

EFFECTS OF FLIPPED CLASSROOM MODELS ON ACADEMIC PERFORMANCE AND MOTIVATION IN MATHEMATICS

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ABSTRACT

Mathematics education continues to face challenges in learners' performance and motivation, particularly in contexts where traditional instruction limits engagement and conceptual understanding. This study examined the effects of group-based and individual ICT-integrated flipped classroom models on Grade 11 ABM students' Mathematics performance and motivation at Bukidnon National High School. A quasi-experimental pretest-posttest design was employed involving two intact groups of 35 students each: one group was exposed to an individual-based flipped classroom model and the other to a group-based flipped classroom model. Academic performance was measured using a teacher-made test, while motivation was assessed using an adapted Mathematics Motivation Questionnaire. Data were analyzed using descriptive statistics and paired-sample t-test. Results showed that both groups had nearly identical pretest performance levels (Individual: $M = 14.80$, $SD = 3.11$; Group-based: $M = 14.83$, $SD = 4.04$), both interpreted as "Did Not Meet Expectations." After the intervention, both groups demonstrated significant improvement in academic performance, with the individual-based group obtaining a posttest mean of 24.00 ($SD = 5.00$), interpreted as "Fairly Satisfactory," and the group-based group obtaining a higher posttest mean of 26.50 ($SD = 4.18$), interpreted as "Satisfactory." In terms of motivation, the individual-based group increased from $M = 3.64$ ($SD = 0.40$) to $M = 4.38$ ($SD = 0.27$), while the group-based group improved from $M = 3.39$ ($SD = 0.26$) to $M = 4.43$ ($SD = 0.27$), both indicating improved motivation after the intervention. Paired-sample t-test results confirmed significant differences in academic performance (Individual: $t = -9.180$, $p = .000$; Group-based: $t = -10.901$, $p = .000$) and motivation (Individual: $t = -11.295$, $p = .000$; Group-based: $t = -94.243$, $p = .000$). Findings indicate that both ICT-integrated flipped classroom models significantly enhance Mathematics performance and motivation among learners. However, the group-based flipped classroom consistently produced higher gains than the individual-based approach, suggesting that collaborative learning combined with ICT integration is more effective in improving both cognitive and affective learning outcomes in Mathematics education.

Keyword: *ICT-integrated flipped classroom, group-based learning, individual learning, academic performance, mathematics motivation*

1. INTRODUCTION

After massive disruption caused by COVID-19 pandemic compelling schools and universities to close and swiftly transition to online learning or giving of modules, students are less motivated and engaged in the classroom, and school districts have to find a way to resolve this. Upon conducting some research, a study by Qiang Jian (2019) found that flipped classroom teaching methods integrated cooperative learning on the promotion of learning motivation and flipped classroom teaching methods integrated cooperative learning on the promotion of learning outcomes. For example, the group-based flipped classroom, allows students to team up to work together on that day's assignment.

This encourages students to learn from one another and helps them learn the correct answers and be able to explain to their peers why the answers are correct. The gap in practice that this project will explore, is the importance that flipped classrooms/teaching will have on student motivation as well as teacher satisfaction. There is a perceived lack of motivation and engagement among students in the K-12 classroom setting. Nevertheless, many students still have difficulty with mathematics despite these efforts. The subject's abstract concepts make it challenging for them. When analyzed from a global perspective, assessment reports become even more alarming. For instance, the Trends in International

Mathematics and Science Study (TIMSS, 2019) revealed that Philippine students' scores fell short of the world average. Accordingly, the Philippines was listed as one of the nations with the lowest math scores in the Programme for International Student Assessment (PISA, 2018). PISA and TIMSS are examples of international tests that not only gauge student performance but also emphasize how important it is for Filipino students to reach global standards.

In the context of Bukidnon National High School, mathematics teachers face significant challenges that impact both academic performance and student motivation. The continuously low Mean Percentage Scores (MPS) of learners on national (National Achievement Test, NAT) and local tests such as school-based assessment, Bukidnon National High School Grade 11 learners got 46.22% in the subject Statistics and Probability from the school year 2023-2024 are another prevalent problem in mathematics education.

One innovative approach that shows promise is the interactive flipped classroom model, particularly when combined with Information and Communication Technology (ICT). Unlike traditional methods, where teachers deliver lectures during class using PowerPoint presentation, the interactive flipped classroom allows students to learn at their own pace before coming to class. They can access video lessons, digital activities, and other resources at home (El Miedany, et.al, 2019). Class time is then used for interactive activities, discussions, and problem-solving, which encourage deeper understanding and active participation. This model not only makes learning more engaging but also gives students more control over their education.

Parallel to this, the flipped classroom model, a pedagogical approach that inverts traditional teaching methods, has gained significant attention in recent years. By shifting direct instruction outside the classroom and utilizing class time for collaborative activities and problem-solving, this model aims to enhance student learning and engagement (Awidi & Paynter, 2019). In a flipped classroom, students learn new material on their own time, often through interactive online videos or readings. This frees up class time for teachers to guide students through problem-solving, discussions, and hands-on activities.

Research supports the benefits of this approach. Studies, such as those by Zainuddin and Halili (2016), have found that students in flipped classrooms often perform better and are more motivated compared to those in traditional setups. Similarly, Bergmann and Sams (2012), who pioneered the flipped classroom model, emphasized its ability to maximize learning time, foster meaningful teacher-student interactions, and cater to diverse learning needs. These findings suggest that integrating ICT into the flipped classroom model can be a powerful way to address challenges in Mathematics education. Research findings consistently suggest that this approach can positively impact student achievement and motivation (Du, 2020; Ng et al., 2024).

Given the rapid digital transformation and the increasing need for 21st-century skills, Bukidnon National High School must explore innovative teaching methods that foster deeper learning and motivate students to excel in Mathematics. One promising approach is the flipped classroom model integrating ICT. However, its effectiveness in addressing the specific challenges faced by learners at Bukidnon National High School has not been thoroughly examined.

This study, therefore, seeks to investigate the effects of ICT-Integrated interactive flipped classroom models on the academic performance and motivation of Mathematics learners at Bukidnon National High School. By addressing this problem, the research aims to provide insights into whether this teaching strategy can help improve outcomes and inspire a more positive attitude toward Mathematics among students.

2. METHODS

2.1 Research Design

To examine the impact of the flipped classroom model on the academic performance and motivation of ABM students in mathematics, this study adopted a quasi-experimental design. This design involved the manipulation of the independent variable, the flipped classroom model, and the observation of its effects on the dependent variables, namely academic performance and motivation. A relevant example of the use of a quasi-experimental design to explore the effects of flipped classrooms on mathematics performance was the research conducted by Madamesila, N. M. (2021). In her

dissertation, “Flipped Classroom on Problem Solving, Critical Thinking Skills, and Students’ Mathematics Performance,” she employed a quasi-experimental approach to evaluate the influence of flipped classroom instruction on first-year college students enrolled in Mathematics in the Modern World. Her findings showed that students who experienced the flipped classroom model exhibited notable improvements in problem-solving skills, critical thinking, and mathematics performance compared to those in traditional classroom settings. This study highlighted the practicality and effectiveness of quasi-experimental designs in assessing educational interventions within authentic classroom environments.

For this study, two intact classes of ABM students were chosen to serve as the experimental and control groups. Both groups completed pre-tests to establish their baseline levels of academic performance and motivation. The experimental group received instruction through the flipped classroom model, which included group-based activities, while the control group was taught using individual-based activities. After the intervention, both groups took post-tests to measure changes in their academic performance and motivation. By comparing the pre-test and post-test results of both groups, the study assessed the effectiveness of the flipped classroom model in improving students’ academic performance and motivation.

2.2 Research Locale

A prominent educational institution in Malaybalay City, Bukidnon, served as the primary site for this study. The school had approximately 3,000 senior high school students and 121 senior high school faculty members. The Grade 11 senior high school consisted of 36 sections, with three sections allocated for the ABM strand. The school offered all senior high school strands and was classified as an urban, very large public secondary school recognized for its high academic and non-academic achievements. The faculty was composed of doctorate holders, master teachers, Teachers III, Teachers II, and Teachers I. Many teachers had already completed their doctoral and master’s degrees, while others were pursuing doctoral programs.

The teachers had undergone various trainings, seminars, and workshops aimed at enhancing their teaching approaches from traditional methods to more competitive and productive practices. Furthermore, teachers employed diverse instructional strategies such as reporting, peer tutoring, and focus group discussions. Some mathematics teachers served as winning coaches in the Metrobank–DepEd MTAP Math Challenge at the divisional level and advanced to the regional level. Every December, both the ABM and Mathematics departments conducted ABM and Mathematics Month celebrations, featuring various academic activities among Grade 11 students.

The school also received books and modules under the DepEd MATATAG Program from the national government. It was equipped with nearly complete educational facilities, including a school clinic, computer laboratory, library, mathematics laboratory, audio-visual room, technical laboratory, culinary laboratory, science laboratory, reading laboratory, discipline office, functional guidance office, and sports facilities. All academic and non-academic departments were fully functional, and mathematics laboratory tools, application software, and manipulative materials were readily available.

2.3 Participants of the Study

The participants of the study were Grade 11 ABM classes of Bukidnon National High School during the school year 2025-2026. Two intact sections were purposively selected and assigned as the experimental and control group both of which was handled by the researcher. These groups were chosen due to accessibility and feasibility, as well as ensuring that both groups were comparable in terms of academic ability and exposure to the same learning competencies in General Mathematics. From each intact class, all students in both sections were included as respondents consisting of 35 students each. Both male and female students were included in the sample. Nonetheless, to analyze the actual population of the participants in the study, table 1 shows the individual measurements in each section by frequency and percentage.

Table 1. Distribution of Research Participants in Each Section of Grade 11 Senior High School Students

| Sections | Male | % | Female | % | Overall | Percentage |
|----------|------|-------|--------|-------|---------|------------|
| A | 17 | 24.29 | 18 | 25.71 | 35 | 50% |
| B | 10 | 14.29 | 25 | 35.71 | 35 | 50% |
| Total | 27 | 38.57 | 43 | 61.42 | 70 | 100% |

The data show that a total of 70 students participated in the study, with an equal distribution of 35 students (50%) in Section A and 35 students (50%) in Section B. In terms of gender, there are more female students (43 or 61.42%) than male students (27 or 38.57%) overall.

In Section A, the distribution of male (17 or 24.29%) and female (18 or 25.71%) students is nearly equal, indicating a balanced gender composition. However, in Section B, there is a noticeable difference, with female students (25 or 35.71%) significantly outnumbering male students (10 or 14.29%). Overall, the sample is dominated by female respondents, and while one section shows gender balance, the other is female-heavy.

3. RESULTS AND DISCUSSION

3.1. Level of Academic Performance of Learners in Mathematics when taught with individual-based and group flipped classroom models.

Table 2.

| Test Variables | N | M | Std. Deviation | Descriptor | Remarks |
|---------------------------|----|-------|----------------|---------------------------|---------|
| Individual-Based-Pretest | 35 | 14.80 | 3.11 | Did Not Meet Expectations | Failed |
| Individual-Based-Posttest | 35 | 24.00 | 5.00 | Fairly Satisfactory | Passed |
| Group-Based-Pretest | 35 | 14.83 | 4.04 | Did Not Meet Expectations | Failed |
| Group-Based-Posttest | 35 | 26.50 | 4.18 | Satisfactory | Passed |

| | | | | |
|----------------------|----|-------|--------------|--------|
| Group-Based-Pretest | 26 | 4.18 | Satisfactory | Passed |
| Group-Based-Posttest | 26 | 26.50 | Satisfactory | Passed |

Legend:

| Score Range | Grading Scale | Descriptor | Remarks |
|--------------|---------------|---------------------------|---------|
| 36-40 | 90-100 | Outstanding | Passed |
| 34-35 | 85-89 | Very Satisfactory | Passed |
| 32-33 | 81-84 | Satisfactory | Passed |
| 30-31 | 75-79 | Fairly Satisfactory | Passed |
| 29 and below | 75 below | Did Not Meet Expectations | Failed |

Table 2 presents the level of academic performance of Grade 11 learners in Mathematics before and after exposure to ICT-integrated flipped classroom models, specifically comparing individual-based and group-based instruction. For the individual-based group, the pretest mean score was 14.80 (SD = 3.11), described as Did Not Meet Expectations with a remark of Failed. After the intervention, the posttest mean increased to 24.00 (SD = 5.00), interpreted as Fairly Satisfactory with a remark of Passed. Meanwhile, the group-based flipped classroom model obtained a similar pretest mean of 14.83 (SD = 4.04), also classified as Did Not Meet Expectations with a remark of Failed, but increased to a higher posttest mean of 26.50 (SD = 4.18), interpreted as Satisfactory with a remark of Passed. As seen, instructional models demonstrated improvement in students' Mathematics performance after exposure to the ICT-integrated flipped classroom approach.

The data reveal a clear enhancement in academic performance from pretest to posttest in both groups, indicating that the intervention had a positive result on learners' achievement. The individual-based model showed a gain of 9.20 points, while the group-based model showed a higher gain of 11.67 points. This suggests that although both strategies contributed to improved performance, the group-based flipped classroom model produced greater academic gains. The lower variability in posttest scores, particularly in the group-based model, further suggests more stable and consistent learning outcomes after the intervention.

3.2 Level of mathematics motivation of students when taught group-based and individual Flipped Classroom Model

Table 3.

| Test Variables | N | M | Std. Deviatio n | Descriptor | Remarks |
|---------------------------|----|------|--------------------|---------------------------|------------------------------|
| Individual-Based-Pretest | 35 | 3.64 | .40 | Agree | Moderate level of motivation |
| Individual-Based-Posttest | 38 | 4.38 | .27 | Agree | Moderate level of motivation |
| Group-Based-Pretest | 35 | 3.39 | .26 | Neither Agree or Disagree | Neutral |
| Group-Based-Posttest | 43 | 4.43 | .27 | Agree | Moderate level of motivation |

Table 3 describes the level of mathematics motivation of Grade 11 learners before and after exposure to ICT-integrated flipped classroom models using individual-based and group-based instruction. For the individual-based group, the pretest mean motivation score was 3.64 (SD = 0.40), interpreted as “Agree” and described as moderate level of motivation. After the intervention, the posttest mean increased to 4.38 (SD = 0.27), still interpreted as “Agree” and indicating sustained moderate level of motivation. In contrast, the group-based model obtained a lower pretest mean of 3.39 (SD = 0.26), interpreted as “Neither Agree nor Disagree,”

indicating a neutral level of motivation prior to the intervention. However, after exposure to the flipped classroom approach, the posttest mean increased to 4.43 (SD = 0.27), interpreted as “Agree,” reflecting moderately positive level of motivation among learners.

The data show a clear improvement in students’ motivation in both instructional models from pretest to posttest. The individual-based group demonstrated an increase of 0.74 in mean score, while the group-based group showed a larger gain of 1.04. This indicates that although both approaches enhanced learners’ motivation, the group-based flipped classroom model produced a greater improvement, particularly in moving learners from a neutral motivational level to a positive one. The relatively low standard deviations in the posttest results also suggest that learners’ motivation became more consistent after the intervention.

These findings imply that ICT-integrated flipped classroom models increased in enhancing students’ motivation in Mathematics. The increase in motivation supports the idea that active and technology-enhanced learning environments contribute to greater learner engagement and interest. This aligns with Güler, Özdemir, and Özkan (2023), who found that flipped classroom environments supported by ICT tools increase student motivation by making learning more interactive and accessible. The results also support Van Alten et al. (2019), who emphasized that ICT-based flipped learning promotes engagement through flexible learning materials such as videos, quizzes, and interactive platforms that allow students to learn at their own pace.

3.3 Significant difference on the Academic Performance and Motivation Level of learners in Mathematics before and after ICT-Integrated Interactive Flipped Classroom Models

Table 4.

| | | Paired Differences | | t | df | Sig. (2-tailed) | Decision |
|------|----------------|--------------------|---|-------|-------|-----------------|----------|
| Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | | | |
| | | | | Lower | Upper | | |
| | | | | | | | |

| | | | | | | | | | | |
|--------|--|-------------------|-------------|---------|-------------------|--------------|-----------------|----|------|------------------------|
| Pair 1 | Individual-Based Pretest and Post test score on Academic Performance | - 9.142 86 | 5.8918 8 | .99591 | - 11.1667 9 | - 7.11892 | - 9.18 0 | 34 | .000 | Reject Null Hypothesis |
| Pair 2 | Group-Based Pretest and Posttest Score on Academic Performance | - 11.68 571 | 6.3420 7 | 1.07201 | - 13.8642 9 | - 9.50714 | - 10.9 01 | 34 | .000 | Reject Null Hypothesis |
| Pair 1 | Individual-Based Pretest and Post test score on Academic Motivation | - .7457 1 | .39058 | .06602 | -.87988 | -.61154 | - 11.2 95 | 34 | .000 | Reject Null Hypothesis |
| Pair 2 | Group-Based Pretest and Posttest Score on Academic Motivation | - 1.042 86 | .06547 | .01107 | - 1.06535 | - 1.02037 | - 94.2 43 | 34 | .000 | Reject Null Hypothesis |

Table 4 talks on the results of the paired-sample t-test on the significant difference in the academic performance and motivation level of learners in Mathematics before and after exposure to ICT-integrated interactive flipped classroom models, specifically comparing individual-based and group-based instruction.

For academic performance, the individual-based model, the computed mean difference between pretest and posttest scores was -9.14286 (SD = 5.89188), with a t-value of -9.180 and a p-value of .000, which is less than the significance level of 0.005. Similarly, for the group-based model, the mean difference was -11.68571 (SD = 6.34207), with a t-value of -10.901 and a p-value of .000, also below the threshold. In both cases, the decision was to reject the null hypothesis, indicating a statistically significant difference between pretest and posttest academic performance.

The data reveal that there is a significant improvement in learners' Mathematics performance after exposure to both individual-based and group-based flipped classroom models. The negative mean differences indicate that posttest scores were higher than pretest scores in both groups, with the group-based model showing a larger improvement (mean difference = 11.69) compared to the individual-based model (mean

difference = 9.14). This suggests that while both instructional approaches were effective in improving academic performance, the group-based flipped classroom yielded a stronger effect on learners' achievement.

These findings imply that the ICT-integrated flipped classroom model has a statistically significant positive impact on students' Mathematics performance. This supports the view of Hiebert and Grouws (2007), who emphasized that student achievement in Mathematics improves when learners are actively engaged in meaningful problem-solving activities rather than passive instruction. The significant gains in both groups suggest that the flipped classroom structure, which allows students to access lessons before class and engage in interactive activities during class, promotes deeper conceptual understanding and retention of mathematical concepts.

4. CONCLUSIONS AND RECOMMENDATION

The study concludes that ICT-integrated flipped classroom models are effective in improving both the academic performance and motivation of Grade 11 ABM students in Mathematics. Both individual-based and group-based approaches led to significant increases in students' posttest scores

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and motivation levels, indicating that the intervention positively influenced learning outcomes. However, the group-based flipped classroom consistently showed higher gains in both academic performance and motivation compared to the individual-based model.

The study further implies and suggests that while both instructional strategies are beneficial, the group-based flipped classroom is more effective due to its collaborative nature, which enhances understanding, engagement, and motivation. This highlights the importance of integrating ICT tools with learner-centered and collaborative approaches in Mathematics instruction to improve students' achievement and learning experience.

Based on the conclusions and aligned with the specific objectives of the study, the following recommendations are proposed:

For Mathematics Teachers. Teachers are encouraged to adopt group-based ICT-integrated flipped classroom models, as results showed higher academic performance and motivation among students exposed to collaborative learning activities.

For School Administrators. School administrators should support flipped classroom implementation by providing access to ICT resources, stable internet connectivity, and professional development programs focused on innovative teaching strategies.

For Curriculum Planners. Curriculum developers may consider integrating flipped classroom strategies into Mathematics instruction, particularly in topics requiring higher-order thinking and problem-solving skills.

For Students. Students are encouraged to actively engage in pre-class learning activities and collaborative in-class tasks to maximize the benefits of the flipped classroom approach.

For Future Researchers. Future studies may explore the long-term effects of flipped classroom models, include other subject areas, larger samples, or compare flipped classrooms with traditional teaching methods to strengthen generalizability.

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