FLIPPED LEARNING AND MATHEMATICS ACHIEVEMENT AND ATTITUDE AMONG GRADE 9 STUDENTS

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ABSTRACT: *This study examined the effect of the flipped learning strategy on mathematics achievement and attitude toward mathematics among Grade 9 students. A quasi-experimental nonequivalent control-group pretest-posttest design was employed involving 82 Grade 9 students from two intact classes in a secondary school in Zamboanga City. Forty-two students comprised the experimental group, which was exposed to the flipped learning strategy, while 40 students comprised the control group, which received traditional instruction. The intervention was implemented for five weeks and focused on selected concepts on Similarity in Grade 9 mathematics. Mathematics achievement was measured using a 20-item achievement test, while attitude toward mathematics was assessed using the Attitude Toward Mathematics Inventory (ATMI). Appropriate parametric and nonparametric statistical procedures were employed based on the distribution of the data. Results showed that both the experimental and control groups significantly improved their mathematics achievement from pretest to posttest. The experimental group obtained a slightly higher mean gain score (3.19) than the control group (3.05); however, the difference between the two groups was not statistically significant (p = .84). The flipped-learning group also demonstrated a significant improvement in achievement from pretest to posttest (p < .001). In contrast, the overall change in students' attitude toward mathematics was not statistically significant (p = .421). Nevertheless, the self-confidence dimension of the ATMI significantly increased (p = .049). The findings suggest that flipped learning can support mathematics achievement and may enhance students' confidence in learning mathematics, although a short intervention may not be sufficient to produce significant changes in overall mathematical attitude.*

Keywords: flipped learning, mathematics achievement, attitude toward mathematics, Grade 9 students, secondary mathematics

1. INTRODUCTION

Mathematics is an essential component of secondary education, yet many students continue to experience difficulties in understanding mathematical concepts and developing positive attitudes toward mathematics. Traditional classroom instruction often places substantial responsibility on the teacher for presenting information during limited face-to-face class time. In this arrangement, students may have limited opportunities to engage in extended problem solving, collaborative learning, and teacher-guided practice. These concerns have encouraged mathematics educators to explore instructional approaches that make classroom time more interactive and learner-centered.

The increasing availability of educational technologies has provided teachers with additional opportunities to reconsider how mathematical content is presented and how classroom time is utilized. One instructional approach that responds to these developments is flipped learning. In a flipped classroom, direct instruction is moved partly outside the conventional classroom through instructional videos or other learning materials, while classroom time is used for active learning, problem solving, collaboration, and teacher-guided activities [1]. Rather than spending the majority of class time delivering information, the teacher can devote more time to assisting students as they apply concepts and address difficulties.

Flipped learning is particularly relevant to mathematics because mathematical understanding requires opportunities not only to receive explanations but also to apply concepts, solve problems, discuss mathematical ideas, ask questions, and receive immediate feedback. Instructional videos can allow students to review explanations at their own pace and revisit portions of a lesson when necessary. The classroom environment can then be used for activities that require students to apply and extend what they have learned. This arrangement can potentially provide greater opportunities for interaction between teachers and students and among students themselves [2].

An important feature of flipped learning is active learning. Instead of passively listening to an extended lecture, students are expected to participate in activities, discussions, problem solving, and collaborative tasks. Active learning places students in situations where they must process and apply information rather than simply receive it. The flipped model therefore creates an opportunity to use face-to-face classroom time for activities that promote deeper engagement with mathematical concepts [3].

The approach also gives students greater responsibility for preparing for classroom activities. By viewing instructional materials before class, students can encounter the basic content in advance and use classroom sessions to clarify misunderstandings and work through mathematical problems with teacher and peer support. The original research underlying this article incorporated instructional videos outside class and cooperative learning and problem-solving activities during class sessions.

The potential of flipped learning to improve academic achievement has been reported in several studies. Research involving flipped instruction has documented improved performance, engagement, and opportunities for collaboration [4–6]. However, findings are not consistently positive. Some investigations have found that students in flipped classrooms performed slightly better than those in traditional classrooms without a statistically significant difference between groups [7]. These mixed results indicate that flipped learning should not automatically be regarded as superior to conventional instruction. Rather, its effectiveness may depend on how the model is implemented, how well students prepare before class, and how effectively classroom time is used.

Students' attitudes toward mathematics are another important consideration. Achievement represents only one dimension of mathematics learning. Students' confidence, motivation, enjoyment, and perceptions of the value of mathematics can influence how they participate in learning activities and respond to mathematical challenges. An instructional approach that gives students opportunities to prepare in advance and receive immediate assistance during classroom activities may potentially influence these affective dimensions.

However, changes in attitude may take longer to develop than changes in academic performance. Students enter mathematics classrooms with attitudes shaped by previous learning experiences, beliefs about their own abilities, and accumulated successes and difficulties. Consequently, a relatively short instructional intervention may improve particular dimensions of students' mathematical attitudes without necessarily producing a significant change in their overall attitude.

Research on flipped learning and mathematics has provided encouraging evidence regarding confidence and engagement. Studies have reported that instructional videos combined with collaborative problem-solving can create opportunities for students to receive support and strengthen their confidence in mathematical learning [5]. Other research has likewise reported improvements in different dimensions of students' attitudes following flipped classroom implementation [6]. At the same time, evidence showing nonsignificant differences in achievement suggests that the effectiveness of flipped learning should be evaluated within the particular context in which it is implemented.

The Philippine educational context provides an additional reason for examining the approach. The flipped model can be implemented using readily available technologies such as mobile phones, tablets, and computers. The original study was conducted in a context where many students had limited internet access. Instead of requiring students to stream instructional videos online, the teacher downloaded the videos and transferred them to students' available devices. This provides an example of how flipped learning can be implemented even when continuous internet connectivity is not available.

The present study therefore examined the effect of flipped learning on mathematics achievement and attitude toward mathematics among Grade 9 students. Specifically, it compared students exposed to flipped learning with those taught through traditional instruction and examined changes in mathematics achievement and attitude before and after the intervention. The study focused on selected Grade 9 mathematics concepts concerning proportion, similarity of polygons, similarity of triangles, and similarity of right triangles.

The study is significant because it provides evidence concerning the use of flipped learning in secondary mathematics while recognizing that an instructional strategy may produce different effects on cognitive and affective outcomes. Its findings can inform mathematics teachers who are considering the use of technology-supported instruction and active classroom learning as alternatives to predominantly lecture-based approaches.

II. MATERIALS AND METHODS

Research Design

A quasi-experimental nonequivalent control-group pretest-posttest design was employed. The design was appropriate because the participants belonged to two intact classes rather than being individually randomly assigned to experimental conditions.

The study involved two heterogeneous Grade 9 classes with a total of **82 students**. The experimental group consisted of **42 students**, while the control group consisted of **40 students**. The experimental group received instruction using the flipped learning strategy, whereas the control group received traditional classroom instruction.

Instructional Intervention

The flipped learning intervention was implemented for **five weeks**. The experimental group received direct instructional content through videos that students were expected to view outside the classroom. Classroom time was subsequently devoted to active learning activities, particularly cooperative learning and problem solving.

The intervention covered selected Grade 9 mathematics concepts from the Similarity module, including proportion, similarity of polygons, similarity of triangles, and similarity of right triangles.

Because internet access was limited among many of the students, the instructional videos were downloaded by the teacher and transferred to students' mobile phones, tablets, or computers. Thus, students were not required to have continuous internet access to participate in the flipped-learning intervention.

Research Instruments

Two principal instruments were used to collect data. The first was a 20-item mathematics achievement test based on the Grade 9 mathematics learning materials covering the concepts included in the intervention.

The second instrument was the Attitude Toward Mathematics Inventory (ATMI), which was used to measure students' attitudes toward mathematics. The ATMI included dimensions relating to value, self-confidence, motivation, and enjoyment.

Data Analysis

The distribution of the data was examined using the Shapiro–Wilk test to determine the appropriate statistical procedures. Parametric and nonparametric tests were subsequently employed depending on the distribution of the variables.

The achievement and attitude scores of the experimental and control groups were compared before and after the intervention. Within-group changes were examined using paired statistical procedures, including the Wilcoxon signed-rank test where appropriate. Differences in gain scores between the two groups were examined using an independent t-test. The level of significance was set at **0.05**.

3. RESULTS AND DISCUSSION

Mathematics Achievement

The experimental and control groups were initially comparable in terms of mathematics achievement. The Mann–Whitney U test indicated no statistically significant difference between their pretest scores (p = .363). This suggests that the groups did not differ significantly in their entry-level content knowledge before the intervention.

After the instructional intervention, both groups demonstrated significant improvement in mathematics achievement. The original analysis reported that the pretest-to-posttest scores of both groups significantly increased ($p < .05$).

Although both groups improved, the experimental group obtained a slightly higher mean achievement gain score than the control group. The experimental group obtained a mean gain of **3.19**, compared with **3.05** for the control group. However, the difference was not statistically significant, with an independent *t*-test yielding a *p*-value of **.84**.

Table 1. Mathematics Achievement Gain Scores

Group	n	Mean Gain	p-value	Interpretation
Flipped Learning	42	3.19		
Traditional Teaching	40	3.05	.840	Not significant

The within-group analysis nevertheless demonstrated that students exposed to flipped learning significantly improved their achievement from pretest to posttest ($p < .001$). Thus, the findings demonstrate significant learning progress within the flipped-learning group but do not establish a statistically significant advantage over traditional teaching.

Attitude Toward Mathematics

The two groups were also comparable in their attitudes toward mathematics before the intervention. The experimental group had a pre-ATMI mean score of **3.47**, while the control group had a mean of **3.43**. The difference was not statistically significant ($p = .80$).

Following the intervention, the overall attitude toward mathematics of the flipped-learning group did not significantly change. The Wilcoxon signed-rank test yielded a *p*-value of **.421**, indicating that the difference between the pre- and post-ATMI scores was not statistically significant.

However, examination of the individual ATMI dimensions revealed a significant change in **self-confidence**. The mean self-confidence score increased from **3.07** before the intervention to **3.18** after the intervention, with a *p*-value of **.049**. The other dimensions did not demonstrate statistically significant changes.

Table 2. Changes in Attitude Toward Mathematics among the Flipped-Learning Group

ATMI Dimension	Pre-ATMI Mean	Post-ATMI Mean	p-value	Result
Value	4.16	4.04	.236	Not significant
Self-confidence	3.07	3.18	.049	Significant
Motivation	3.26	3.16	.282	Not significant
Enjoyment	3.46	3.39	.225	Not significant

The findings indicate that although the flipped-learning intervention did not significantly change students' overall attitude toward mathematics, it was associated with a significant improvement in the self-confidence dimension.

The findings provide a nuanced understanding of the potential contribution of flipped learning to mathematics instruction. Students who experienced the flipped approach significantly improved their mathematics achievement between the pretest and posttest. This result suggests that the instructional arrangement was capable of supporting learning during the intervention. The use of instructional videos before class provided students with an opportunity to encounter lesson content in advance, while classroom sessions provided opportunities to apply concepts, solve problems, collaborate with peers, and obtain teacher assistance.

The improvement in achievement can be considered in relation to one of the central purposes of flipped learning: the redistribution of instructional time. When direct instruction is moved partly outside the classroom, face-to-face time can be used for activities requiring students to apply information rather than simply receive it. In mathematics, this is particularly relevant because students often need immediate feedback when working through problems. The classroom component of the intervention provided opportunities for cooperative learning and problem solving, which were explicitly identified as the active-learning approaches used during the intervention.

At the same time, the comparison between the experimental and control groups requires careful interpretation. The flipped-learning group obtained a mean gain of 3.19, slightly higher than the 3.05 mean gain of the traditional group. However, the difference was not statistically significant ($p = .84$). Consequently, the results do not provide sufficient evidence to conclude that flipped learning was statistically superior to traditional instruction in terms of mathematics achievement under the conditions of this study.

This distinction is important. The significant pretest-to-posttest improvement among students exposed to flipped learning indicates that they learned during the intervention. However, because the traditional group also significantly improved and the difference between the two groups' gain scores was nonsignificant, the improvement cannot be attributed exclusively to the flipped strategy. The result instead suggests that flipped learning functioned as a viable alternative instructional arrangement whose achievement outcome was comparable to that of traditional instruction.

This finding is consistent with the observation that evidence on flipped learning is not uniformly conclusive. Some studies have reported significant achievement advantages associated with flipped classrooms, while other investigations have found no statistically significant differences between flipped and traditional groups [4–7]. The present findings add to the latter body of evidence by showing that students can improve substantially under a flipped approach without necessarily outperforming students who receive conventional instruction.

Several factors within the implementation may help explain the absence of a statistically significant difference. The flipped model requires students to assume greater responsibility for accessing and studying instructional materials before class. In the original study, although students generally considered the instructional videos informative, some did not consistently watch them before attending class. Others watched the videos but did not take notes for subsequent review. Consequently, some students arrived at class insufficiently prepared, and additional time had to be spent clarifying video content rather than engaging fully in active learning activities.

This finding highlights an important condition for successful flipped learning: providing instructional videos is not, by itself, sufficient to ensure that students are prepared for active classroom learning. Students need support in developing the habits required to participate effectively in a flipped environment. Teachers may need to provide structured viewing guides, short preparatory tasks, comprehension checks, or other mechanisms to encourage students to engage with the material before class.

Technology access also influenced the implementation. The original study was conducted in a context where many students did not have regular internet access, and instructional videos were therefore transferred to students' devices. This approach demonstrates that flipped learning does not necessarily require constant online connectivity. However, students still experienced difficulties related to their devices. Some students reported problems hearing the videos on their phones and relied on classmates' devices to view the material. Such conditions can affect consistency of exposure to the pre-class content and consequently influence the amount of time available for meaningful classroom interaction.

The results concerning students' attitude toward mathematics provide a different perspective. The overall ATMI score of the flipped-learning group did not significantly change following the intervention (p = .421). This finding suggests that an instructional strategy that can support academic achievement may not necessarily produce an immediate broad change in students' attitudes toward mathematics.

Attitudes toward mathematics are complex and develop through repeated experiences. Students enter the classroom with established beliefs about mathematics, their own mathematical competence, and the difficulty or usefulness of the subject. A five-week intervention may therefore be sufficient to influence learning performance but insufficient to substantially modify a broader attitude that has developed over a much longer period.

Nevertheless, the significant increase in **self-confidence** is an important finding. The self-confidence mean increased from 3.07 to 3.18, and the difference reached statistical significance (p = .049). This result may be associated with the opportunity to encounter lesson content before classroom discussions. Students who were able to watch and study the instructional materials beforehand could enter the classroom with greater familiarity with the topic. This preparation may have reduced uncertainty and made students more willing to participate in classroom activities.The finding is particularly meaningful because confidence can influence students' willingness to engage with mathematical tasks. A student who feels more prepared may be more willing to attempt a problem, participate in a discussion, or ask for clarification. Thus, even though the overall ATMI did not significantly improve, the increase in self-confidence may represent an early affective benefit of the flipped approach.

The absence of significant changes in motivation, enjoyment, and value also deserves consideration. Students' enjoyment and motivation toward mathematics may be influenced by factors extending beyond the instructional format itself, including the difficulty of mathematical concepts, previous experiences, peer interactions, and perceptions of personal competence. The original findings similarly reported that some students enjoyed the flipped process and appreciated being able to prepare before class, while others found mathematical concepts difficult and therefore continued to experience challenges in maintaining motivation and enjoyment.

The results therefore suggest that the effects of flipped learning should not be viewed as uniform across all educational outcomes. In this study, the strongest evidence was found in mathematics achievement within the experimental group and in the self-confidence dimension of attitude toward mathematics. The broader attitude measure did not show a statistically significant improvement, and the experimental group did not significantly outperform the control group in achievement gain.

These findings also demonstrate why the implementation of flipped learning should be accompanied by appropriate classroom support. The flipped model is not simply a process of replacing classroom lectures with videos. Its effectiveness depends on what students do before class and, perhaps more importantly, what they do during class. The classroom component needs to make productive use of the time freed from direct instruction through problem solving, collaborative activities, feedback, and teacher-student interaction.

In the context of secondary mathematics, flipped learning can therefore be considered a promising alternative to conventional instruction, but its implementation should be responsive to students' readiness, access to technology, and ability to prepare independently. Teachers should also recognize that achievement and attitude may respond differently to the same instructional intervention. Sustained exposure to the flipped approach, coupled with structured preparation and active classroom engagement, may be necessary to produce more substantial changes in students' mathematical attitudes.

4. CONCLUSION AND RECOMMENDATIONS

The findings indicate that flipped learning can support mathematics achievement among Grade 9 students. Students exposed to the strategy significantly improved their achievement from pretest to posttest. However, although the flipped-learning group obtained a slightly higher mean achievement gain than the traditional group, the difference between the two groups was not statistically significant. Thus, the results support flipped learning as a viable alternative instructional strategy but do not establish it as statistically superior to traditional instruction in terms of achievement gain.

The intervention also did not significantly improve students' overall attitude toward mathematics. However, the significant increase in self-confidence suggests that flipped learning may have a more immediate influence on particular affective dimensions than on students' overall mathematical attitude.

The findings further emphasize that successful flipped learning requires more than the provision of instructional videos.

Students need to engage with the materials before class, while teachers need to use classroom time effectively for problem solving, collaboration, feedback, and individualized support. Difficulties in preparing before class and limitations in access to devices may reduce the potential benefits of the approach.

Overall, flipped learning may be considered a useful alternative approach for secondary mathematics instruction, particularly when the goal is to provide students with more opportunities for active classroom engagement and preparation before face-to-face sessions. Future research may examine the strategy over a longer period and with larger groups to determine whether sustained implementation can produce stronger effects on students' mathematics achievement and broader attitudes toward mathematics.

4. REFERENCES

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