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STUDENTS' MATHEMATICS PERFORMANCE, ENGAGEMENT AND INFORMATION AND COMMUNICATION TECHNOLOGY COMPETENCIES IN A FLIPPED CLASSROOMENVIRONMENT

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Abstract

An investigation was conducted to ascertain the effectiveness of the Flipped Classroom in the mathematics performance, engagement, and ICT competencies of the Grade 9 students of Malinao High School Extension- Gastav Campus. Specifically, the study sought to: (1) identify the level of mathematics performance of the students when exposed to flipped classroom; (2) determine the level of students' engagement in Mathematics with the use of flipped classroom; (3) ascertain the level of students' ICT competencies with the use of flipped classroom; (4) differentiate the level of Mathematics performance of the students with the integration of flipped classroom; (5) find out if there is a significant difference in students' level of engagement in Mathematics with the integration of flipped classroom; (6) distinguish if there a significant difference in students' ICT Competencies with the integration of flipped classroom.

A one shot pretest-posttest was conducted to assess the effectiveness of the flipped Classroom. Results showed that students exposed to Flipped classroom have significantly higher performance in terms of posttest and retention test scores. Also, a significant difference in the students' mathematics engagement and ICT competencies before and after the intervention was found.

Key Words: Flipped classroom, pretest, posttest, retention test

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Introduction

The quality of Math education has been a great shot concern in the Philippines. One of the perceived problems happening in society is the difficulty in learning Mathematics. However, teachers today are trying to find any method other than the traditional teaching to engage and increase the performance of students. As educators consider the type of learners today as 21st-century learners, the teaching of Mathematics in a teacher-centered setting is challenging. It needs a whole lot of effort by the teachers because their students get easily distracted with their gadgets at school and home.

This scenario is also evident in Malinao High School Extension-Gastav Campus. Students are usually pre-occupied with their cell phones-scrolling social media sites during their free time instead of studying their lessons. Thus, with the use of instructional videos, students' interests are captured and at the same time learning is initiated.

Students' engagement towards math seems to be shaped by how they perceived and meaningfully understand the problem. If students do not consider mathematics is essential then they will not think that it is worthy enough to spend time on. The motivation of these students would be shallow. Thus, it will be challenging to have students learn mathematics meaningfully and gain enough understanding (Dunlap, 2002).

Based on the records, for the past two years, Malinao High School got a mean percentage score (MPS) of 49.58% in Mathematics which is below average. This MPS showed that the majority of students failed to reach the average 75% mean percentage score (MPS). It further means that mathematics teachers need to strategize 21st-century teaching methods. They also need to develop students' engagement to achieve better performance both in the teaching and learning process and at the same time identify how digitally literate the students are. The result of the study will be utilized in planning and strategizing teaching methods to meet the needs of the students and to improve performance in mathematics. In this connection, the researcher seeks to find out the teaching method to increase the performance of students in mathematics. This teaching method is called a flipped classroom.

A flipped classroom is a place where students use resources (videos of lectures, podcasts of material, content readings, documents) outside of the classroom, that allows an extended class time for more hands-on instructional activities (Enfield, 2013).

Research findings of Tang, Chen, Zhu, Zou, Zhong, Wang, Zhou, Zou, and Llang (2017) investigated that there is a better approach to teaching than using the traditional one, that is, flipped classroom. Flipped classroom stimulates students' learning motivation, improves their performance in the final exam, and may help to enhance clinical thinking and communication skills. Also, Segumpan and Tan (2018) recommended that future researchers may consider inclusion of the level of computer or technology-related literacy of the students. Thus, this investigation.

Based on the reasons above, this study came into reality. This study is concerned with the possibility of improving students' mathematics performance when the usual classroom scenario is flipped.

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Review of Literature

Students' Mathematics Academic Performance

In mathematics and other subject's reasoning skills are essential for success. Mathematics, mainly, is a base for all scientific and technological studies. Besides, mathematics has high relevance and practical applications to many real-life situations and problems. Vital as it may be, the study of mathematics has however unfortunately been not easy for many students. Mathematics is one of the subjects in school in which many students often perform poorly (Mundia, 2010).

Filipinos perceived learning mathematics to be complicated. Students' problems in mathematics are impossible to be prevented; an equally important goal seeks solutions to the identified problems. According to Nambatac, as cited by Guita and Tan (2018) stated that Filipinos performed poorly in Mathematics among the 41 participant countries. Moreover, they also added that in Science and Mathematics subjects it is reported that Filipino students have poor performance. The national mean percentage scores (MPS) in Mathematics on 2012 was only 48.90 which was below the national standard and was among the lowest in the five subjects in the National Achievement Test (NETRC, 2012).

Students' performance has always been the concern of teachers resulting from the amount of effect shown in the teaching and learning process. Teachers need to organize their instruction on essential concepts. Moreover, they should have the competence to make learning meaningful to diverse learners. Toprac, as cited by Bersano (2016), stated that teachers who use a range of instructional strategies in presenting materials and facilitating student interaction have major success in meeting the range of student needs.

Engagement towards Mathematics

Affective Engagement

The factors involved in student engagement and motivation can affect each other in a circular nature. Students who lack the competence to perform at a requisite level may end up having lower levels of affective engagement. The more disengaged students are, the less likely they are to learn and acquire the skills necessary to succeed (Pagan, 2018).

Wehlage et al., as cited by Pannozzo (2005), recommended that successful programs for at-risk students should focus on overcoming obstructions to educational engagement and school membership, and promoting a sense of commitment and attachment.

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In summary, research helps to clarify aspects of student engagement in blended learning, higher education classes. The excellent information is that the pedagogical decisions an instructor makes appear to have a stronger impact on student engagement than the location of the learning activity or the individual characteristics of the learner. Learning activities that provide learner choices and develop sociality are perceived as necessary to the student and are seen as relevant to existing student knowledge. These are all associated with higher levels of both cognitive and emotional engagement (Manwaring, 2017).

Cognitive Engagement

Students' engagement to a specific subject like mathematics has contributed to one's performance towards it. Student engagement (SE) is defined as student-led creation of knowledge and skills value the increase in overall benefits in the student's university education, specific to their profession. SE is seen as a function of student involvement (SI) and student participation (SP). Student motivation is a crucial element within the learning process (BRAVO, et al., 2011).

As found in the work of Hamdan et al., as cited by Sharpe (2016), a teacher's engagement increase, students also began exceeding expectations. More specifically, the findings were partially in line with the hypothesis that positive emotions and motivational thoughts intensify participation, and that positive feelings broaden cognitive capacity. For instance, the path from an emotional engagement at 9th grade to behavioral engagement at 10th grade was significant. Also, the path from Grade 10 emotional engagement to Grade 11 cognitive engagement was also significant (Li & Lerner, 2012).

The study of Burrows (2010) examined the hypothesis that cognitive and affective engagement has strong positive relations with academic engagement variables and significant negative association with behavioral engagement variables.

Achievement test scores, attendance records, and information about the number of credits accrued by students were obtained from the school district's database. Results indicated that cognitive engagement was a significant predictor of achievement test scores after controlling for other types of engagement (Spanjers, 2007).

ICT Competencies

In business, education, and society computers play a significant role. One must recognize that some aspects of computer knowledge are more relevant to a pursuit in higher education than others. The result of this study suggests that students' exposure to computers before college has resulted in a few mastering knowledge in computer technology (Robinson & Thomas, 2001).

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They also added, at present, information, media and ICT-related skills and competencies are recognized to be among the main competencies in order to become competent participants in education. These major competencies are often addressed together as the convergent concept of digital literacy. The transformation of children's informally acquired digital competencies into digital literacy cannot be left to the students alone.

If students can perform or use the mouse, choose commands from a menu, enter and save text, open files, etc. they will have the foundational skills necessary to use many other software programs as well. They will gain independence to develop their skills on their own when they will be able to follow instructions in order to learn to use new software programs. In the study of Meckelborg (2003), he found that different indirect measures of computer literacy were effective as predictors of performance.

Moreover, multimedia components like computerized homework, tutorials, and video lectures, when coupled with immediate feedback, have been shown to improve mathematics learning (Twigg, 2003).

Ukwoma&Iwundu (2016) concluded from their work that digital literacy is critical, its advantages include increased learner's effectiveness or performance gain, increased learner efficiency, greater learner engagement or satisfaction and more positive students' attitudes to learning.

Flipped Classroom: A blended learning method

The flipped classroom is an ingenious teaching methodology and an approach that is growing in popularity. Flipped formally introduced in 1998, it flips the lecture from occurring within the classroom to being delivered outside of class meetings. This method allows time for active learning and assignments to be completed during class meetings. The activities inside the classroom are meant to focus students on the content application to gain a better understanding of the material being studied. These activities could be individual or collaborative and move the instructor from being a knowledge source to a facilitator of students' learning (Gillette, 2018).

Hence, according to Parham (2018) as cited from the work of Brame, he stated flipped classroom is where the students have their first exposure to fresh material outside of class, mostly through reading or watching lecture videos, and then utilize instruction time to do the challening task of gaining that knowledge, probably through problem- solving, discussion, or debates. This method contrasts from the traditional model in which 'first exposure' occurs via lecture in class, with students assimilating knowledge through homework.

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Enfield (2013) used the flipped classroom model in order to address several challenges related to giving the same learning outcomes for the whole class whoever is their instructor, engaging students with diverse technical expertise during guided instruction, and providing time for students to apply what they learn to various situations. This one-semester study found that the majority of the students were engaged with the learning material and were successful in the course. In addition, the students reported that they had also learned to use various technologies and that their self-efficacy improved.

Gaughan (2014) reported that the flipped learning environment had a positive effect on students' social interaction, classroom participation, and positive attitudes towards course material, technical skills, and overall learning experience.

In addition, flipped classroom stimulates students' learning motivation, improves their performance in the final exam, and may help to enhance clinical thinking and communication skills. The flipped classroom approach needs to be further optimized in terms of specific subjects, students' workload, as well as the evaluation system of students' performance (Tang, et, al 2017).

Lastly, the results showed that for the learning achievement tests, the scores for the experimental group (the integration of OCW with the flipped classroom) were significantly higher than those of the control group (the integration of OCW with a conventional classroom) (Sun & Wu, 2016). It was also concluded from the study of Zhoggen and Guifang, 2015,that the flipped business English writing classroom brought about better academic achievements than the traditional one.

Methodology

Research Design

This study made use of one group pretest-post-test experimental design. This type of design used one class which were subjected to the pretest, posttest, retention test to determine the significant difference on the academic performance, engagement, and their ICT competencies towards Mathematics.

The group took the teacher made test with Cronbach alpha of 0.703 that served as a pretest of the study. The same test was used as the posttest at the end of the intervention. A retention test was administered two (2) weeks after the posttest. The pretest, posttest, and retention test served as the data in the evaluation of the study.

Research Locale

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This study was conducted at Malinao High School Extension- Gastav Campus. It is located at the municipality of Banisilan, Cotabato.

Respondents of the Study

The representative samples of the study were the Grade 9 Edison students of Malinao High School Extension- Gastav Campus, SY 2018-2019 who were taking Mathematics 9 subject, specifically, topics on Geometry.

This one section was selected, under the one-shot pretest-posttest experimental design.

Data Gathering Procedure

A designed lesson plan matrix for the Flipped classroom was followed to see the difference and significance of improvement on the mathematics performance, engagement, and ICT competencies.

The pre-test for the mathematics performance and questionnaire of the mathematics engagement and ICT competencies were given before the start of the experimental period. The posttest for the measurement of mathematics performance, level of engagement and ICT competencies were also given after the experimental period. Moreover, a retention test was given two (2) weeks after the administration of posttest.

Research Instrument

The researcher adopted a 58-item teacher made test which covered the topics in the fourth grading period stipulated in the K to 12 Mathematics 9 Curriculum. The content and reliability of the test were validated by the experts. It was analysed with reliability (KR21) equal to 0.703.

The researcher adapted Student Engagement Instrument (SEI) developed by Appleton, et al. (2006) with a cronbach alpha of 0.922 to determine the mathematics engagement of the students.

The researcher adapted and modified a questionnaire from Paglinawan (2015) with a Cronbach alpha of 0.971 to determine the level of ICT Competencies of students.

Statistical Techniques

Descriptive statistics like mean, standard deviation, frequency, and percentage were used to determine the levels of academic performance, engagement, and ICT competencies towards Mathematics.

The Paired sample T-test was used to compare the performance of students as well as the difference of students' engagement and ICT competencies towards Mathematics.

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Findings

To identify the level of mathematics performance of the students when exposed to the flipped classroom in the pretest, posttest and retention test, descriptive statistics such as mean, frequency, and percentage were used.

The pretest score performance of the students exposed to Flipped Classroom shows the recorded mean score of 15.78 or 66% which is interpreted as "very low performance". The result of the pretest implies that all of the students' do not have enough knowledge from the content of the test prior to the exposure of the Flipped classroom.

As to the posttest, they obtained a mean score of 37.68 or 78% indicating below average level with a "low performance" result. It can be observed that after the exposure to the Flipped classroom the mean performance of the students was still low.

Retention test results showed mean score of 38.25 or 78% which indicated a "low performance". It was observed that after the retention test, the mean performance of the students was still low. However, after two (2) weeks, students were able to retain important content and information based on the increase of the mean score. This means that with the use of the Flipped classroom, students' retention scores increased.

To determine the level of students' engagement in Mathematics with the use of flipped classroom descriptive statistics such as mean, frequency, and percentage were also used.

Before the experimentation, the affective and cognitive engagement of students towards Mathematics when exposed to Flipped classroom was 3.17 and 3.26 respectively. Results signify that prior to exposure; the students moderately have affective and cognitive engagement in Mathematics class.

After the experimentation, students have an over-all mean score of 3.80 and 3.87 in the affective and cognitive engagement. This shows that students both positively engaged in the math class.

To ascertain the level of students' ICT competencies with the use of flipped classroom descriptive statistics such as mean, frequency, and percentage were also used.

The overall mean score of the students is 1.42 indicating "no competency" prior to exposure and this changed to 2.23 described as "basic level" after the intervention. The result implies that the students have no competency in ICT at the beginning. However, students performed basic level in all ICT competencies after the intervention of the Flipped classroom.

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To differentiate the level of Mathematics performance of the students with the integration of flipped classroom in terms of posttest and retention test, the paired t-test was used.

As can be observes in table 1, there is a significant difference between students Mathematics performance before and after exposure to the Flipped Classroom (p = 0.00) with the mean score of 15.78 in the pre-test and 37.68 in the post test. Students' performance improved to "low performance" level; hence the change in performance is significant. This implies that the students' exposure to the Flipped Classroom had a positive impact to their Mathematics performance.

In line with the above findings, Casem (2016) found that the flipped instruction had a large effect on the improvement of mathematics performance of the participants. This is because within the flipped model students were better able to prepare for the class sessions and have more opportunities to interact with the instructor and peers than in the traditional lectures.

Baker, Kutz, Simmons, and Wilkinson (2013) also found that flipping the classroom in academic library instruction provided more time for active learning and classroom discussion. Also, in the same study, the flipped classroom generated student success.

Table 1. Comparison of students' Mathematics performance when exposed to Flipped Classroom

VARIABLES	MEAN	SD	T-VALUE	PROBABILITY(2-tailed)
PERFORMANCE				
Pre-test	15.78	3.880	-22.687	0.00**
Post-test	37.68	6.346		

**significant at 0.05 level

Table 2 shows the comparison of students' Mathematics performance when exposed to the flipped classroom. It reflects the mean score of 15.78 in the pre-test and 38.25 in the retention test. Thus, there is a significant difference in the students Mathematics performance. Students' performance improved to "low performance" level, thus the change in performance is significant. This implies that the students' exposure to the Flipped Classroom after two (2) weeks made a positive impact to their Mathematics performance.

It is parallel to the findings of Segumpan and Tan (2018) when he found that students exposed to Flipped Learning retained important information of Mathematics concept taught in the class in the retention test after 16 days.

Table 2. Comparison of students' Mathematics performance when exposed to the Flipped Classroom

VARIABLES	MEAN	SD	T-VALUE	PROBABILITY(2-tailed)
PERFORMANCE				
Pre-test	15.78	3.880	-18.406	0.00**
Retention test	38.25	8.233		

**significant at 0.05 level

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To find out if there is a significant difference in students' level of engagement in Mathematics with the integration of flipped classroom in terms of posttest, paired t-test was used.

Table 3 shows, there is a significant difference in the students' level of affective engagement towards Mathematics before and after exposure to the Flipped classroom (p = 0.00). This result shows that the difference in the students' engagement level from "moderately engaged" to "engaged" category indicates that after exposure to the Flipped classroom, students became more affectively engaged towards the subject.

This finding is supported by the study of Gaughan (2014) who reported that the flipped learning environment had a positive effect on students' social interaction, classroom participation, and positive attitudes towards course material, technical skills, and overall learning experience. Also, Parham (2018) confirmed the above results when he claimed that flipped classroom models a reverse traditional classroom paradigm from classroom content delivery and independent application and home practice to a model in which students learn their lessons outside of the four walls of the classroom and utilize their allotted instructional time for exploration, practice, application and increased interaction with teachers and classmates.

Table 3. Comparison of students' Mathematics affective engagement when exposed to Flipped Classroom

VARIABLES	MEAN	SD	T-VALUE	PROBABILITY(2-tailed)
AFFECTIVE ENGAGEMENT				
Pre-test	3.17	0.548	-5.989	0.00**
Post-test	3.80	0.290		

**significant at 0.05 level

Table 4 shows that there is a significant difference in the students' level of cognitive engagement towards Mathematics before and after exposure to the Flipped classroom (p= 0.00). This result shows that the difference in students' engagement level from "moderately engaged" to "engaged" category indicates that after exposure to the Flipped classroom students were more cognitively engaged towards the subject.

This result is parallel to the study of Enfield (2013) who found that the majority of students who were engaged with the learning material were successful in the course. Tang, et.al. (2017) further supports this as he found that Flipped classroom stimulates students' learning motivation, improves their performance in the final exam, and help enhance critical thinking and communication skills. The flipped classroom approach needs to be further optimized in terms of specific subjects, students' workload, as well as the evaluation system of students' performance. Moreover, the overall usage of the system is quite high and the learning performance of the student showed improvements after using the system (Ng, et.al, 2013).

Table 4. Comparison of students' Mathematics cognitive engagement when exposed to Flipped Classroom

VARIABLES	MEAN	SD	T-VALUE	PROBABILITY(2-tailed)
COGNITIVE				

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ENGAGEMENT				
Pre-test	3.26	0.533	-5.183	0.00**
Post-test	3.79	0.313		

**significant at 0.05 level

To distinguish if there a significant difference in students' ICT Competencies with the integration of flipped classroom in terms of posttest, paired t-test was used.

Table 5 presents that there is a significant difference in the students' level of ICT Competencies towards Mathematics before and after exposure to the Flipped classroom (p = 0.00). This result shows that the difference in students' ICT competencies level from "no competency" to "basic level" indicates that after exposure to the Flipped classroom, students acquired basic skills.

This result is in congruence with the study of Gaughan (2014) who reported that the flipped learning environment has a positive effect on students' social interaction, classroom participation, and positive attitudes towards course material, technical skills, and overall learning experience. Moreover, it is also parallel to the claim of Enfield (2013) who reported that the students also learn to use various technologies and that their self-efficacy improved in the flipped classroom model.

Table 5. Comparison of students' Mathematics ICT Competencies when exposed to Flipped Classroom

VARIABLES	MEAN	SD	T-VALUE	PROBABILITY(2-tailed)
ICT Competencies				
Pre-test	1.42	0.307	-11.038	0.00**
Post-test	2.23	0.300		

**significant at 0.05 level

Conclusion

Based on the findings, the following conclusions are drawn:

Mathematics performance of the students under the Flipped classroom environment during the pretest was very low and became low in the posttest and retention test. However, there was an improvement on their performances based on the increase of the mean scores in the post-test and retention test of the students.

Students' were affectively and cognitively engaged in a Flipped classroom environment based on the increased mean scores from their pre-test to post test.

Students gained basic knowledge of ICT competencies based on the increase in the over-all mean scores from the pre-test to post test. They acquired basic skills after exposure in a Flipped classroom.

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There was a significant difference in the students' Mathematics performance when exposed to the flipped classroom in terms of posttest and retention test. Students improve their Mathematics performance after their exposure to the Flipped Classroom. More so, they retained their knowledge significantly.

There was a significant difference in the affective and cognitive engagement of students in Mathematics when exposed to the flipped classroom. Students were significantly engaged in both cognitive and affective aspects while learning Mathematics.

There was a significant difference in the students' mathematics ICT competencies before and after exposure to the Flipped Classroom. Students significantly improve their ICT competencies.

Suggestions and Recommendations

Based on the summary, findings and conclusions of the study, the following recommendations are given:

Mathematics educators may consider the idea of having prepared instructional videos to be used as instructional tool. Teachers are encouraged to refrain from giving home-based assignments as a final summary of the lesson, instead, to use them as an introduction for the next lesson.

Mathematics educators may apply Flipped Classroom instruction method in class to maximize class time for a more meaningful interaction and doing of activities rather than purely lecture-discussion. For in a flipped classroom instruction, interaction is maximize that may improve their Mathematics performance. Flipping also brings changes for teachers, traditionally teachers engaged most with the advance confident students who ask questions. Flipping allows teachers to target who really need help instead with just those who are confident. Furthermore, instead of instructing in front teachers guide them on the side, this allows them to work closely within the individuals or small groups. Again teachers gain more time to focus on the needs of their class.

Mathematics educators may apply the Flipped classroom instruction method in class to improve the students' affective and cognitive engagement and create more interactive activities inside the class. Furthermore, teachers are encouraged to prepare meaningful activities that can promote interaction rather than pure lecture-discussion.

Students' exposure in a Flipped Classroom is a good way to increase their information and communication technology competency. Students' acquired basic skills as supported by the result of the level of their ICT competency the implementation of Flipped classroom.

Mathematics educators are encouraged to embed Flipped Classroom in the class to improve students' performance and retention of concepts. It may help students to appreciate the

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subject which are applicable in a real life situated scenario. In addition, this approach is helpful to increase students' active participation and outcome in class activities.

Mathematics educators are encouraged to expose students' to Flipped Classroom to improve students' affective and cognitive engagement. It may help students to appreciate and become actively involved in the subject. In addition, this approach is helpful to increase students' engagement in class activities.

Mathematics educators are encouraged to implement Flipped Classroom to improve ICT competencies of their students. It may help students to acquire basic knowledge and skills on information and communication technology.

For future researchers, a study of other type of blended learning, other than the activities and specific approach presented on this study, may be conducted. The longer period of implementation is highly suggested for efficacy and reliability of the methods used.

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