teachers. This aids the teacher more and really relegates him/her to the real facilitator of the subject matter.

The reason for looking for alternative modes of learning is that learners may have issues in maintaining their engagement inside the classroom. It has already been well documented that high engagement predicts high academic achievement (Lei, Cui, & Zhou, 2018). In the study involving PISA takers, it was established that learners with high engagement achieved high levels of achievement (Fung, Tan, & Chen, 2018).

2. LITERATURE REVIEW

2.1. *The Flipped Classroom and Academic Achievement*

The positive effect of the flipped classroom (FC) model on academic performance is well-documented, especially in English as a Foreign Language (EFL) contexts (Turan & Akdag-Cimen, 2020). According to Arslan (2020), this pedagogical model fosters student success and satisfaction. Beyond language learning, Fuchs (2021) claims that the FC model breaks traditional classroom monotony, offering the flexibility required for an ever-changing world of education. This is supported by Esperanza, Himang, Bongo, Selerio, and Ocampo (2023), when he was able to show that flipping the classroom allows students to pace their learning as well as provides lecturers with extended discussion through more in-depth sessions.

In the sciences, Rathner and Schier (2020) found that flipping advanced physiology classrooms led to higher passing rates and improved final grades. However, Andrés and Contelles (2022) emphasize that these benefits are contingent upon proper implementation, requiring high-quality resources and purposeful class time dedicated to problem-solving and feedback. Despite these gains, caution must still be observed. Leatherman and Cleveland (2020) observed that student satisfaction is based on individual preferences toward video-based learning. Furthermore, a

small but vocal minority of students remains critical of the model, electing for traditional lecture formats (Díaz, Antequera, & Pizarro, 2021).

2.2. Student Engagement

Student engagement is generally categorized into three domains: cognitive, behavioral, and affective. Generally, all 3 domains prove to be good predictors for academic success (Delfino, 2019; Estévez, Rodríguez-Llorente, Piñeiro, González-Suárez, & Valle, 2021; Lei et al., 2018). But in some cases, only behavioral engagement is a determinant in student achievement (Çali, Lazimi, & Ippoliti, 2024). Further, the affective domain, at times, can be negatively correlated to academic achievement (Kassab, Rathan, Taylor, & Hamdy, 2024).

In an FC setting, engagement is often triggered by factors such as self-efficacy, emotional well-being, and a sense of belongingness (Fung, Besser, & Poon, 2021). This elevated engagement has been observed across various demographics, from K-12 to undergraduate and special education students Lewis-Kipkulei, Singleton, Small Singleton, and Davis (2021). However, Hava (2021) cautions that the FC model's ability to sustain engagement is not universal and could vary across different learning situations.

2.3. Flipped Classroom and Teacher Evaluation

Strelan, Osborn, and Palmer (2020) observed that many studies do not report anything specific about teacher evaluation under the flipped classroom model. Nevertheless, their findings still suggest that the FC had a weak-to-moderate positive effect on student satisfaction with their instructors. Samuel (2021) found that students rated their instructors significantly higher than their counterparts in the traditional setting. It is noted, however, that in this study, the courses are different from one another and that what was being evaluated was only the pedagogical techniques. Moraros, Islam, Yu, Banow, and Schindelka (2015) showed that 80% of students evaluated the effectiveness of the teaching model as very effective. However, graduate school students participated in the research.

2.4. Synthesis

Finally, the link between student engagement and high academic performance cannot be denied, especially when it is placed in a flipped classroom environment. There were significant increases in students' academic achievement when there was a corresponding high student engagement (Alebrahim & Ku, 2020; Busebaia & John, 2020; Mansoor, 2021; Polat & Karabatak, 2022; Yan, Tan, & Kifle, 2023). In light of the recent literature surveyed, the findings suggest that the impact of the flipped classroom environment on academic performance and engagement is not conclusive. Much of the research conducted is broad, and there is a notable scarcity of literature on science courses. Definitely, the results of this research endeavor could be able to fill these gaps, aiming to provide the necessary scaffolds required to drive student achievement in this modern educational landscape.

2.5. Research Questions

The main objective of this endeavor is to be able to test the effectiveness of the flipped classroom in learning science in higher education. Specifically, the research intends to answer the following research questions:

- 1a. Is there a significant difference between the pretest and posttest mean scores of students in the traditional classroom in learning Earth Science?
- 1b. Is there a significant difference between the pretest and posttest mean scores of students under the flipped classroom in learning Earth Science?
- 1c. Is there a significant difference between the posttest scores of students in the traditional classroom and those in the flipped classroom?
2. Is there a significant difference in the levels of engagement of students before and after the intervention within both the traditional and flipped classrooms across the following domains?

- a. Cognitive Engagement.
- b. Behavioral Engagement.
- c. Affective Engagement.

3. Is there a significant difference in the evaluation scores provided by students for the teacher under the traditional classroom versus the flipped classroom?

3. METHODOLOGY

3.1. Participants of the Study

Forty-nine undergraduate students of Benguet State University taking up the Bachelor of Science in Education who were enrolled in Science Education 101: Earth Science during the first semester of the school year 2024–2025 were considered in the study. The students were then divided randomly into two experimental groups, namely the traditional classroom and the flipped classroom.

3.2. Research Design and Instrumentation

The research is quasi-experimental by design. Students in the traditional classroom were exposed to the usual lecture method inside the classroom all throughout the semester. In contrast, students in the flipped classroom were exposed to video lectures that were available online, which were doled out week after week all throughout the semester. The teacher-researcher facilitated the course for both groups. Learning materials (videos and lecture presentations) were validated by experts before the research was carried out. Here is a summary of the conduct of the experiment.

A 30-item multiple-choice achievement test in earth science served as the primary tool that was administered before and after the intervention. It covers comprehensive topics in geology, hydrology, and meteorology. The questionnaire for engagement in learning science (Bawang & Prudente, 2018) contains 8 items for each domain, i.e., cognitive, behavioral, and affective. Both the test in earth science and the survey questionnaire instrument were subjected to validation and were pilot-tested before the conduct of the study. Both instruments are found to be highly reliable (Cronbach's alpha coefficients of 0.89 and 0.903, respectively). The 20-item Philippine Association of State Universities and Colleges (PASUC) tool for evaluating teaching effectiveness was used for the study since it is the standardized instrument for all Higher Education Institutions (HEIs) in the Philippines. For this research, the said instrument proved to be highly reliable at $\alpha = 0.911$.

3.3. Treatment of Data

The descriptive measure used is the weighted mean, which was used in describing the test scores, level of engagement, and teacher evaluation by students. The t-test was used for comparing the means of the test scores and teacher evaluation since a normally distributed data set was established. For the comparison of the means of the level of engagement, normality could not be established; therefore, the nonparametric test, namely the Wilcoxon signed-rank test, was utilized to test the difference between the students' level of engagement before and after the intervention. Statistical analyses were set at the 0.05 alpha level.

The experiment can be summarized in Figure 1. The phases are: a) pre-intervention phase, b) intervention phase, and c) post-intervention phase. The pre-intervention phase involves planning and selection of student participants for the research. After selection, the students are oriented on the objectives of the study, and at the same time, clarifications about the experiment and even the totality of the research were raised and answered. This is also the time the group was divided randomly into two. Informed consent was then explained and eventually solicited from the participants. The pretest and pre-survey instruments were then personally floated and collected by the researcher.

For the intervention phase, both groups of students were then exposed to the assigned learning environment. Lastly, in the post-intervention phase, the post-test and the post-survey questionnaire were personally administered and collected by the researcher. Evaluation of the teacher ensued.

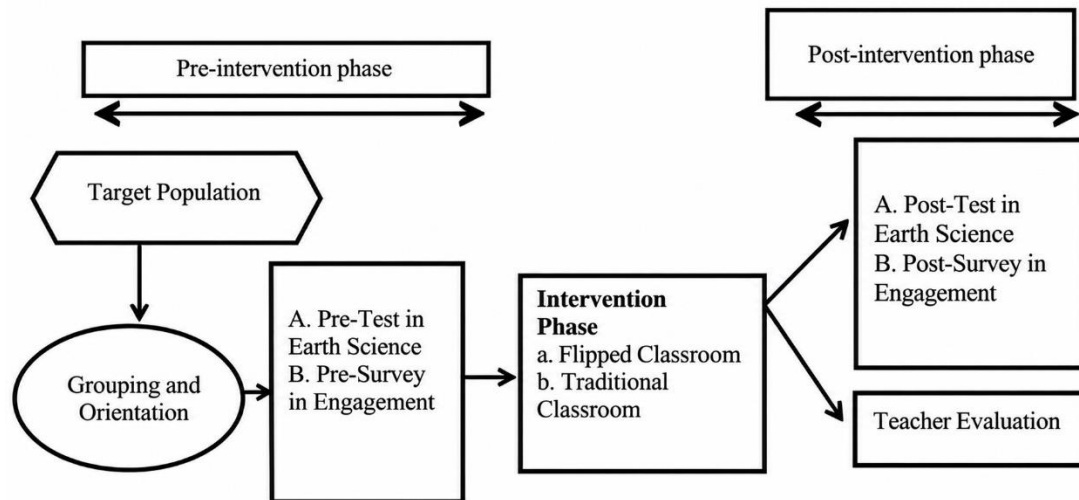


Figure 1. Process flow of the study.

4. RESULTS AND DISCUSSION

4.1. Comparison Between the Pretest and Post-Test Mean Scores of Students Under the Flipped Classroom and Traditional Classroom in Learning Earth Science

Table 1a presents the shift in the academic achievement of students in earth science in both the flipped and the traditional classroom groups. Before the intervention, students in the flipped classroom group attained a “passing” mean score of 16.9, while the traditional group earned a “fair” mean score of 17.2. After the intervention, post-test results indicate improvement for both groups: the flipped classroom group reached a “superior” level ($\bar{x} = 26.6$), while the traditional group registered an “above average” rating ($\bar{x} = 24.6$). When pre- and post-test scores were compared, statistical analyses for both groups showed highly significant differences, namely the flipped classroom ($t_{\text{computed}} = -8.44$, $p = 0.001$) and the traditional classroom ($t_{\text{computed}} = -7.14$, $p = 0.001$). This means that both classroom environments are effective in raising students’ achievement.

Table 1a. Comparison of pretest and posttest scores of students within traditional classroom and the flipped classroom, respectively.

Learning Modality	Mean Before Intervention ($\bar{x}$)	DE	Mean After Intervention ($\bar{x}$)	DE	t_{computed}	P
Flipped Classroom	16.9	Passing	26.6	Superior	-8.44**	0.001
Traditional Classroom	17.2	Fair	24.6	Above Average	-7.14**	0.001

Note: ** = Highly significant.
Mean Score Descriptive Equivalent (DE)
28.00 – 30.00 Excellent
26.00 – 27.99 Superior
24.00 – 25.99 Above Average
20.00 – 23.99 Average
17.00 – 19.99 Fair
15.00 – 16.99 Passing
<15.00 Failed

4.2. Comparison Between the Post-Test Scores of Students in the Traditional Classroom and Those in the Flipped Classroom

Table 1b shows the comparison of the pretest and post-test scores between the two groups. Although the pretest scores of the students under the flipped classroom were just “passing” ($\bar{x} = 16.9$) and those of the traditional group were “fair” ($\bar{x} = 17.2$), the statistical test suggests no significant difference between the baseline scores ($t_{\text{computed}} = -2.03$, $p = 0.840$). This means that both student groups possess equivalent aptitude toward learning earth science before the intervention.

For the post-test performance, the flipped classroom group achieved a “superior” rating ($\bar{x} = 26.6$), while their traditional-group counterpart was rated as “above average” ($\bar{x} = 24.6$). However, further analysis indicates that the scores between the two groups were not statistically different ($t_{\text{computed}} = -2.03$, $p = 0.060$). This means that academic outcomes, regardless of the learning mode, are highly similar.

Both results in Table 1a and Table 1b align with the findings of Andrés and Contelles (2022) and Estévez et al. (2021), confirming that the flipped classroom is highly comparable to the traditional classroom. Consequently, it could also be inferred that both learning methods are able to support high academic achievement, especially in learning earth science.

Table 1b. Comparison between the posttest scores of students in the traditional classroom and those in the flipped classroom.

Phase	Flipped Classroom	DE	Traditional Classroom	DE	t_{computed}	P
Before Intervention	16.9	Passing	17.2	Fair	-2.03 ^{ns}	0.840
After Intervention	26.6	Superior	24.6	Above Average	1.922 ^{ns}	0.060

Note: ns = Not significant.
Mean Score Descriptive Equivalent (DE)
28.00 – 30.00 Excellent
26.00 – 27.99 Superior
24.00 – 25.99 Above Average
20.00 – 23.99 Average
17.00 – 19.99 Fair
15.00 – 16.99 Passing
<15.00 Failed

4.3. Comparison in the Levels of Engagement of Students Before and After Intervention Within Both the Traditional and Flipped Classrooms

Table 2 shows the level of engagement between the learning modalities before and after the intervention for each group of students. For the cognitive engagement before intervention, students in the traditional and flipped classroom groups registered high engagement in learning earth science with means of 3.4250 and 4.2050, respectively. After intervention, levels of engagement for the two groups slightly improved with means of 3.6300 and 3.8462, respectively. Statistical analyses showed significant increases in the level of engagement for both groups with p-values of 0.030 ($z_{\text{computed}} = -2.166$) and 0.001 ($z_{\text{computed}} = -3.418$), respectively. This could only mean that both learning modalities were effective in raising the cognitive engagement of students for both groups.

For the behavioral engagement before intervention, both traditional and flipped classroom groups also have high levels of engagement in learning earth science, with means of 4.2000 and 4.1667, respectively. After the intervention, students in the traditional group maintained their high engagement with a mean of 4.1800. This is verified by statistical analysis indicating that the level of engagement before and after intervention is not significantly different ($z_{\text{computed}} = -0.053$, $p = 0.958$). It can be deduced that the traditional learning modality may not be able to effectively increase the behavioral engagement of students in learning science. In contrast, students under the flipped classroom registered very high levels of engagement after intervention ($\bar{x} = 4.3606$). Further statistical analysis confirms this increase to be significant ($z_{\text{computed}} = -1.958$, $p = 0.047$). This only means that the flipped classroom can raise behavioral engagement in learning science.

Lastly, Table 2 further shows high levels of affective engagement for both traditional and flipped classroom groups with means of 4.1050 and 3.9135, respectively. After the intervention, the traditional group achieved a lower mean of 4.0550 for their level of engagement, which is still described as high, though. Statistical analysis indicates, however, no significant change ($z_{\text{computed}} = -0.061$, $p = 0.958$) in the level of engagement of students in learning science. This implies that the traditional classroom was not able to raise affective engagement. Alternatively, the flipped classroom students were able to achieve a higher level of engagement after intervention ($\bar{x} = 4.2452$). This is further confirmed by statistical analysis that the said increase is highly significant ($z_{\text{computed}} = -3.148$, $p = 0.002$). The finding means that the flipped classroom approach is impactful in enhancing affective engagement.

The results coincide with the observations of Lei et al. (2018); Estévez et al. (2021); and Delfino (2019), showing that flipping the classroom enhances the engagement of students, especially in learning science. However, the findings contradict the observation of Çali et al. (2024) that only behavioral engagement is significant in developing engagement, as well as the result of the study of Kassab et al. (2024), in which it was found that affective engagement may be negatively correlated with academic achievement.

Table 2. Comparison between the level of engagement of students in learning science before and after the experience within the traditional classroom and the flipped classroom.

Engagement Domains	Learning Modality	Mean Before Intervention	DE	Mean After Intervention	DE	Z _{computed}	p
Cognitive	Traditional	3.425	HE	3.630	HE	-2.166*	0.030
	Flipped	3.476	HE	3.846	HE	-3.418**	0.001
Behavioral	Traditional	4.200	HE	4.180	HE	-0.053 ^{ns}	0.958
	Flipped	4.167	HE	4.361	VHE	-1.958*	0.047
Affective	Traditional	4.105	HE	4.055	HE	-0.061 ^{ns}	0.951
	Flipped	3.913	HE	4.245	VHE	-3.148**	0.002

Note: ** = Highly significant, * = Significant, ns = Not significant.

Mean Descriptive Equivalent (DE)
 1.00 – 1.80 Very Low Engagement (VLE)
 1.81 – 2.60 Low Engagement (LE)
 2.61 – 3.40 Moderate Engagement (ME)
 3.41 – 4.20 High Engagement (HE)
 4.21 – 5.00 Very High Engagement (VHE)

4.4. Comparison of the Evaluation Scores Provided by Students for the Teacher Under the Traditional Classroom Versus the Flipped Classroom

Table 3 shows the results of students' evaluation of their teacher under a traditional and a flipped classroom environment. There were four domains of teaching, namely commitment, knowledge of subject matter, teaching for independent learning, and management of learning, that were evaluated as outstanding by the students under the traditional group, indicated by the means 4.43, 4.66, 4.41, and 4.55, respectively.

This could also be said for students in the flipped classroom who evaluated their teacher with a mean of 4.32, 4.71, 4.56, and 4.61, respectively. Statistical analyses confirm these as equal observations across the four areas since no significant difference between the means of the two learning modalities could be established ($t_{\text{computed}} = -0.817$, $p = 0.418$; $t_{\text{computed}} = 0.452$, $p = 0.653$; $t_{\text{computed}} = 1.083$, $p = 0.285$; and $t_{\text{computed}} = 0.485$, $p = 0.630$, respectively). The inference: regardless of the learning modality employed by the teacher, the perceived effectiveness in handling the course is the same.

This is in contradiction to the findings of Samuel (2021) and Moraros et al. (2015), showing teachers who are flipping the classroom were significantly ranked better than their traditional counterparts.

Table 3. Comparison between the evaluation score given by students to their teacher in the traditional classroom and the flipped classroom.

Areas	Traditional Classroom	DE	Flipped Classroom	DE	t _{computed}	P
Commitment	4.43	Outstanding	4.32	Outstanding	-0.817 ^{ns}	0.418
Knowledge of Subject	4.66	Outstanding	4.71	Outstanding	0.452 ^{ns}	0.653
Teaching for Independent Learning	4.41	Outstanding	4.56	Outstanding	1.083 ^{ns}	0.285
Management of Learning	4.55	Outstanding	4.61	Outstanding	0.485 ^{ns}	0.630

Note: ns = Not significant.

Mean Descriptive Equivalent (DE)
 1.00 – 1.80 Poor
 1.81 – 2.60 Fair
 2.61 – 3.40 Satisfactory
 3.41 – 4.20 Very Satisfactory
 4.21 – 5.00 Outstanding

5. CONCLUSION

The study revealed that students achieve comparable academic success whether they are in a traditional or a flipped classroom, proving that both pedagogical approaches effectively support performance. However, a clear distinction emerged regarding student engagement. While those in the traditional setting only showed significant growth in cognitive engagement, students in the flipped classroom experienced higher levels of engagement across cognitive, behavioral, and affective domains. Finally, teacher evaluations for both methods were outstanding, suggesting that Earth Science can be taught effectively regardless of the specific instructional approach used.

6. RECOMMENDATIONS

The study highlights that while the traditional classroom remains effective for academic performance, the flipped classroom serves as a compelling alternative due to its unique ability to boost engagement across all domains. Consequently, school administrators should encourage a blended approach that allows students to leverage modern technology while still embracing traditional learning methods. To support this transition, institutions should provide resources like digital repositories and video production tools. Above all, teachers should still maintain a strong classroom presence. Since both groups rated their instructors as outstanding, educators need not fear that their roles will diminish when adopting blended learning strategies.

Funding: The study was funded by Benguet State University (BSU).

Institutional Review Board Statement: This study was approved by Benguet State University, Philippines, under protocol number [HERRC-2024-SO31], dated [December 23, 2024].

Informed Consent Statement: Informed verbal consent was obtained from all participants, and all data were anonymized to protect participant confidentiality.

Transparency: The author states that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.

Competing Interests: The author declares that there are no conflicts of interest regarding the publication of this paper.

Disclosure of AI Use: The author used Gemini and Grammarly to improve the grammar and clarity of the paper. It is also declared that no idea was generated by any AI tool.

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