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Flipped Classroom Approach in Teaching Science in Senior High School

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Abstract. Teaching in today's classroom is a complex and challenging profession, in which the integration of technology is widely advocated to meet the demands of 21st-century learning. However, there is limited research on addressing complex topics such as Bioenergetics using the Flipped Classroom Approach. The study investigated (1) students' economic status, ICT background, and accessibility of ICT devices; (2) students' performance before and after the implementation of the Flipped Classroom Approach, specifically in the different content areas in Bioenergetics; (3) the statistical significance of the performance of the students between the flipped and traditional classroom approaches; and (4) students' and teacher's experiences in using the approach. A pretest-posttest quasi-experimental design was employed with 85 Grade 11 students from a public national high school, comprising two experimental groups: 25 students from ABM, 38 from HUMSS, and a control group of 22 students from GAS. A teacher-made test, aligned with Department of Education standards, was used to assess the student's performance. Statistical analysis using ANOVA confirmed that there was no assignment bias among the groups before treatment. Results showed that the student's performance was at the lower end of mastery before the implementation. After implementing the Flipped Classroom Approach, scores increased significantly, with students progressing toward mastery in all content areas. Statistical analysis confirmed that the experimental groups outperformed the control group, demonstrating the effectiveness of the approach. The qualitative data from the interviews and focus group discussions, using Braun and Clarke's thematic analysis, revealed that students' and teachers' experiences aligned with the four pillars of F-L-I-P learning: flexible learning, learning culture, intentional content, and professional educator. The study recommends integrating the flipped classroom approach into subjects with the least learned competencies, expanding student access to ICT devices to support digital learning, and establishing a school-wide Learning Management System for effective implementation.

Keywords: Bioenergetics; Earth and Life Science; Flipped classroom approach; F-L-I-P learning; Information and communications technology; Senior high school.

1.0 Introduction

Addressing learning gaps in science education remains a challenge, especially when dealing with complex topics in Science, such as Bioenergetics. The use of traditional methods, such as lecture-style approaches, tends to disengage students, resulting in minimal retention and understanding of the subject matter. This makes teaching in today's classroom a challenging profession. The teacher needs to possess a broad repertoire of skills and the ability to adapt to the changes brought about by technological advancements. According to the Partnership for 21st Century Skills (2019), people live in a generation and media-driven environment with rapid advancements in technological equipment. Hence, teachers should re-equip themselves with current trends in teaching, such as the integration of technology to meet the demands of 21st-century learning, which involves the use of the Flipped Classroom Approach (FCA) to improve students' learning.

The Flipped Classroom Approach (FCA) is a growing movement in both K-12 and higher education that prompts educators to rethink how to utilize valuable class time with learners. A flipped classroom is a pedagogical model in which lectures are provided to students for access outside of the classroom. At the same time, class time is dedicated to scaffolding, skill development, and collaborative sessions (Bok Center for Teaching and Learning, 2024). This approach utilizes short video lectures, providing students with the flexibility to learn at their own pace. Class time is dedicated to interactive discussions, exercises, and hands-on activities. According to Fields (2023), FCA benefits both slow and fast learners, as slower learners can pause and repeat instructional materials while fast learners can progress to advanced topics. In Japan, the use of the flipped classroom approach is emerging, which enhances students performance and improved learning environments (Zhang & Wang, 2022). However, despite its growing adoption, the studies on its effectiveness in the Philippine context remain limited.

The increasing availability of digital technology further justifies the integration of FCA into the curriculum. The Department of Education (DepEd) has issued revised guidelines to enhance the implementation of the Computerization Program, which aims to equip public schools with suitable ICT devices to enrich the teaching and learning process (Department of Education, 2023). As of 2025, 64,816 laptops and smart TV packages work Php. 1.913 billion will be delivered across 16 regions, aiming to address the 69.3% insufficient student-to-device ratio (Department of Education, 2025). These investments in the public school system demonstrate improvement in digital accessibility in education and highlight the potential of FCA in addressing learning gaps.

Furthermore, research on the use of the Flipped Classroom Approach is increasing exponentially, according to the Institute of Education Sciences (ERIC) database; however, more research on the Flipped Classroom Approach in local settings remains scarce. Existing studies have focused on the implementation of FCA in general education, but few have explored its effectiveness in teaching Bioenergetics. The study aims to fill this gap by investigating the effectiveness of FCA on students' performance in Bioenergetics,, comparing it with the use of traditional classroom methods, and exploring the experiences of both students and teachers with the approach. The findings will contribute to the growing research on FCA, provide insights into its applicability in Philippine settings, and address the least-learned competencies in science subjects.

2.0 Methodology

2.1 Research Design

The study employed a pretest-posttest quasi-experimental design to assess the impact of the Flipped Classroom Approach (FCA) on student performance. In this design, two groups (HUMSS and ABM) were assigned as experimental groups, while one group (GAS) served as the control group. The assignment was based on their existing class sections. The experimental groups received instruction using the FCA, while the control group followed the traditional classroom approach. According to Thomas (2020), a quasi-experimental design is an approach often employed when randomization is impractical, aiming to minimize threats to internal validity by using non-random criteria for group assignments. In addition, it involves comparing scores from different groups or conditions and uses a non-manipulative variable to define the groups or conditions being compared. To complement the quantitative data, a phenomenological research design was used to explore students' and teacher's experiences with FCA. The data was collected through an interview and a Focus Group Discussion to unveil the commonality of experiences in this approach.

2.2 Research Locale

The study was carried out in a public national high school in Polomolok, South Cotabato. It is one of the public secondary high schools in the Municipality of Polomolok that offers comprehensive secondary education, including a Senior High School (SHS) program, which encompasses the strands involved in this study.

2.3 Research Participants

The participants in the study were the Grade 11 students of a public national high school, specifically those in classes with a subject in Earth and Life Science during the first semester of the 2017-2018 school year. There were 25 students in Accountancy, Business, and Management (ABM), 38 students in Humanities and Social Sciences (HUMSS), and 22 students in the General Academic Strand (GAS), totaling 85 students.

2.4 Research Instrument

This study utilized an adapted and modified questionnaire from the Erasmus+ Programme: "21st Century European Classroom: Meeting the Challenge of the Digital Era with Innovation and Creativity." The questionnaire was used to identify the profile of the respondents, including their economic status, ICT background, and accessibility of ICT devices. The questionnaire was modified by simplifying the language used, additional questions on digital literacy, and adjustments to fit the local educational context. To evaluate students' performance in various content areas of Bioenergetics, a 75-item multiple-choice test with one correct answer and three distractors, along with a Table of Specifications, was developed. The validity of the teacher-made test was established through expert review, ensuring alignment with the DepEd Learning Competencies. The teacher-made test was pilot-tested twice with Grade 12 students who had previously taken the Earth and Life Science subject. The teacher-made test underwent item analysis and option analysis during the first pilot testing, resulting in a reduction of the test items to 30 multiple-choice questions. The 30 multiple-choice items underwent reliability testing using Kuder and Richardson-20 after the second pilot testing. The KR-20 of the teacher-made test was 0.6, indicating a moderate internal consistency for a test. In exploring the experiences of students and teachers, interview and Focus Group Discussion guides were developed. Research experts validated the guides using content analysis to ensure relevance, clarity, and alignment with research objectives.

2.5 Data Gathering Procedure

This study used specific steps to collect data. First, permission was obtained from the Schools Division Superintendent and school administrators before the data collection. Before the intervention was implemented, the students completed the questionnaire and took the pre-test to establish baseline performance levels. The result of the pre-test was analyzed using ANOVA to determine if assignment bias existed across the groups before the application of the treatment. The ANOVA revealed that no assignment bias existed among groups ($F(2,82)=2.07$, $p>.01$).

In the implementation of the FCA, the experimental groups (ABM and HUMSS) received instruction through validated flipped classroom videos, instructional materials, and lesson exemplars developed by the researcher following the DepEd standards. The control group (GAS) received the traditional lectures and conventional assessments. After the implementation, all students took the post-test identical to the pre-test to measure the learning gains. A Focus Group Discussion (FGD) was conducted with nine students, purposively selected to represent diverse perspectives based on their performance levels and class engagement. The teacher was also interviewed about their experience with FCA.

In the analysis of data, the pre-test and post-test results were analyzed using paired-sample t-tests and ANOVA to assess the effectiveness of the FCA. Braun and Clarke's 6-Step Thematic Analysis was used to identify the themes that emerged from the transcribed and translated responses in the Focus Group Discussion and interview.

2.6 Ethical Considerations

Several potential ethical issues were considered in the conduct of the study. The researcher considered the consequences of the research for the participants as an important area of concern. The names of the schools and the respondents/participants remained anonymous, and the information gathered was confidential and stored securely. All participants were provided with written information about the research in advance, and signed contract forms were collected at the beginning of the FGD. All participants were informed of their rights to withdraw or refuse to participate at any stage of the research. Anonymity and confidentiality were assured to all participants since the researcher was fully aware of the Data Privacy Act of 2012. Approval was obtained from the Institutional Ethics Committee and school administration to ensure compliance with the ethical guidelines.

3.0 Results and Discussion

3.1 Students' Economic Status

The results (see Table 1) showed that the majority of the students in each strand have a family average monthly income between Php. 5,001.00 to Php. 10,000.00 (49.4%). According to the 2021 Family Income and Expenditure Survey (FIES) of the Philippine Statistics Authority (PSA) (2022), the survey revealed that the average annual family income of Filipino families was approximately Php. 307,190. Hence, if the annual family income of Filipino families were divided over 12 months, the average monthly income of every Filipino family is approximately Php

25,600 per month. Thus, the family average monthly income of the students in each strand was below the expectations set by the 2021 Family Income Expenditure Survey conducted by the Philippine Statistics Authority (PSA). In addition, the average family's monthly income will most likely be spent on necessities that they deem necessary, rather than purchasing gadgets or other ICT devices such as smartphones, tablets, and computers, which are considered ancillary needs for an average or below-average income-earning Filipino family.

Table 1. *Frequency and percentage distribution of respondents in terms of economic status*

Economic Status	Frequency	Percentage (%)
Below Php. 5,000.00	26	30.6
Php. 5,0001.00 to Php. 10,000.00	42	49.4
Php. 10,001.00 to Php. 15,000.00	11	12.9
Php. 15,0001.00 to Php. 20,000.00	4	4.8
Php. 20,001.00 to Php. 25,000.00	2	2.3
Above Php. 25,001.00	0	0.0
Total	**85**	**100.0**

3.2 ICT Background

The results (see Table 2) showed that, in terms of students' knowledge of different ICT activities, the majority were participating in various social networking sites (90.6%). In terms of searching online information, it revealed that most of the students know about editing online text containing internet links and images (54.1%), can e-mail a file to someone (40.0%), and can participate in a discussion forum on the internet (41.2%). In comparison, only a few students know how to create and maintaining blogs or websites (16.5%), and create and/or edit a questionnaire or poll online (30.6%). In 2023, Filipinos spent an average of 3 hours and 34 minutes per day on social media platforms worldwide, ranking them as the top social media users globally (Statista, 2024). With the exponential increase of students' participation in social networking sites, teachers can use this in the implementation of the flipped classroom approach as a Learning Management System (LMS) and make the students' time spent on the internet productive, such as the use of blogs or forums, questionnaires or online forms, and use of emails.

Table 2. *Frequency and percentage distribution of respondents in terms of ICT Background*

ICT Background	Frequency	Percentage (%)
Produce text using a word processing program	55	64.7
Edit digital photographs or other images	53	62.4
Edit online text containing internet links and images	46	54.1
Create a database	19	22.4
Create and/or edit a questionnaire or poll online	26	30.6
Email a file to someone	34	40.0
Save electronic documents on the computer	44	51.8
Use a spreadsheet program	24	28.2
Create a multimedia presentation	47	55.3
Participate in discussion forums on the internet	35	41.2
Create and maintain blogs or websites	14	16.5
Install software	40	47.1
Participate in social networks	77	90.6
Judge the reliability of information found on the internet	41	48.2
Use the internet safely	77	90.6
Use information found on the internet without copying or pasting in homework/assignment	39	45.9
Protect yourself from spam, junk mail, and computer viruses	69	81.2

In terms of student's knowledge of the basic skills and operations of ICT devices, it revealed that most of the students know about producing text using a word processing program (64.7%), editing photographs or other images (62.4%), creating a multimedia presentation (55.3%), save electronic documents in computer (51.7%), install

the software (47.1%). In comparison, only a few students know how to create a database (22.4%) and use a spreadsheet program (28.24%). In terms of using ICT devices as a tool for information searching, the majority of students know how to use the internet safely (90.6%) and protect themselves from spam, junk mail, and computer viruses (81.2%). In comparison, most students (48.2%) are aware of judging the reliability of information found on the internet, and 45.9% use the information found on the internet without copying or pasting it into homework or assignments. This implies that the student's background in basic skills and ICT device operations is limited. Hence, the teacher's assistance is a prerequisite for the implementation of the Flipped Classroom Approach, in which the use of ICT devices is important.

3.3 ICT Accessibility

The results (see Table 3) showed that, in terms of accessibility to ICT devices, the majority of students can access various devices outside school (100.0%) and at school (76.5%). Furthermore, it also revealed that the majority of students can access ICT devices, specifically at home (31.8%) and in internet cafés (45.9%). This implied that the majority of the students can access a wide variety of ICT devices outside school, specifically at home and in the internet cafés. The Philippine Statistics Authority (PSA, 2020) reported that 56.1% of households had internet access. This underscores the importance of internet cafes in providing internet access, as only a few households can afford to own a computer and have an ISP subscription due to the cost. Therefore, the utilization of school resources, including the Computer Laboratory and Table PCs, has been employed to address the accessibility gap.

Table 3. *Frequency and percentage distribution of respondents in terms of ICT Accessibility*

ICT Background	Frequency	Percentage (%)
Outside School	85	100.0
At home	27	31.8
At a friend's home	9	10.6
At a family member's home	9	10.6
Business establishments	1	1.2
In the public library	0	0.0
Internet café	39	45.9
Internet at school	63	74.1
ICT devices at school	65	76.5

3.4 Students' mastery levels before and after the traditional and FC approach was used

The results (see Table 4) showed the students' mastery level before the traditional and flipped classroom approaches were used; they revealed that Sections A and B attained a low mastery in the topic of cell structure and function, with a mean score of 34.1 in Section A and 30.0 in Section B. In addition, Section C demonstrated an average mastery of the topic of cell structure and its organelles, with a mean score of 36.0. This indicates that students have not yet mastered the competencies related to cell structure and its function. Sections A, B, and C attained an average mastery of the topic of photosynthesis. Section A attained a mean score of 45.3, Section B a mean score of 44.0, and Section C a mean score of 45.6. This implied that all the sections were familiar with the topic of photosynthesis. Sections A, B, and C attained an average mastery of the topic of cellular respiration. Section A attained a mean score of 41.4, Section B a mean score of 39.2, and Section C a mean score of 48.0.

Table 4. *Students mastery level before the traditional and flipped classroom approach was used*

Section	Cells		Photosynthesis		Cellular Respiration	
	Mean	Interpretation	Mean	Interpretation	Mean	Interpretation
A	34.1	Low Mastery	45.3	Average Mastery	41.4	Average Mastery
B	30.0	Low Mastery	44.0	Average Mastery	39.2	Average Mastery
C	36.0	Average Mastery	45.6	Average Mastery	48.0	Average Mastery

This implies that all sections are familiar with the topic of cellular respiration. The various topics in bioenergetics were already covered in Integrated Science in both elementary and junior high school. In the K to 12 Science Curriculum Guide (2023), cell structure and function are emphasized in the Grade 7 Second Grading Period, while photosynthesis and cellular respiration are undertaken in the Grade 9 First Grading Period. Thus, the pre-test results revealed that the students had grasped the content of Bioenergetics to some extent. However, the topics under bioenergetics were considered not yet mastered by Science teachers due to their difficulty in teaching the topics.

The results (see Table 5) showed the students' mastery levels after the traditional and flipped classroom approaches were used; they revealed that Sections A, B, and C achieved an average mastery of the topic of cell structure and its function. Section A attained a mean score of 34.6, Section B 46.1%, and Section C with 58.0%. This indicated that students in Section A showed a slight improvement in the topic of cell structure and its function, while Sections B and C demonstrated significant improvement from a mean percentage in the pre-test, which was near the borderline between low mastery and average mastery. Sections A and B attained an average mastery in the topic of photosynthesis, with a mean score of 51.8% in Section A and 56.3% in Section B. Moreover, Section C demonstrated a significant improvement in the topic of photosynthesis, achieving a mean score of 65.6%.

Table 5. *Students mastery level after the traditional and flipped classroom approach was used*

Section	Cells		Photosynthesis		Cellular Respiration	
	Mean	Interpretation	Mean	Interpretation	Mean	Interpretation
A	34.6	Average Mastery	51.8	Average Mastery	39.6	Average Mastery
B	46.1	Average Mastery	56.3	Average Mastery	53.7	Average Mastery
C	58.0	Average Mastery	65.6	Moving Towards Mastery	59.2	Average Mastery

This implied that Sections A and B showed improvement based on the mean scores in the pre-test and post-test, while Section C demonstrated the most significant improvement. Sections A, B, and C attained an average mastery of the topic of cellular respiration. The Section A attained a mean score of 39.6%, Section B a mean score of 53.7%, and Section C a mean score of 59.2%. This indicated that students in Section A showed slight improvement in the topic of cellular respiration, while Sections B and C demonstrated significant improvement from a mean percentage in the pre-test, which was near the borderline between low mastery and average mastery. Thus, students who underwent the flipped classroom approach showed significant improvement and grasped the content and competencies in Bioenergetics under the Earth and Life Science class more effectively than before.

In the Earth and Life Science Curriculum Guide (2016), the topics under bioenergetics are emphasized in the Second Quarter with a learning code of S11/12LT-IIbd-4-8. The learning codes were emphasized in the making of the materials, lesson plans, and video materials to establish coherence in the curriculum guide. On the other hand, the interpretation of mean scores and mean percentages in both the pre-test and post-test, in which the majority of students attained average mastery. This was due to the disparity in the range of percentages in the Seven-Descriptive Equivalent of Mastery Level of DepEd-NETRC, which was used in data analysis and interpretation. With these varied and rich experiences and learnings shared by the students after the flipped classroom approach was implemented, it implied that the students were able to grasp important concepts and come up with realizations in the topic of bioenergetics.

3.5 Significant differences before and after the traditional and FC approach was used

The results (see Table 6) showed the students' performance before and after the traditional classroom approach was implemented in Section A. The computed *t*-value of 0.40 was less than the *t*-critical value of 2.52 at a 0.01 level of significance with 21 degrees of freedom. The null hypothesis was, therefore, accepted. This means that the result in the pre-test was comparable with the post-test. This implies that the traditional classroom approach in Section A was ineffective in improving students' performance in this study. Implementing a traditional classroom approach does not improve students' mastery and development of higher-order thinking skills. However, teachers are still using the traditional classroom approach despite the criticism from various researchers because it is easier to implement. Additionally, it does not require a significant amount of time or money, allows for easy communication with students, is easier to prepare and complete the set standards and competencies, and promotes active learning between teachers and students.

The results (see Table 7) showed the students' performance before and after the flipped classroom approach was implemented in Section B. Since the computed *t*-value of 9.20 was more significant than the *t*-critical value of 2.43 at a 0.01 level of significance with 37 degrees of freedom. The null hypothesis was therefore rejected in favor of the research hypothesis. This means that the post-test result was higher than the pre-test result. It implied that the use of the flipped classroom approach in Section B was effective in improving students' performance.

The results (see Table 8) showed the students' performance before and after the flipped classroom approach was implemented in Section C. Since the computed *t*-value of 8.68 was more significant than the *t*-critical value of 2.49 at the 0.01 level of significance with 24 degrees of freedom. The null hypothesis was therefore rejected in favor of the research hypothesis. This means that the post-test result was higher than the pre-test result. It implied that the use of the flipped classroom approach in Section C was effective in improving students' performance. This data presented in Tables 7 and 8 revealed that the use of the flipped classroom approach in the class was effective in improving students' performance.

Table 6. *Summary table for the t-test for the student's performance before and after the traditional classroom the approach was implemented in Section A (GAS)*

Treatment	Mean	Variance	df	Computed *t*-value	*t*-Critical value
Pre-test	12.14	10.79	21	0.40^{ns}	2.52
Post-test	12.59	18.16			

ns - significant at 1%

Table 7. *Summary table for the t-test for the student's performance before and after the flipped classroom the approach was implemented in Section B (HUMSS)*

Treatment	Mean	Variance	df	Computed *t*-value	*t*-Critical value
Pre-test	11.32	7.95	37	9.20**	2.43
Post-test	15.61	7.22			

** - significant at 1%

Table 8. *Summary table for the t-test for the student's performance before and after the flipped classroom the approach was implemented in Section C (ABM)*

Treatment	Mean	Variance	df	Computed *t*-value	*t*-Critical value
Pre-test	12.96	12.29	24	8.68**	2.49
Post-test	18.28	15.63			

** - significant at 1%

Table 9. *Summary table for the Analysis of Variance (ANOVA) of the student's performance among the different treatments*

Source of Variation	df	SS	MS	Computed F-value	Tabular F-value
Between Groups	2	378.75	189.38	15.17**	4.87
Within Groups	82	1023.44	12.48		
Total	84	1402.19			

** - significant at 1%

Table 10. *Comparison of the mean scores among the different groups using Scheffe's test*

Between Groups	F′	(F.01) (K-1) (4.87) (2)	Interpretation
A (GAS) vs B (HUMSS)	10.18	9.74	Significant
A (GAS) vs. C (ABM)	30.36	9.74	Significant
B (HUMSS) vs C (ABM)	8.61	9.74	Not Significant

According to Baig and Yadegaridehkordi (2023), the flipped classroom improves critical thinking, teamwork, and problem-solving abilities among students. This study was supported by a meta-analysis that students in flipped classrooms outperformed those in traditional classrooms (Roehling & Bredow, 2021). Hence, the flipped classroom approach is a student-centered approach that enhances content mastery and skills as compared to the traditional classroom approach, where the teacher is the center of learning. Moreover, the teacher-made test used in the study comprised higher-order thinking skills (HOTS) questions, which the traditional classroom approach failed to establish. Unlike the flipped classroom approach, low-order thinking skills (LOTS) were developed through assignments, while higher-order thinking skills (HOTS) were emphasized and practiced in the classroom.

3.6 Analysis of Variance of students' performance among the different treatments

The results (see Table 9) showed the students' performance across different treatments (traditional and flipped classroom approaches) used in various sections, as analyzed using Analysis of Variance (ANOVA). The F-computed value of 15.17 was more significant than the tabular F-value of 4.87 at the 0.01 level of significance with

2 and 82 degrees of freedom. This indicated a significant difference in the mean scores on the post-test among the groups after the treatment was applied. Furthermore, the average post-test scores between the control and experimental groups differed significantly. The results (see Table 10) showed a significant difference in the mean scores on the post-test between Sections A and B and Sections A and C. However, Sections B and C do not significantly differ in their mean scores. This implied that the use of the flipped classroom approach in Sections B and C was more effective than the traditional classroom approach in Sections A. The use of the flipped classroom approach improved students' performance compared to the traditional classroom approach, as indicated by the pre-test and post-test results, as well as the comparisons among the groups in this study.

3.7 Students' and Teacher's Experiences

The following data presents the qualitative and descriptive findings of students' and teachers' experiences with the Flipped Classroom Approach in Earth and Life Science. From their experiences, the following themes emerged.

Theme 1: Flexible Time and Space

The Flipped Classroom is flexible in several ways. As classroom time is spent on various activities, the physical space must be flexible, allowing for the rearrangement of desks, chairs, tables, and materials according to the type of activity. Having a flexible classroom encourages interaction and connection between students and teachers, providing teachers with an opportunity to facilitate the learning process (Cole et al., 2021). Moreover, the time is also flexible, allowing students to learn at their own pace and at their own convenience, as opposed to the traditional format. In the implementation of the flipped classroom approach, students shared different experiences with relevance to flexible time and space.

S-3: "*It is nice to watch at home, specifically at nighttime, because it is very quiet, and I can hear the words being uttered by Ma'am [teacher-demonstrator].*"
S-4: "*If I am alone in our home, I watch the video lectures of the teacher-demonstrator, Ma'am." I can easily understand the lessons about cells and photosynthesis.*"
S-5: "*Once I am using my cellphone and headset, I can easily focus and internalize what the video implies.*"
S-2: "*…every time I finished watching the videos, I learned many things, and I could easily recall the ideas and other details upon returning home." If I get bored at home, I watch the videos. That is why I can easily understand and recall.*

This suggests that the majority of students experienced flexibility in terms of time and space. Students also reported that they preferred using video materials at home because they could focus and internalize the lessons more effectively. Hence, learning at one's own pace and during class time is one of the key features of the flipped classroom. The result is associated with a decreasing attention span and the use of technology in their studies or in their spare time. As students are given the flexibility to learn at their own pace and in their own time, there is a need to safeguard them if they have watched the assigned videos. With this, it is ensured that when students enter the classroom, they are already ready for the assignment and series of activities.

S-9: "*Ma'am [teacher-demonstrator] always reminded us to play or watch the videos in advance so we could gain ideas and information about the lesson." Then, if the videos are played during class, we already have an idea about the lesson and new information will be added during class hours.*

Based on the students' responses, it implied that students experienced flexibility in time and space, were able to overcome barriers that hindered their learning of the content, and that the teacher safeguarded them from watching the videos.

T-D: "*…in the absence of the teacher, with the presence of a video still, the class will proceed.*"
T-D: "*…every one of the students has a TV at home. Therefore, even if they are doing other things, such as working on their projects or cooking, they are still doing their homework. They can play the video and listen to what I am talking about. Therefore, this video can help them a lot, even if they are doing other things.*

This indicates that the teacher-demonstrator experienced the flexibility of time and space, allowing students to learn the content either at home, in the science laboratory, or outside the classroom. The teacher-demonstrator also noted that even when students are doing other tasks or the teacher is not present. The class is still going on.

According to the Center for Research on Learning and Teaching (2021), there are low-tech strategies to overcome challenges, such as partial flipping, where traditional lectures are supplemented with hands-on activities as the class gradually transitions to the flipped classroom model. Through this, the learning process continues.

Theme 2: Instructional Materials

In a flipped classroom approach, the use of various teaching materials that aid learning is essential. The teacher can either utilize the resources available in the school or on the internet, or create instructional videos using various applications, software, and programs. After implementing the flipped classroom approach, the students described and shared their experiences with the materials used.

> S-2: *"In the video, you can repeat it as many times as needed for us to understand."*
> S-7: *Specifically, to those subjects where students find it difficult and to those subject teachers who teach too quickly, causing students to fall behind and struggle to understand the lesson. I prefer to use videos so we can pause and take notes.*

Based on the students' responses, the students cited the advantages of the instructional materials, such as easy repetition of content and easier note-taking.

> T-D: *"…the teacher herself is the teacher demonstrator in the video, and the students can connect with the teacher because they have already established a rapport ahead of time."*
> T-D: *"It is well presented because, aside from the fact that the teacher is discussing the concepts, diagrams, and illustrations are also presented, making it easy for students to follow what the teacher is talking about."*
> T-D: *"I think that for me, listening to the video and what I've talked about so many times." I think the students can memorize and master the lesson I am teaching them.*

This indicates that video lectures are used as instructional materials in the implementation of the flipped classroom approach. It also revealed that the teacher-demonstrator in the video lectures is the one who teaches the subject. This is excellent because the teacher-demonstrator and the students already have an established relationship, making students motivated, responsible, and easily understand the content in video lectures. Additionally, the instructional materials can help students master the lessons through repetition, as outlined in Thorndike's Law of Exercise.

Theme 3: Differentiated Activities and Meaningful Learning

Learning culture is one of the pillars of flipped learning, describing the shift from a traditional teacher-centered model to a learner-centered approach. As a result, students are allowed to participate and evaluate their learning in a meaningful manner (Bok Center for Teaching and Learning, 2024). Hence, in the flipped classroom, the teacher should consider providing students with opportunities to engage in meaningful and varied activities that enhance the skills they have learned and develop those they have not yet mastered. In the flipped classroom, the teacher should consider providing students with opportunities to engage in meaningful and varied activities that enhance the skills they have learned and develop those they have not yet mastered. Students shared varied experiences about differentiated and meaningful activities.

> S-2: *"I experienced photosynthesis during our experiment with the beaker, where we counted the number of bubbles that rose every 3 minutes."*
> S-7: *"The class was interesting, especially when we experimented with the onion, cell, and saliva." I realize that there were many concepts that we did not know. I had a great time experimenting with the balloon. When I shook the balloon, it inflated. Afterward, we measured the size of the balloon. I enjoyed it much."*
> S-8: *"I discovered: "How and why certain things occur?", "Where do those things come from?" "If the cell did not exist, how would our body, plants, or animals respond?" and how did it all begin? In this case, this approach enables us to discover what made us feel amazed.*

Based on the students' responses, they experienced differentiated activities in which they performed various laboratory tasks and engaged in introspection afterward, promoting meaningful learning experiences. Hence, through the differentiated activities experienced by the students, they were able to grasp and understand the significant concept, making the learning experience more meaningful.

T-D: "*…there were different activities given to the students to help them understand what the video is about and, of course, to provide a clear idea or understanding of the topic.*"
T-D: "*…after the assignment is given, followed by a discussion, and then a series of activities.*"

Based on the teacher-demonstrator's experience, it was revealed that differentiated activities are considered in the implementation of the flipped classroom approach. It also revealed that using differentiated activities provides students with a clearer understanding of the lesson and enables them to arrive at correct answers to the questions. This makes learning more meaningful.

Theme 4: Maximizing Classroom Time
In the flipped classroom, the use of various instructional methods, such as active learning strategies, peer instruction, or problem-based learning, helps maximize classroom time.

S-3: "*She just gave us only a warm-up on our mind [brainstorming activities].*"
S-4: "*She always calls on a student to summarize the lessons and activities we have previously done." It was our daily routine to give a summary of the past lessons.*"
S-5: "*It makes us active.*"

Based on the shared experiences of the students, it was evident that the teacher maximized classroom time by incorporating brainstorming activities and recapitulating previous lessons or activating prior knowledge. With this, active learning strategies are emphasized in the flipped classroom.

T-D: "*…the activities given are not only knowledge-based but also require students to think beyond what is in the lesson.*"
T-D: "*It is not only a flipped classroom strategy, but also a question-answer relationship strategy that is being integrated into that approach, wherein students utilize higher-order thinking skills, as mentioned in Bloom's Taxonomy.*"

Based on the teacher's shared experience, it was revealed that the teacher maximized classroom time by using challenging activities, as described by the teacher-demonstrator as "not simply knowledge." This indicates that classroom time was effectively utilized in developing higher-order thinking skills (HOTS). According to Samadi et al. (2024), flipped classrooms have a significant influence on learners' development of higher-order thinking skills through engagement in evaluative, analytic, and synthesis processes. This enables the class to maximize time in a more meaningful and important way.

Theme 5: Students' Responsibility and Autonomy
Giving students responsibility and autonomy is a key feature of the flipped classroom. It is a setting where students are responsible for their own learning while teachers provide support and guidance.

S-8: "*She gave us the autonomy to learn on our own; either we would watch the video or we would discover and try to learn from it on our own.*"
S-5: "*…we have the autonomy to gather ideas using videos to answer questions.*"
S-6: "*The teacher-demonstrator allows or permits us to discover and learn new things on our own.*"

Based on the shared experiences of the students, it was revealed that they are given responsibility and autonomy in their learning, such as using instructional materials as a source of information, performing tasks independently, and allowing them to discover or explore new things. This concept is closely tied to the idea of independent learning. According to Susiani et al. (2022), independent learning fosters a supportive learning environment, enhancing student motivation, confidence, and inclusion. Hence, as students become responsible and independent, learning becomes more meaningful.

Theme 6: Scaffolding and Giving Feedback

Scaffolding and giving feedback are important aspects of the flipped classroom approach. In this aspect, teachers help learners maximize their learning, identify their strengths and areas for improvement or limitations, support students, seek solutions to improve and provide continuous guidance even outside the classroom.

S-4: *"She always asked for clarifications or additional questions to ensure that we got the ideas and information in the video that she wanted us to learn."*
S-5: *"She also asked if we understood the lessons or not and if my classmates said' No,' she explained it thoroughly again for us to understand the lesson."*
S-7: *"The misconceptions that we believed were being corrected."*

Based on the shared experiences of the students, it was revealed that the teacher scaffolds students, specifically those who did not grasp the main point and assists them. Scaffolding is practical and can benefit the students in building their' experiences and knowledge as they learn new skills. It showed that the teacher gives feedback to the students by correcting misconceptions, clarifying ideas, and allowing students to ask questions. According to Buhl-Wiggers et al. (2023), the success of implementing the flipped classroom approach varied depending on the teacher's approach, resulting in varying levels of student achievement.

T-D: *"I first presented the video to them, and then I gave the assignment. After giving the assignment, we had a discussion, followed by a series of activities."*
T-D: *"I can also connect to them because we have this so-called, "Messenger" or "Facebook" in which I could follow up with our students if they were able to watch the video and if they were able to answer the different activities given to them and be prepare themselves for the formative or even summative test that will be given…"*

Based on the teacher's shared experience, it was revealed that the teacher provides feedback to students by discussing the answers in their assignments. Additionally, the teacher-demonstrator revealed that the assignment was given during the first part of the lesson. Providing feedback on their assignments in the first part of the class helps students identify their strengths and areas for improvement. With this, the teacher determines which students require support and which students need to progress to more advanced material.

Theme 7: Collaboration with Other Educators

Collaboration with other educators is one of the important characteristics of becoming an effective teacher. Through collaboration, teachers are willing to share, support, participate in, and explore ideas that will reduce teacher attrition, improve student learning, and enhance professional aspects.

T-D: *"During our MPRE [Mid-Year Performance Review and Evaluation] in the making of instructional materials, I presented the flipped classroom to our fellow teachers in science, and we were delighted because they responded positively."*
T-D: *"I encourage my Grade 11 teachers to use this kind of strategy in remediating our students because we have problems with absenteeism. By giving videos and using the flipped classroom strategy, we can connect with and reach out to our students."*
T-D: *"It could also be applied to other subjects, such as mathematics." It could also be applied to English."*

Based on the teacher's shared experience, it revealed that the teacher preferred the use of the flipped classroom approach by other teachers and different subjects. The teacher also emphasized the importance of the flipped classroom approach in remediation, particularly for students with attendance issues and those with below-average or average performance. With this, the teacher not only taught the students but also provided them with continuous, real-time feedback. Hence, collaboration with other educators plays a crucial role in professional development, enabling teachers to identify their strengths and weaknesses.

4.0 Conclusion

Students who underwent the flipped classroom approach (FCA) showed significant improvement in their performance in Bioenergetics. Before the implementation, the student's performance level was between low and average mastery, but after the implementation, the results indicated a shift towards mastery. Using statistical

analysis, it is confirmed that there are improvements in students' performance levels, with t-test results showing a significant difference in students' performance before and after the use of FCA. In contrast, no significant difference was found in the use of the traditional approach. Analysis of Variance further supported the effectiveness of FCA, demonstrating a significant difference in students' post-test scores among groups. Scheffe's test revealed that the experimental groups outperformed the control group.

The FCA demonstrated flexibility in time and space, allowing students to engage in learning at their own pace by using the flipped classroom videos. Students found the materials engaging and comprehensive, which highlights the benefits such as repetition of the content, enhanced note-taking skills, and constructive scaffolding of teachers. The teacher emphasized that FCA aids in improving student understanding through continued monitoring of online platforms and an emphasis on higher-order thinking skills (HOTS). Even if the students have access to ICT devices despite financial constraints, further research may be conducted to explore how socioeconomic factors and digital access influence students' performance levels. Furthermore, additional studies may be conducted to examine the impact of FCA on different subject matters with varying demographics, facilitating efficient integration in diverse educational settings.

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