

Conference Paper

Flipped Classroom Approach in Teaching Biology: Assessing Students' Academic Achievement and Attitude Towards Biology

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Abstract

flipped classroom is a specific model of blended learning that involves online delivery of *content and instruction while students are at home or outside the school. This model is combined with a face-to-face teacher-guided instruction where students complete projects and tasks inside the classroom. The research investigates the effect of the flipped Classroom Approach on students' academic achievement and in attitude towards Biology. The study also aims to collect data from teacher observations that can provide an unbiased and multi-perspective assessment of the implementation of the flipped Classroom Approach based on the following criteria: (1) academic involvement; (2) student-peer-teacher involvement; and (3) time allotment.*

The quasi-experimental design was used in this study. Two randomly assigned groups of students participated: (I) the Traditional Group (TG) and; (II) the flipped Classroom Group (FCG). The students' academic achievement in Biology was assessed through descriptive and inferential statistics. Also, the students' interest and confidence levels in biology were measured. The results showed statistically significant difference in favor of the FCG, where students performed better in both lower and higher order thinking skills. Moreover, FCG obtained significantly higher gain scores than TG. In terms of attitude, FCG gained a significantly higher level of interest and confidence in the subject matter after the intervention. Analysis of the results of multi-perspective assessment revealed that teacher-observers generally perceived the flipped Classroom Approach as a novel way of teaching that promotes highly evident collaborative and active student-teacher and student-student interactions. The flipped classroom instruction also provided opportunities for scaffolding and differentiation, which helped the teacher address individual needs of students. Moreover, as the students gained higher levels of interest and confidence in the subject matter, they became more actively engaged in the performance of activities and building of ideas, and more participative and articulate during small group discussions.

Keywords: blended learning; flipped classroom; academic achievement; students' attitude; quasi-experimental.

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1. Introduction

We live in an increasingly globalized society that offers both opportunities and challenges to educators and learners [1]. Educational leaders continuously collaborate to share what quality educational system can offer, in order to address these challenges, and to come up with a common goal of meeting global standards in education [2]. Over the years, Asian countries instituted major reforms in their educational system driven by the inspiring and dramatic societal and economic advancement of leading countries in the region. In the

Educational Policy Research Series of 2014, The United Nations Educational, Scientific and Cultural Organization (UNESCO) presented contemporary educational issues to the Association of Southeast Asian Nations (ASEAN) countries, which gave the impetus for member countries to institute educational reforms. Among the highlighted educational concerns were *technological advancement* and the issue of the impact of digital learning on education [3].

In response, many organizations took the initiative to promote collaboration among Asian countries that focused on educational reforms; Southeast Asian Ministers of Education Organization (SEAMEO) is one of them. It spearheaded regional cooperation for strategic planning in education, science and culture for Southeast Asian development [4].

In the 21st century learning environment, we are constantly challenged by the digital world, which is characterized by the rapidly growing global knowledge and a continually advancing information and communication technology. It is undeniable that technology has made a huge impact on today's generation of learners. Students as young as pre-schoolers can navigate various devices better than adults [5]. Born and raised in the age of Information Evolution, these students can no longer be perceived and treated as "empty containers" just waiting to be filled up. Hence, for learning to effectively take place, educators must develop and adopt more appropriate teaching methods and approaches to cater to the needs of this new breed of learners.

Teachers must take on the challenge of utilizing technology to commit to a paradigm shift, from a teacher-centered to a student-centered learning style, focusing not on how to teach, but how to facilitate learning. Students must be taught how to learn, so that they can continually learn on their own, even outside the classroom setting and throughout their lives [6]-[8].

Moreover, teachers are encouraged to face the challenges of developing a variety of suitable instructional materials and activities to address the needs of all students,

while engaging all learners with different abilities, preferences, and interests [9]. The use of World Wide Web has been known to promote active teacher-student exchange of ideas and learning interactions [10].

One of the latest trends in educational instructions that explores the potential value of online resources and technology is the flipped Classroom Approach. It allows the learners the opportunity to access learning instruction at their own pace and to apply what they have learned through different activities provided, as they enter the classroom for face-to-face interaction. [11], [12]. In flipped learning, direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment, where the educator guides students as they apply concepts and engage creatively in the subject matter. Teachers are encouraged to give students options to learn concepts from books, videos, audio files, or any other types of materials that cover a given topic. Afterwards, students are expected to take a central role and able to demonstrate understanding through performance tasks and other activities in the classroom [13]-[16].

Given that the flipped classroom has been widely utilized nowadays, it is still at its infancy period in some countries, including the Philippines. Hence, this study aimed to determine the effectiveness of flipped Classroom Approach in the improvement of biology students' academic achievement and attitude towards t Biology, using quasi experimental design.

Concurrently, this study evaluated the implementation of the flipped classroom, based on teachers' perspectives, to help validate previous research findings. Science teachers were invited to observe the conduct of the study, particularly the delivery of the lesson in order for them to contribute their perceptions on how students interacted during the process. Consolidated insights from the researchers and teacher provided a "*multi-perspective*" and "*unbiased*" assessment of the implementation of the flipped classroom.

The results of this study could help address major challenges that many teachers encounter, that include time constraints in covering the syllabus, and the introduction of complex and highly technical topics. Suffice to say that the Philippines, as an archipelagic country in its geographic location in the Pacific, tended to encounter a lot of natural calamities, which more often than not led to inevitable class suspensions over the past so many years. It is in this situation where the flipped classroom is expected to work better than the traditional approach.

During the in-class sessions, students were given more opportunities for individualized learning, geared towards helping them develop higher order thinking skills through engagement in more challenging activities.

In a flipped classroom, Biology teachers can carry out virtual laboratory activities in a seamless way, safeguarding them from possible violation of bioethical and safety standards, especially when using microorganisms, plants or animals as test organisms in experiments. In addition, teachers can also show events and processes that are impossible to show through chalk-and-board teaching process.

2. Objectives of the Study

This study determined the effects of the flipped classroom approach on students' academic achievement in and attitude, particularly their interest and confidence towards Biology.

It also gathered and analyzed data on the teachers' perspectives in the implementation of flipped classroom, as support to quantitative findings.

3. Materials and Methods

In this study, the quasi-experimental design was used. Both descriptive and inferential statistics were used to analyze the gathered data.

3.1. Participants

A total of 80, Grade 10 students, in a non-sectarian private school, in Metro Manila, participated in the study. They were grouped into Traditional Group (TG), which was taught conventionally, and flipped Group (FG), which received both online and face-to-face instruction. Groupings of students were formed prior to the study and matched based on mental ability scores obtained from OTIS-Lennon Scholastic Ability Test (OLSAT). This was to ensure that the two groups of students who took part in the study were on equal footing in terms of mental ability.

3.2. Instruments

Instructional materials. The researchers developed instructional materials such as lesson plans, video clips, and test items focused on topics in Molecular Genetics for Grade 10 students. These were validated by experts in Science Education.

Students in both groups were taught based on the same standards of competency and learning outcomes.

Pretest and posttest items. A 50 item test used in this study was piloted and subjected to item analysis in terms of the indices of difficulty and discrimination.

Attitudinal questionnaire. A 20-item Likert Scale type attitudinal questionnaire adopted and modified from "A *Biology Attitude Scale by Russell and Hollander*" was used in the study [17]. The participants were asked to honestly rate their attitudes towards Biology before and after the intervention, using the following responses: (5 = *Strongly Agree*), (4 = *Agree*), (3 = *Undecided*), (2 = *Disagree*) and (1 = *Strongly Disagree*)

Survey questionnaires. Teachers' perception about the flipped classroom was determined through the researcher-made questionnaire that covered 3 major aspects, namely: *a. Academic involvement*, *b. Student-Student -Teacher Interactions* and *c. Time Allotment*.

The participating teachers rated their responses as follows: (5 = *Strongly Agree*), (4 = *Somewhat Agree*), (3 = *Neutral*), (2 = *Somewhat Disagree*) and (1 = *Strongly Disagree*). The survey questionnaire also included 3 open-ended questions for teachers to answer.

3.3. flipped classroom procedure

The cooperating teacher assigned an online class using EDMODO and enrolled the students online. Learning materials made by the researchers such as concept articles, power points, and video clips were uploaded online. Four major stages were observed under the flipped classroom approach such as:

Stage 1: Understanding the lesson

In every lesson, students were given guide questions to help them focus on salient points as they watch lectures online. Students learned at their own pace at home while collaborating with their peers and the teacher. The teacher had control over what and when the students can access the files.

Stage 2: Applying understanding

A pre-assessment test was answered by the students online and submitted at a teacher-designated time. The students' scores served as the basis for grouping the students during classroom activities and in determining who among the students needed more time and assistance in the lesson.

Stage 3: Application of new understanding

Homework was done in the classroom, where group tasks and individual worksheets were completed. Different interactive and dynamic activities were introduced to students for concept engagement. The advanced students, identified based on pre-assessment test results, were tasked to help their classmates in understanding the lesson.

Stage 4: Assessment of learning

Students' learning was assessed using teacher-made tests and other tasks accompanied by scoring rubrics.

Data analysis

The independent samples *t*-test was used to determine any significant difference in terms of achievement and attitude between the two groups. The level of significance (α) was set to 0.05 in all *t*-test analysis and the *p*-value approach was used in deciding whether or not the differences between the two data sets are statistically significant.

To provide more comprehensive evidence on the difference between students' achievement and attitude, the Hake's [18] normalized gain score formula was used:

$$\text{Gain Score} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Perfect Score} - \text{Pretest Score}}$$

For the students' attitude, the following scale with verbal interpretations was also used: (4.1 – 5.0 = *Very Positive*); (3.1 – 4.0 = *Positive*); (2.1 – 3.0 = *Moderately Positive*); (1.1 – 2.0 = *Negative*) and; (1.0 and below = *Very Negative*).

To further support the findings, descriptive statistics was used to describe the teachers' perceptions about the flipped classroom.

4. Results and Discussion

The students' gained scores in lower order thinking (*Knowledge, Comprehension, and Application*) and higher order thinking (*Analysis, Synthesis and Application*) skills were analyzed using the independent samples *t*-test.

TABLE 1: Analysis of Students Lower Order Thinking Skills Achievement.

Group	\bar{x}	s	t value	df	p-value
Traditional Group	0.481	0.044			
flipped Group	0.647	0.041	3.592	78	<.001
n = 40 $\bar{x}_1 - \bar{x}_2$ = 0.166					

Based on the gain score analysis in Table 1, the two groups have significantly different gain score means based on the values $t(78) = 3.592, p < .001$, in favor of the flipped group.

TABLE 2: Analysis on Students Higher Order Thinking Skills Achievement.

Group	\bar{x}	s	t value	df	p-value
Traditional Group	0.216	0.017			
flipped Group	0.403	0.024	5.833	75	<.001
n = 40 $\bar{x}_1 - \bar{x}_2$ = 0.187					

Table 2 showed that in terms of higher order thinking skills, the flipped group obtained a significantly higher gain score, compared to the traditional group ($t(75) = 5.833, p < .001$).

The results shows that the flipped group performed significantly better than the traditional group in both lower and higher order thinking skills. This part of the study responds to the call of Bishop [19] to further investigate how students' learning outcomes can be enhanced in the flipped classroom. These results are similar to those of previous studies by Turner [20], Missildine [21], Schultz [22] and Adams [23], where they noted an improvement of students' performances and achievement in Chemistry class and health allied courses, under a flipped classroom. Similar positive effects on achievement were observed in the work of Engin [24] and Kong [25] in language and information literacy courses.

Based on Table 3, the difference in the gained interest in Biology between the flipped classroom and traditional group is statistically significant, where $t(5.755, df = 78)$ and $p (<.001)$, in favor of the flipped classroom group.

TABLE 3: Gain Score Analysis on Students' Interest in Biology.

Group	\bar{x}	s	t value	df	p-value
Traditional Group	0.277	0.212			
flipped Group	0.553	0.216	5.755	78	<.001
n = 40 $\bar{x}_1 - \bar{x}_2$ = 0.276					

It shows that the flipped classroom significantly increased students' interest in learning Biology. This finding contributes to the claim of Movahedzadeh [26] that interest in Science must be given importance through innovative teaching method that can motivate students to develop positive attitude. Consistent with the findings of Siegle [27], this study noted a favorable attitude of students towards flipped classroom. This can be attributed to the opportunities given to students to utilize learning materials at their own pace and time, and the flipped classroom, which provided individualized learning and teacher availability.

These results can also be used as a response to Prokop's [28] plea to teachers to discover how students develop their attitudes toward science, particularly in Biology.

TABLE 4: Gain Score Analysis on Students' Confidence in Biology.

Group	\bar{x}	s	t value	df	p-value
Traditional Group	.201	.139			
flipped Group	.439	.179	6.645	73	<.001
n = 40 $\bar{x}_1 - \bar{x}_2$ = 0.237					

Based on Table 4, the gained confidence of the FCG (**M = .439, SD = .179**) is higher compared to the TG (**M = .201, SD = .139**). This implies that students who are given the chance to experience more interactive activities while in a flipped classroom are likely to gain more confidence in Biology. The result of the *t*-test (*t* (73) = 6.645), and (*p*<.001) confirms that the difference between the gain scores of the flipped and traditional group is statistically significant.

These results complemented the observations of teachers that the students who studied independently using the learning materials shared by the teacher in a flipped classroom showed more evident abilities, skills, and strategies in dealing with applications of learning, while inside the classroom. They also confirm the findings of McLean [29], that flipping the classroom allows students to develop independence and self-confidence so that they can be more engaged in deep and active learning. This means that in whatever circumstance, students who showed self-belief would be able to

perform their tasks well. Moreover, students in FCG showed maturity and competence in the performance of in-class activities. This could be attributed to online preparatory activities done at home, prior to in-class face-to-face instruction. McLean [29] also claimed that students in a flipped classroom gained enough confidence to acquire independent learning skills, to efficiently manage study time, and to develop higher order thinking skills. Easy access to technology may be one contributory factor that paved the way to a deep engagement in off-campus and online activities.

The results of this study are also consistent with the findings of Morris [30] and Gerstein [30] about off-campus activities which included online testing. They pointed out that the online activities can be a motivating factor for students to improve their level of performance.

To provide a multi-perspective and unbiased assessment of the implementation of the flipped classroom, other science teacher-observers were invited to evaluate the method based on the following aspects:

(1) Academic involvement (2) Student-Peer-Teacher Involvement and (3) Time allotment. After a series of observations, the observers were given questionnaires to fill up. Their observations, insights and perceptions were tallied, analysed and synthesized.

In Tables 5, 6 and 7, the teachers' perceptions about academic involvement under the flipped classroom are presented. Numerical values with corresponding verbal descriptors are as follows: **(1.0 and below Least evident), (1.1-2.0 Less Evident), (2.1-3.0 Slightly evident), 3.1-4.0 Evident) and (4.1-5.0 Very evident).**

Table 5 shows that teachers rated **Very evidently** all the statements that measured academic involvement in a flipped classroom. Among these statements, item **4** ranked the highest garnering a mean score of 4.83. It implies that the students in the flipped classroom showed a deep involvement in the performance of activities, which can likely result in mastery of content and high gains in achievement.

However, the teacher-observers view the flipped classroom as a novel pedagogical model that they still need to get accustomed to, as indicated by a mean of **4.17** for *statement 1*, which corresponds to the verbal descriptor **Very evident**. Thus, for the participating teachers, this learning approach is not common. As shown in the table, academic involvement in the flipped classroom is **Very evident** as communicated by a mean of **4.54**. Based on Table 6, teachers' responses to all the statements can be interpreted as **Very evident**. Statements 3 and 5 ranked highest with an average mean of **4.83**. This affirms that the flipped classroom promotes continuous learning. That even when students are outside the school, they are able to extend their learning

TABLE 5: Teachers’ Perceptions of Academic Involvement in flipped Classroom.

STATEMENTS	Teachers’ Perception		
	Mean Scores	Verbal Interpretation	Rank
1. flipped classroom is a new approach to me.	4.17	Very Evident	4
2. The activities in flipped classroom help engage the disengaged learners (students are more active, interested and participative).	3.33	Very Evident	2
3. The flipped classroom fully exploits the potential of ICT in providing an opportunity for students to learn prior to class.	3.73	Very Evident	3.5
4. The mastery of the lessons among the students is evident based on in-class activities (performance tasks, worksheets etc.) completed.	3.45	Very Evident	1
5. Assessment of students’ learning and feedbacking is done efficiently. (provided with proper tools like rubrics.)	3.68	Very Evident	3.5
Weighted Mean	4.54	Very Evident	

experiences at home through online instruction. Moreover, there is clear evidence that while the approach employs differentiated instruction to address individual needs of students, the flipped classroom was still able to promote deep involvement and closer student-to-student interaction during small group discussions.

On the other hand, the lowest mean of **4.50** was obtained in the responses to *statements 2 and 4* but which can still be described as **Very evident**.

At this point, there is a strong evidence to suggest that based on teachers’ perceptions, the flipped classroom offers the students a more engaging and active learning environment.

Table 7 shows that teachers used the descriptor **Very evident** for all the statements that measured time allotment in a flipped classroom. *Statements 2 and 3* ranked highest obtaining a mean of **5.00**. This high score can be interpreted to indicate strong evidence of a continuous connection between teacher and students even outside the classroom, making possible the delivery of lessons at any time and in any place. Online access to learning materials provides students the content knowledge needed to engage in meaningful discussion during classroom instruction, and consequently helps them

TABLE 6: Teachers' Perceptions on Student-Peer-Teacher Involvement in flipped Classroom.

STATEMENTS	Teachers' Perception		
	Mean Scores	Verbal Interpretation	Rank
1. The flipped classroom provides opportunities for students to study independently, and organize ideas in the way that fits their interests.	4.67	Very Evident	3
2. The flipped classroom provides the students greater opportunities to communicate and collaborate with their fellow students and other teachers.	4.50	Very Evident	4.5
3. The flipped classroom bridges the gap between the school and home.	4.83	Very Evident	1.5
4. Learners are actively engaged in both individual and group work.	4.50	Very Evident	4.5
5. Assessment of students' learning and feedbacking is done efficiently. (provided with proper tools like rubrics.)	3.68	Very Evident	1.5
Weighted Mean	4.67	Very Evident	

excel, challenges them to think and motivates them to demonstrate learning during the performance of varied tasks involved in a face-to-face interaction.

The lowest mean score of **4.5** was obtained by the *statements 1 and 4*, but still described as **Very evident**. Based on the consolidated responses of the teachers, one remarkable quality of the flipped classroom was that it overcomes time constraints, because it offers teachers the opportunity to deliver lessons effectively and to assess students' learning even outside class hours. It further relieves students and teachers from worries about not finishing lessons or tasks when there are class suspensions or interruptions.

Moreover, teacher-observers noted strong evidence of efficient time management, with time allocation being given a weighted mean of **4.83**, interpreted as **Very evident**.

Based on the descriptive statistics, teacher-observers claimed that the flipped classroom achieved one difficult goal, which was to make students feel more interested and engaged in the science subject. This new approach undoubtedly promotes student-centered learning and maximizes time for learning. Based on the results gathered by the researchers combined with insightful observations and comments of teacher observers, the flipped classroom can be an effective approach in enhancing students' achievement and attitude towards Biology.

TABLE 7: Teachers’ Perceptions of Time Allotment in flipped Classroom.

STATEMENTS	Teachers’ Perception		
	Mean Scores	Verbal Interpretation	Rank
1. In flipped classroom, time is maximized evidently for students to perform activities, and for the teacher to determine students’ progress and achievement.	4.67	Very Evident	4.5
2. flipped classroom fosters student-centered learning and shows a seamless integration of online lesson and in-class activities.	5.00	Very Evident	1.5
3. Students show efficiency in performing in-class activities and high order thinking skills is evidently demonstrated.	5.00	Very Evident	1.5
4. flipped classroom addresses time constraints in instruction and inevitable interruption of classes.	4.67	Very Evident	4.5
5. flipped classroom allows students to learn at their own pace and offers faster pacing of lesson delivery without compromising the content of lessons that students should learn.	4.83	Very Evident	3
Weighted Mean	4.83	Very Evident	

5. Conclusion and Recommendation

The result of the study manifested a significant improvement in both achievement and attitude towards Biology in favor of the FCG. The exposure to flipped classroom instruction developed a more positive attitude in students, which also resulted in a greater improvement of understanding of concepts as reflected in their performances. flipped classroom instruction provided avenues for the students to be participative in class, and to articulate their ideas during small group discussions. Students’ participation was maximized while the teacher’s dominance in the class was minimized as perceived by the teacher-observers.

Moreover, it promoted individualized learning and better student access to their teacher, even outside the classroom. Students were given more opportunities to take charge of their own learning through the resources uploaded by the teacher online. The students had actively taken part in the dynamic teaching-learning process, as they created, assessed and reflected on their own learning.

Based on the findings of this study, the researchers recommend the use of the flipped classroom in teaching Biology. In promoting learning anytime and anywhere, using flipped classroom in other disciplines is also highly encouraged.

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