

TECHNOLOGY-AIDED FLIPPED CLASSROOM: AN INNOVATIVE APPROACH IN TEACHING SELECTED TOPICS IN SCIENTIFIC RESEARCH ON STE STUDENTS

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Abstract

In this research, a mixed-method approach was used to assess the effectiveness of technology-aided flipped classrooms as an innovative approach in teaching in scientific research on the Grade 9 students under the Science Technology and Engineering program of Marcelo H. Del Pilar National High School. The respondents were the 88 students from the said program, who were divided into two groups. Forty-four students utilized the technology-aided flipped classroom approach in an asynchronous setting, while the remaining half attended classes in scientific research using the traditional synchronous learning approach. The same sets of tests or quizzes were given to both groups along with the corresponding competencies as stipulated in the most essential learning competencies prescribed by the Department of Education. Furthermore, three students who are the class presidents of each section were subjected to the virtual interview. The participants gave insights on the advantages and disadvantages of the technology-aided flipped classroom approach. Likewise, suggestions to further improve the said teaching approach were also gathered from the participants. Answers were tallied and ranked according to frequency. When the data were treated and subjected to statistical analysis, results revealed that there is no significant difference on the quiz scores of the two groups of students. It is hereby recommended to utilize the same approach across the different academic programs, most especially for the students who do not have access to internet connectivity within Marcelo H. Del Pilar National High School. The sustainability of the materials being prepared for this research could still be utilized again by the learners. The video lectures can sustain for a long period of time. They can be enhanced or redefined to meet the needs of the learners. Flipped materials like these are very timely, especially since the educational system in today's world has faced a very challenging time.

Keywords: flipped classroom, mixed method, scientific research, special program, technology-aided flipped classroom

Introduction

When the COVID-19 pandemic hit the global scenario, its devastating effects on the lives of millions were observed. The foremost recent public health emergency of worldwide concern started in China and infected every country within the entire world. This terrible disease is caused by a totally unique coronavirus (SARS-CoV-2, previously mentioned as 2019-nCoV) and has received global attention from growing infections (Guo et al., 2020). The coronavirus pandemic is quickly spreading and affecting 213 territories and countries throughout the earth. The global number of new

cases reported was over 3.4 million, a 12% increase as compared last year. Globally, COVID-19 case weekly incidence increased with an average of around 490 000 cases reported each day. Following a steady decline for over two months, the number of weekly deaths reported was 57 000. The cumulative number of cases reported globally is now over 190 million and the number of deaths exceeds 4 million (World Health Organization, 2021).

Taking into consideration the very alarming rate of infected individuals across the globe, the United Nations International Children's Emergency Fund explained that more than 1 billion children are at risk of falling behind due to school closures aimed at containing the spread of COVID-19 (UNICEF, 2020). In the Philippines, the problem escalated since the pandemic began. It is confirmed that 21,724,454 learners have enrolled in public and private schools nationwide for the academic year 2020-2021 (Montemayor, 2020). The solution of how to address the problem at hand given the world-wide chaos became a challenge within the department of education.

Consultative meetings across the different agencies in the country have been done. Finally, the Department of Education introduced the different learning modalities to benefit the learners around the country. They launched the online synchronous and asynchronous modalities along with the printed modules comprising the most essential learning competencies. Most of the schools utilized the printed modular approach to deliver the lessons. However, there are other public schools which offer special programs such as the Special Program in Science, Technology and Engineering which is considered advanced in the field of science and mathematics.

Under the Special Curricular Program in Science, Technology and Engineering (formerly ESEP) it envisions highly responsible, morally upright, globally competitive, and work-ready learners from schools offering relevant and innovative special programs in Science, Technology and Engineering (STE) education. Committed to this vision, the STE high schools shall be the centers of excellence in Science, Technology and Engineering education in the schools' divisions that shall develop the full potential of students along these areas (Department of Education-Bataan, 2016). It is in this regard that these students need special attention when it comes to how they will be catered academically given the present situation. The concept of how the delivery of the lessons is introduced to these students is very challenging. Academically, the students are very advanced and inclined to science and engineering. Yet some of the students on the said program do not have internet access, personal computers, TVs or even radio at home, amplifying the effects of existing learning inequalities.

Thus, the researcher came up with an idea to utilize the technology-aided flipped classroom approach especially in teaching scientific research. In a flipped classroom setting, teachers make lessons available to students to be accessed. Teachers can deliver this instruction by recording and narrating screenshots of work they do on their computers, creating videos of themselves teaching, or curating video lessons from trusted internet sites (Hamdan, 2020). It is a pedagogical method in which direct instruction moves from a group to an individual learning environment, transforming the resulting group space into a dynamic, collaborative learning environment in which the instructor assists students in applying ideas and intervening creatively in the subject matter (Sams, 2014). The flipped classroom as a key

component of blended learning arouses great interest among researchers and educators nowadays. The technology of flipped classrooms implies such organization of the educational process in which classroom activities and homework assignments are reversed. The present paper gives an overview of the flipped classroom technology and explores its potential for both teachers and students (Evseeva, 2015).

The application of flipped classroom methods in K-12 education yielded a neutral or optimistic effect on student performance as opposed to traditional classrooms. Students' attitudes regarding the flipped classroom technique were found to be mixed. Challenges in integrating flipped classrooms have been defined and classified in terms of student issues, professional challenges, and organizational challenges (Lo, 2017). Numerous studies suggest that flipped classroom approaches have a significant preference over the traditional learning system. For instance, research conducted by McLaughlin (2014) analyzed the experiences of the technology-aided flipped classroom approach for pharmacy students, showing that students prefer studying the learning material before class and use the class time for applied learning and that the students see themselves as more committed than students taking conventional courses through a flipped-classroom approach.

On the other hand, a large majority of students had a positive attitude toward the flipped classroom, video, and Moodle, and a positive attitude toward the flipped classroom was strongly correlated with perceptions of increased motivation, engagement, increased learning, and effective learning (Nouri, 2016). The flipped classroom approach gained different standings as to the disadvantages and difficulties of implementing the flipped classroom approach. One of which is the potential workload of educators producing flipped educational materials and the students' disengagement in out-of-class education (Lo & Hew, 2017).

In a local setting, Marcelo H. Del Pilar National High School's most difficult elective subject for Science, Technology and Engineering students is scientific research. This subject requires a full scientific paper, which requires scientific experiments and mathematical calculation. To maintain the good standing of the students, they are likewise encouraged to finish the whole paper. However, the vagueness being brought by this pandemic is keeping the students from complying with their school requirements.

The main purpose of this research is to examine the effectiveness of the technology-aided flipped classroom approach and determine its effectiveness in teaching scientific research to the Grade 9 students under the special program in STE.

Research Questions

The main purpose of this study is to determine the effectiveness of the flipped classroom approach in teaching selected topics in scientific research among grade 9 STE students during the COVID-19 pandemic. Specifically, it sought to answer the following questions:

1. What are the advantages and disadvantages of flipped classroom approach in teaching selected topics in scientific research on the Grade 9 STE students during the COVID-19 pandemic?

2. Is there a significant difference between the means of the test results score of the students engaged in the flipped classroom and those with the traditional learning approach?
3. What suggestions can be made to further enhance the utilization of the flipped-classroom approach in teaching scientific research specially during this COVID-19 pandemic?

Hypothesis

The researcher hypothesized that:

Ho¹: There is no significant difference between the test score means of the students engaged in the flipped classroom approach and the traditional approach.

Scope and Limitations

This study is delimited only to the Grade 9 STE students currently enrolled in Marcelo H. Del Pilar National High School for the school year 2020-2021. The technology-aided flipped materials, as part of the flipped classroom approach included in this research, are in the form of video lectures prepared by the researcher herself. The topics are limited to basic statistics like the descriptive and inferential. Included topics in the descriptive statistics are the mean, median, mode, and standard deviation. The inferential statistics include the independent sample *t*-test, dependent *t*-test, and analysis of variance (ANOVA) with post-hoc analysis. The same set of quizzes are given to the two groups of students. Then the scores were tallied and tabulated using the Google Sheets. Lastly, the same competencies are highlighted during this study.

Methods

This section includes the type of research, a description of participants, the sampling procedure, a detailed description of the instrument used, steps undertaken during the data gathering process, and the statistical treatment presented in tabular forms utilized to address the problems reflected in this study.

Type of Research

This is action research that employed the mixed-method technique. Mixed methods research draws on potential strengths of both qualitative and quantitative methods, allowing researchers to explore diverse perspectives and uncover relationships that exist between the intricate layers of multifaceted research questions (Smith, 2017).

Respondents

A total of 88 students from the Grade 9 Special Program in Science, Technology, and Engineering served as respondents in this study. The students were chosen based on the same characteristics. Three students served as participants, and they answered the open-ended questions through virtual interviews.

Sampling Method

Students were randomly selected using the fishbowl technique. The basis of using such an approach in choosing the respondents was purely based on the same level of interests, categories, strengths, and sections. The respondents were assigned to their respective sections heterogeneously; thus, the level of analytical skills and intelligence established among them are equal.

Instruments

Self-made, technology-aided flipped materials in the form of video lectures prepared by the researcher were utilized in this study. Quizzes and a set of data for statistical treatment were presented using the Excel file. Moreover, the Statistical Packages for Social Sciences (SPSS) was also used to treat the data being collected. As for the participants who have undergone the virtual interview, open-ended questions were prepared by the researcher, which afterward underwent a transcription and were then arranged using thematic analysis.

Data Collection Procedure

The letter requesting approval to conduct action research was sent to the office of the OIC of Science and to the school principal. Alongside, the researcher also prepared a letter to the parents of students asking their consent that their children be the respondents and participants in the study. After the letter was secured, the instruments were immediately disseminated to the students since they were previously picked randomly.

Google Forms and Google Meet played a big part in the collection of data. The test scores of the respondents were processed directly by the Google Sheet and laid out perfectly. An independent sample *t*-test was used in the treatment of the test scores. This type of statistical analysis was used because the students belonged to two different groups.

Ethical Considerations

To ensure ethical considerations and privacy of the respondents and participants, the names of the students did not reflect on the Google Forms, but instead, they were given a random number. Moreover, during the virtual interview, the camera of the students was closed, and only the interviewer's camera was on. The consent form signed by the parents and the Data Privacy Act of 2012 were highly emphasized during this study.

Data Analysis

The numerical data collected by the researcher was subjected to statistical treatment using the Statistical Package for the Social Sciences (SPSS) software. An independent sample *t*-test was used to establish the significant difference between the test results of the two unrelated groups. However, the responses from the virtual interview were also presented and analyzed using the thematic analysis.

Results and Discussion

This section presents the data gathered, which was analyzed and interpreted with the use of appropriate statistical tools. Table 1 refers to the independent sample t -test of the quiz scores on the descriptive statistics topic of the two groups of students, one of which is under the flipped classroom approach and the other of which is under the traditional teaching approach. Statistical Packages for Social Sciences (SPSS) was used to treat the data, and the results are revealed below. Moreover, Table 2 refers to the results of the independent samples t -test on the quiz scores on the inferential statistics topic, specifically the paired sample t -test of the two groups of students under the flipped classroom and the traditional teaching approach. The same tool was used in the treatment of data. Results are also reflected below.

Table 3 reflects the calculated values on the test scores of the analysis of variance topic of the two groups. Presentations of scripts from the interview conducted are presented through a group of themes to the participants to answer the questions about the advantages and disadvantages of the flipped classroom approach in teaching selected topics in science research. They are presented using the thematic analysis. Lastly, Table 4 emphasizes the suggested ways made by the participants to further improve the flipped classroom approach in teaching selected topics in scientific research of Special Programs in Science Technology and Engineering students, most especially during this COVID-19 pandemic.

Table 1

Independent Sample t -Test Results of Quiz Scores on the Descriptive Statistics Topic Between the Technology-aided Flipped Classroom and Traditional Classroom Teaching Approach on the Grade 9 Special Programs in Science, Technology, and Engineering Students

	Group						<i>t</i>	df	<i>p</i>
	Traditional			Flipped					
	M	SD	n	M	SD	n			
Test Results	12.30	2.40	44	12.07	2.59	44	.43	86	.670

An independent sample t -test was conducted to compare the students' quiz scores in the frequency and percentage distribution lesson between the flipped classroom and the traditional teaching approach. The results revealed that there is no significant difference on the quiz scores of the students in the normal classroom approach ($M = 12.30$, $SD = 2.40$, $n = 44$) and those in the flipped teaching approach ($M = 12.07$, $SD = 2.59$, $n = 44$); $t(86) = .43$, $p = .670$. These results suggest that flipped classroom approach is an effective teaching strategy to be utilized in the teaching of selected topics in science research among the Grade 9 Special Programs in Science, Technology, and Engineering students.

Table 2

Independent Sample t-Test Results of Quiz Scores on Inferential Statistics (Paired Sample t-Test) Topics Between the Technology- aided Flipped Classroom and Traditional Classroom Teaching Approach on the Grade 9 Special Programs in Science, Technology, and Engineering Student

	Group						<i>t</i>	df	<i>p</i>
	Traditional			Flipped					
	M	SD	n	M	SD	n			
Test Results	15.59	3.43	44	15.39	3.16	44	.29	86	.772

Another independent sample *t*-test was conducted to compare the students' quiz scores in the inferential statistics topic, specifically the *t*-test distribution lesson, between the flipped classroom and the traditional teaching approach. The results revealed that there is no significant difference on the quiz scores of the students in the normal classroom approach ($M = 15.59$, $SD = 3.43$, $n = 44$) and those in the flipped teaching approach ($M = 15.39$, $SD = 3.16$, $n = 44$); $t(86) = .29$, $p = .772$. These results suggest that flipped classroom approach is an effective teaching strategy to be utilized in the teaching of selected topics in science research among the Grade 9 special programs in Science, Technology, and Engineering students.

Table 3

Independent Sample t-Test Results of Quiz Scores on Inferential Statistics Topics (ANOVA) Between the Flipped Classroom and Traditional Classroom Teaching Approach on the Grade 9 Special Programs in Science, Technology, and Engineering Students

	Group						t	df	p
	Traditional			Flipped					
	M	SD	n	M	SD	n			
Test Results	20.64	3.00	44	20.33	3.14	44	.63	86	.532

An independent sample *t*-test was conducted to compare the students' quiz scores in the inferential statistics, specifically the analysis of variance (ANOVA) lesson between the flipped classroom and the traditional teaching approach. The results revealed that there is no significant difference on the quiz scores of the students in the traditional classroom approach ($M = 20.64$, $SD = 3.00$, $n = 44$) and those in the flipped teaching approach ($M = 20.33$, $SD = 3.14$, $n = 44$); $t(86) = .63$, $p = .532$. These results suggest that flipped classroom approach is an effective teaching mechanism to be utilized in the teaching of selected topics in science research among the Grade 9 special programs in Science, Technology, and Engineering students.

Qualitative Results

Results from the qualitative phase of the study highlighted the answers of the participants to the interview questions. On the first question, which was about their insights on the advantages of the technology-aided flipped classroom approach in teaching selected topics of scientific research, participants answered:

“I would like to say that it is very helpful in so many ways. Like for example the sense of independence where we can do it on our own. The COVID-19 helps us to become independent”. -*Participant 1*

“The value of this approach is we are taught to be responsible with our time. The way we use it properly.” -*Participant 2*

“I affirm this approach is very helpful to students like me because I can simply bring the material wherever I go”. -*Participant 3*

The above table pointed out the advantages of the flipped classroom approach when it is used in the teaching of science research. The participants shared equally brilliant sides of the approach as very advantageous on the part of the students. As reflected in the script, students have independence and control over the lessons, could practice proper time management skills, and lastly, the students value the sense of accessibility in learning to think that the material is there, and they can bring it wherever they go. On the other hand, question number two points out the disadvantages of this technology-aided flipped classroom approach to the students. Below is a summary of answers:

“What if the environment is noisy? I believe it could be hard for them to focus”. -*Participant 1*

“Sometimes, working and studying in a place where it is not comfortable is difficult. No matter how good the material is, if the environment is not healthy, then it is useless”. -*Participant 2*

“Before I can fully understand it, I need to repeat it again, so it is time consuming.”. -*Participant 3*

The answers above highlighted the disadvantages of the flipped classroom approach when it is used in the teaching of science research. The participants shared their sentiments on the possible impact this approach might have on the students. Moreover, there is the fear that this approach might add an additional burden to the students in terms of the financial aspect since additional devices with high memory are required to download such videos for the lessons. Another concern being highlighted is that this might cause possible distractions to the students unlike with the teacher right in front of them. Lastly, the idea that students might have a hard time learning independently because of various reasons and instances wherein each one works in a diverse environment with individual differences to consider.

Table 4

Suggested Ways to Further Improve the Flipped Classroom Approach in Teaching Scientific Research During COVID-19 Pandemic

Suggestions	Frequency
1. Enough time should be given before the actual classes so that students can do proper scheduling.	2
2. Be specific and straight to the point when introducing a lesson to avoid confusion for every student.	1
3. Explore variety of teaching materials so that students will remain interested.	1
4. Make more entertaining and engaging videos to capture the students' interest.	2
5. Video editing must be done smoothly to avoid confusion and that video files must be organized for the students to easily download it.	3

Table 4 shows the suggested ways given by the participants to further improve the flipped classroom approach. As reflected above, the most common response and commonly suggested by the participants is that video editing must be done smoothly and make sure that the videos are well organized and readily available for downloading. Another suggestion from the participants is to make sure that the videos are entertaining and could capture the interest of the students. Likewise, the participants also suggested that the students be given enough time before the classes started so that they could prepare themselves for proper scheduling. Lastly, exploring a variety of materials to maintain the interest as well as be specific and direct to the point when discussing the lesson were also suggested by the participants.

Therefore, the hypothesis in this research has been answered, and it has been proven that there is no significant difference in the means of quiz scores of the two groups of students. The technology-aided flipped classroom approach is equally as effective as the traditional approach in teaching science research. Based on the results of this study, the researcher therefore recommended utilizing this approach not just in the Special Program in Science, Technology, and Engineering but also across the special programs within Marcelo H. Del Pilar National High School. Produce more flipped materials, such as self-made video lectures and activities, for those that do not have access to the internet. This research implies sustainability since the flipped materials can still be used in the future. Generations of learners can still utilize the materials not just during COVID-19 but when things are back to their normal state once again.

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