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FLIPPED LEARNING IN TEACHING SENIOR HIGH SCHOOL EARTH SCIENCE: COMPARATIVE ANALYSIS ON CONCEPT MASTERY AGAINST LECTURE METHOD

Christian M. Santiago, LPT, M.Sc.[*1]
Research Coordinator, Midway Colleges, Cabanatuan City, Philippines
cmsantiago@midwaycolleges.edu.ph
Allan Gregy V. Balic, LPT[*2]
Graduate Student, Central Luzon State University, Science City of Munoz, Philippines
allan@clsu2.edu.ph
Ira O. Santos, LPT[*2]
Graduate Student, Central Luzon State University, Science City of Munoz, Philippines
Santos.ira@clsu2.edu.ph
Jonelle B. Paragas[*2]
Graduate Student, Central Luzon State University, Science City of Munoz, Philippines
paragas.jonelle@clsu2.edu.ph
Lyra Anne P. Estrada[*2]
Graduate Student, Central Luzon State University, Science City of Munoz, Philippines
Estrada.lyra@clsu2.edu.ph

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Abstract:
The study generally tried to determine the difference in concept mastery level of grade 11 students when using video-based flipped learning (FL) compared to lecture when teaching earth science. Six section from a private school was tested using the slightly modified researcher-made test for group equivalence four sections were found statistically equal. The classes were then divided into two groups, one for each group, they were then pre-tested using the same test with more items and post-tested after applying the different methods. The study used frequency, mean, percentage and mean gain scores for description of the components and ANCOVA for the analysis of difference in concept mastery between groups.
Results showed that FL significantly increase student's concept mastery, $F(1,41)= 81.608$, $p<.05$, $\eta^2=.666$, more than the lecture-discussion method. Suggesting that in increasing concept mastery of student about earth science FL is a better strategy than the latter.

Keywords: Video-based learning, Flipped, Earth Science, Concept Mastery

1.INTRODUCTION

Progress of technology in the modern society has significantly affected education. The integration of technological devices and resources to enhance learning has been widely used across the educational systems. One of which that has been greatly enhanced is the teaching strategies augmented with technology, evidently affecting different learning areas and capacities of students [14]. Luckily, students nowadays from generation Z has the characteristics to use and integrate technology in their daily lives, in which the educational sector has invested with [22-33].

For this reason different technology-based teaching strategies has been invented and recently there has been a spate of interest in the teaching strategy called flipped learning, a strategy that heavily relies on technological tools such as interactive videos, interactive in-class activities, and video conference systems advancement [15]. It has been widely investigated across discipline such as various education degree and program in secondary up to tertiary education and hard sciences such as engineering, nursing, and many others [5-9-15-20-23-34]. It has been proven to significantly increase students' academic achievement in general science, biology, chemistry and physics [12-19-24-29-33]. However, little has been investigated on the effect of this technologically-based teaching strategy to earth science course.

The Geological Society of America (GSA) in their position statement posted last 2011 stated that the basic knowledge of Earth science is important meeting the challenges of environmental and resource of the twenty-first century, that is it essential that the education sector fortifies the foundation of earth science across K-12 levels [13].

This recommendation was followed by the current educational program of the K-12 of the Department of Education in the Philippines and integrated the course as a component of science education in public and private schools at all levels. Thus, investigating the effects of flipped learning in teaching earth science concepts.

Moreover, has been widely examined in comparison to lecture discussion in terms of teaching, social and cognitive aspect of both teacher and students. Kay et al (2019) claimed that flipped learning significantly increase these areas more than lecture-based teaching, in was also found to increase understanding of the course resources, and enhance their communication skill, active learning, creative, problem solving and team work on low-performing students [16], however he has also stipulated that students still preferred lecture-based due to the reason of increased burden and pressure upon the students [11-36]. Another limitation of known studies is that it has fully review on higher education [3,4-21-26-31], research on secondary level specifically senior high school program is still in its infancy [10-17], moreover, restrictions brought by limited and few numbers of experimental samples gives more room for investigation.

Thus, this paper described the effects of flipped learning strategy on concept mastery of senior high school grade 11 students on earth science subject compared to lecture method, using quasi experimental pre-test post-test equivalent control group design.

2. MATERIALS AND METHODS

2.1 Research Design

The study employed a quantitative, quasi-experimental, pre-test post-test control design. The treatment flipped classroom strategy, was given to the assigned experimental group while the control group will receive the usual lecture/discussion strategy.

2.2 Respondents of the Study

The sample was composed of Grade 11 students from Midway Colleges, each group has 40 students totaling to 80 students. Eight sections were first tested for group equivalence using their first semester grade point average (GPA), determining two sections of School Year 2020-2021 composed of 40 students, as groups with equal level of academic performance. As shown in Table 1, using Multiple Analysis of Variance (MANOVA).

Table 1. Multiple Comparison of Grade Point Average of Four Sections

SECTIONS			MEAN DIFFERENCE	Sig.	95% CONFIDENCE INTERVAL Lower Bound	Upper Bound
LSD	1	2	-.13255	.902	-2.2583	1.9932
		3	6.10597*	.000	4.0389	8.3731
		4	2.97837*	.008	.8113	5.1455
	2	1	.13256	.902	-1.9932	2.2583
		3	6.33853*	.000	4.1912	8.4859
		4	3.11093*	.005	.9636	5.2583
	3	1	-6.20597*	.000	-8.3731	-4.0389
		2	-6.33853*	.000	-8.4859	-4.1912
		4	-3.22760*	.004	-5.4158	-1.0394
	4	1	-2.97837*	.008	-5.1455	-.8113
		2	-3.11093*	.005	-5.2583	-.9636
		3	3.22760*	.004	1.0394	5.4158

*Significant at 0.05 level of significance

The determination of which group will be the experimental or control was done using a draw lots method. Hereafter, the two sections were pre-tested, to fully assess the equivalence on initial concept acquisition of the students. Their academic performance was also measured, using a fifty (50) – item test, before instructional strategies to compare their performances. Data suggest that the students of both groups gained low score in the 50-point tests, before the instruction, which is to be expected since the topic, was first introduced during the Grade 8 level. Result of independent sample t-test, suggests that the two groups are initially statistically the same before the implementation of the two teaching strategies, $F(1,46)= .510$, t-Value= -.771, $p>.05$ (Table 2), therefore can be used to compare the two teaching strategies with each other in terms of effect to academic performance.

Table 2. Independent t-Test of Pre-Test for Group Equivalence

VARIABLE	MEAN	SD	F	SIG	t-Value	p-Value
Experimental Group	12.083	2.8425	.510	0.477	-.771	0.419
Control Group	12.792	3.4133				

2.3 Instrumentation

The study employed a researcher-made test in both the flipped learning group and lecture discussion group in finding the significant impact of flipped learning strategy. It is researcher-made test composed of item test of multiple choice that was administered to the students one day after the accomplishment of the socio-demographic questionnaire and motivated strategies for learning questionnaire. The test is based upon a table of specification, with the pre-determine length of teaching that the instructor thought to be enough in teaching all the chosen topics. The questions were taken from several accredited and published books of the K-12 curriculum [2-18-27]. The scores of the students were classified using the perspective of Department of Education, NAT standard. Mastery classification bracket includes description as absolutely no mastery, very low, low, average, moving towards mastery, closely approximating mastery, mastered (Table 3). Mean percentage scores (MPS) were calculated using the actual scores of the students obtained from the fifty (50) item researcher-made test divided using the total score of the test multiplied by one hundred percent (100%) to get the MPS. This is then describe using the description of mastery.

Table 3. DepEd Perspective of Student mastery level using Mean Percentage Score (MPS).

Mean Percentage Score (MPS) Bracket	Description
96 % - 100 %	Mastered
86 % - 95 %	Closely Approximating Mastery
66 % - 85 %	Moving towards mastery
35 % - 65 %	Average
16 % - 34 %	Low
5 % - 15 %	Very Low
0 % - 4 %	No Mastery

2.4 Data Gathering Procedures

The preparation phase included the development of the instruments and the selection of samples used in the study. Online videos were adapted from different credited online personalities retrieved from online sources that are widely used in different countries and platforms, this were used by students offline through their cellphones or media devices to ensure that even without internet at home they have access to the video lectures. Videos are usually seven to fifteen minutes in length, enough to encompass all necessary contents and concepts of the chosen topics including examples and problems to be solved. Links of the online platforms was also given to students. All used videos, activities and materials used were validated by the experts of different fields. For the pedagogical & instructional elements and factors of the videos, educational experts from the University Science High School (USHS) - Central Luzon State University (CLSU), and Dean College of Education. For the content aspect of the videos, such as sufficiency and correctness of information and examples, professors of the Department of Environmental Sciences, were asked. Rubrics was given to each expert, one rubric per video. Scores of the videos were derived from the average of the scores of each five-scaled criteria of the rubrics, a total of twelve criteria were used in each aspect of the video.

2.5 Methods of Data Analysis

Descriptive statistics such as frequency counts, percentages and means in describing the concept mastery level of the students. In determining the difference between the concept mastery of the students before the instruction, independent sample t-test was used, and after the treatment, multiple analysis of co-variance (ANCOVA) was used to determine the difference between groups.

3.0 RESULTS AND DISCUSSION

Academic performance of the student after instruction of Flipped learning and Lecture.

After the implementation of the strategies, the researcher-made tests was re-administered. Results state a significant increase in the test score of both group from the average 12-point score, the post-test score increase for flipped learning group (Mean=46.13, SD=1.83, Mean gain= 46.13), having the lowest score value of 42 and highest value of 48, an almost perfect score for the test. On the other hand, the lecture/discussion group has also increased scored (Mean=39.83, SD=2.73, Mean Gain=39.83) with a lowest score of thirty-four (34) and highest value of forty-six (46) (Table 4). Data suggest that after the implementation of the strategy the student in the flipped learning has higher score compared to the students taught using lecture/discussion strategy. The difference in the mean and mean gain score are simple evidence of effects of the two strategies from each other.

Table 4. Mean and Standard Deviation of Post-Test of Students' Academic Performance

GROUP	HIGHEST SCORE	LOWEST SCORE	MEAN	SD
Flipped Learning Group	48.00	42.00	46.13	1.83
Lecture/Discussion Group	46.00	34.00	39.83	2.73
Total	94.00	76.00	85.95	4.55

To fully assess the difference in the strategies and whether this difference in increase in test scores of the groups is due to the difference in the instructional strategy, ANCOVA analysis was done. Results showed that Age [F(1,41)=.052, p>.05, η^2 =.001] has no significant effect on the post-test score of the subject, congruent with Sex [F(1,41)=.072, p>.05, η^2 =.002] which has also no significant effect on post-test score, furthermore, father educational attainment [F(1,41)=.276, p>.05, η^2 =.007] and mothers' educational attainment [F(1,41)= 1.316, p>.05, η^2 =.031] have no significant effect on the test result after the experimentation. Data revealed that only the difference in the instructional strategy [F(1,41)= 81.608, p<.05, η^2 =.666] has the only significant effect in the post-test score in favor of the flipped learning strategy (Table 5).Data revealed that the difference in the scores of the two groups is attributed to the difference in the implemented instructional strategy favoring the flipped learning strategy.

Table 5. ANCOVA of Post-test of Students' Academic Performance

VARIABLES	F-Value	*p*-Value	η^2
Age	.052	.820	.001
Sex	.072	.789	.002
Father's educational attainment	.276	.602	.007
Mother's educational attainment	1.316	.258	.031
Pre-test score	.388	.537	.009
Teaching Strategy	81.608	.000	.666

This data suggest that in increasing students' academic performance using flipped learning is better instructional strategy than the lecture/discussion. Mastery level of both groups is presented in Table 6. The frequency of scores obtained by both groups, the percentage and equivalence description of mastery based on the Fernandez (2013), a Perspective of lesson proficiency of the Department of Education-Philippines. NAT Standard percentages were obtained by dividing the actual score of the student by the total number of the test items (50-items) multiplied by one hundred percent (100%). As the table reveals, huge number of the lecture/discussion group, 79.17%, scored 66%-85% on the test, described as moving towards mastery, and the 20.83% achieved closely approximating mastery, score of 86%-95% in the test. However, it is also worth noting that none among the students from the lecture/discussion group has reached the complete mastery, score of 96%-100%, of the lessons. On the contrary, students from the flipped classroom are mostly described as closely approximating mastery, a score of 86%-95%, of the lesson, 70.83% of the total number of the participant are describe under this mastery level. And unlike the lecture/discussion group, 20.83% of the flipped learning group has achieved complete mastery of the lesson presented, score of 96%-100%, and small portion are only described as moving towards mastery, 8.33%. This supporting result suggests that flipped learning strategy is a better instructional strategy when teaching earth science as it enhances students' academic performance, and allows complete mastery of the lesson and/or close to complete mastery in comparison to the mastery level of the lecture/discussion group. This increased academic performance has been recorded on numerous researches conducted in every year, stating that flipped learning strategy is better than lecture/discussion strategy [14-38,39].

Furthermore, Tang *et al*. (2017) have shown that flipped classes can improve student performance, since students in these classes had higher exam scores compared with students who did not participate in flipped classes [36]. This can be attributed to the characteristic of flipped learning as an strategy that allows great control of the learner to their own learning [25], when students have the ability to control their learning pace, they can know how much information they can understand and therefore, store in a long term, increasing retention and depth of knowledge [1-32]. The increased in score and its significant difference in the test score over the lecture/discussion group, can be attributed to the fact that flipped learning as described allows long-term retention of knowledge since students are able to master concept through active-learning using activities given during the class time [8]. Furthermore, the removal of class lecture in a flipped learning allowed more time to practice problem solving activities such as monohybrid and dihybrid test crosses problem, allowing more time for the student to fully immerse themselves in process and skills of analyzing and solving problem, noted that as student watches videos before class and doing many activities in class recreates positive effect, not boring; interactive; on students' perception of a science class increasing their interest to learn the topic given. The ability to watch and re-watch class lessons has allowed students to overcome difficulties related with more complex concepts and therefore helped in increasing their test score and academic performance [28].

Table 2. Mastery Level of Flipped learning group and lecture/discussion group after instruction.

GROUP	SCORE	f	%	NAT STANDARD PERCENTAGE	MASTERY LEVEL
Control group	34.0	1	4.17	68	Moving towards mastery
	36.0	1	4.17	72	Moving towards mastery
	37.0	2	8.33	74	Moving towards mastery
	38.0	2	8.33	76	Moving towards mastery
	39.0	7	29.17	78	Moving towards mastery
	40.0	4	16.67	80	Moving towards mastery
	42.0	2	8.33	84	Moving towards mastery
	43.0	3	12.50	86	Closely approximating mastery
	44.0	1	4.17	88	Closely approximating mastery
	46.0	1	4.17	92	Closely approximating mastery
	Total: /50	24	100.0	100	
Experimental group	42.0	2	8.33	84	Moving towards mastery
	43.0	1	4.17	86	Closely approximating mastery
	44.0	1	4.17	88	Closely approximating mastery
	45.0	3	12.50	90	Closely approximating mastery
	46.0	3	12.50	92	Closely approximating mastery
	47.0	9	37.50	94	Closely approximating mastery
	48.0	5	20.83	96	Mastered
	Total: /50	24	100	100	

Descriptive Equivalent of NAT percentage:

96 - 100 - Mastered
86 - 95 - Closely Approximating Mastery
66 - 85 - Moving towards mastery
35 - 65 - Average
16 - 34 - Low
5 - 15 - Very Low
0 - 4 - Absolutely No Mastery

Majority of students stated that was taught strategy used in the flipped classroom setting were convenient and helped them learn more efficiently in learning the concept of Earth Science [6]. Moreover, students felt they had two opportunities to learn, once with videos (at home) and again in class, furthermore students are also allowed to re-watch their video lecture during activities that allows self-understanding of the activities employed [7]. Attribute of flipped learning that has been observed to affect academic performance in positive way is the concept of student sharing their ideas in their group, sharing knowledge, and experience with each other [30]. Further the extensive support of the teacher in flipped learning as the students do activities also affect academic performance positively [7]. Additionally, corrective teacher feedback in flipped classroom showed increased student performance compared to homework completed outside the classroom [34]. Flipped classroom model practices are very crucial in terms of including metacognitive activities that increase students' performance and academic achievement since students internalize concepts, gain critical thinking skills, and monitor their developments in terms of learning outcomes through flipped classroom model applications.

Student Interview after Flipped Learning Strategy Implementation

After the implementation and the observed significant increase in the students' academic performance, and better understanding of genetic concepts in favor of the flipped learning strategy, the researcher randomly selected 12 students to be interviewed in their experience in the flipped learning environment and how did the strategy helped them understand genetic concepts. The interview was transcribed and the following key points were extracted. Some statements were translated by the researcher. The most notable statement of the selected students were they have learned the topics given due to the fact that they can re-watch the videos given to them whenever they did not understand the explanation or the concept tackled by the video, increasing mastery resulting to better score on the test, all the interviewed students have mentioned this factor [28]. Furthermore, one hundred percent (100%) of the interviewed students also stated that the flipped learning strategy in teaching earth science is fun since they do not get bored on hearing lectures during class, since this is omitted in a flipped classroom and they only do activities that allows active learning making the proses fun and meaningful (Table 7). It is also notable that 91.67% of the interviewed students responded that, because of the structure of flipped learning environment having student only do

activities during class hours the teacher has more time to roam around the class to help students who struggle in learning and mastering the concept of the topics around, giving much more extended guidance on students who have unclear thoughts on the topic given while the students who already understood the lesson do activities (Table 30). Creating the feeling of concern and extended help among the students who are classified as slow-learners, making mini-lecture on groups who are difficulty, Sweet & Michaelsen (2012) highlighted that a key component to flipped classroom practice is the micro-lecture [35]. Additionally, 83.33% of the students interviewed stated that they have build-up confidence in coming to class and answer activities since that have pre-knowledge and overview of the topic at hand from the recorded videos [40]. Seventy-five percent (75%) said that they learned in a flipped learning environment because of the numerous amount of activities were they can practice their understanding before the actual evaluation such as quiz or test, since the materials or lectures are given beforehand the contact time with students' increases and this allows enhancement of students' learning process [34]. Lastly, 66.67% of the students responded that time before the new topic is introduced where the teacher clears concept asked by the student about the previous topic helps them better understand the concept.

Table 7. Transcribed Statements of Selected Interview Students.

TRANSCRIBED STUDENT RESPONSES	FREQUENCY	PERCENTAGE
1. I was able to understand key concept because I can rewind the video as much as I needed to.	12	100.00
2. I had increased confidence in coming to class because I can able to advance read by watching the video and master the concept.	10	83.33
3. I learn because of the many activities that allows me to master the concepts of the topics	9	75.00
4. My teacher can focus on my questions regarding unclear or difficult concept while my classmates who already understand the topic are doing their own activity.	11	91.67
5. It is fun learning science using videos and then only do activities in class.	12	100.00
6. Our teacher has enough time to clear misunderstood or unclear concept of the previous topic before going to new topic.	8	66.67

*Multiple Response Statistics

4.0 CONCLUSION

This study concluded that after the instruction, flipped learning strategy were found to increase concept mastery of the students in learning earth science concept, it is determined that flipped learning is a better way of teaching earth science better than lecture method that significantly increases student perception, understanding and mastery of the subject matter.

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