

A New Flipped Classroom Model: Deriving from the Experiences of Teachers and Students in Teaching/ Learning Patterns and Algebra

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ABSTRACT

This study aimed to examine the effect of the flipped classroom model on Grade 6 students' performance in mathematics in Patterns and Algebra. It also explored the experiences of teachers and students during its implementation as a basis for developing a flipped classroom instructional model.

Specifically, the study investigated the effects of the flipped classroom model on students' procedural fluency, problem-solving skills, and conceptual understanding. It also compared the mathematics performance of students taught using the flipped classroom approach with that of students taught using traditional instructional methods. In addition, it explored teachers' experiences in enhancing their Mathematical Content Knowledge (MCK) and analyzed students' learning experiences that contributed to improved mathematical performance.

A sequential mixed-methods design was employed, integrating quantitative and qualitative approaches. The quantitative phase involved 216 Grade 6 learners from intact classes. Their mathematics performance was assessed using a 60-item multiple-choice test administered as pre-test and post-test to measure procedural fluency, problem-solving skills, and conceptual understanding in Patterns and Algebra.

The qualitative phase employed a grounded theory approach to generate insights to inform the development of a flipped classroom model. Semi-structured interviews were conducted with twelve (12) students, purposively selected based on their performance levels (highest, middle, and lowest scorers) to represent varied learning experiences. Additionally, ten (10) mathematics teachers who implemented either the traditional or flipped classroom approach were interviewed to explore their instructional experiences and the influence of the strategy on their Mathematical Content Knowledge (MCK). Data were analyzed thematically to identify emerging patterns in instructional strategies, classroom engagement, reflective practices, and learning experiences.

Findings revealed that students exposed to the flipped classroom model demonstrated significant improvements in procedural fluency, problem-solving skills, and conceptual understanding compared to their pre-test results and to students taught through traditional instruction. Teachers reported enhanced confidence in lesson planning, deeper engagement with mathematical concepts, and improved facilitation of interactive learning activities. Students expressed increased motivation, engagement, and conceptual understanding due to pre-class preparation and collaborative in-class problem-solving. Despite challenges such as limited access to technology and time management issues, these were addressed through adaptive instructional strategies.

Keywords: Flipped classroom, procedural fluency, problem-solving skills, conceptual understanding, Grade 6 Mathematics, Patterns

INTRODUCTION

Mathematics instruction in elementary education continues to pose difficulties, particularly in topics such as Patterns and Algebra, which require learners to recognize relationships, generalize rules, and apply reasoning skills. In many classrooms, teaching remains predominantly teacher-centered and follows a traditional format characterized by lectures, procedural demonstrations, and repetitive drills.

While this approach may develop computational accuracy, it often leads to surface learning because learners focus on following steps rather than understanding mathematical relationships. Recent classroom-based investigations report that students primarily exposed to procedural instruction demonstrate limited reasoning and difficulty in transferring knowledge to unfamiliar problems (Karjanto & Acelajado, 2022; Llego, 2021). When learners are not given opportunities to explore patterns and explain solutions, mathematical ideas remain fragmented and disconnected.

The limitations of traditional instruction become more evident in the development of algebraic thinking. Learners may successfully perform calculations but often struggle to predict patterns, justify rules, or generalize mathematical relationships. Research in mathematics pedagogy emphasizes that meaningful understanding develops when learners actively construct knowledge through discussion, exploration, and guided inquiry rather than passive listening (Omoniyi et al., 2025). Studies comparing traditional lecture-based instruction and flipped classroom approaches indicate that while traditional methods may support procedural fluency, they frequently fall short in promoting conceptual understanding and problem-solving skills. In contrast, flipped classroom environments provide opportunities for students to review foundational concepts before class and engage in collaborative problem-solving during class, thereby enhancing both conceptual and procedural knowledge (Eriyagama & Mohammed, 2024; Influence of Flipped Learning Approach in Mathematics Learning Outcomes, 2025).

An important factor influencing mathematics learning is the teacher's Mathematical Content Knowledge (MCK), which refers to the depth of understanding of mathematical concepts, structures, and relationships. Teachers with strong MCK can explain concepts flexibly, identify misconceptions, and connect ideas across lessons. Conversely, limited content knowledge often results in rigid procedural teaching that emphasizes memorization rather than understanding. Empirical findings indicate that students taught by teachers with stronger mathematical content knowledge demonstrate higher conceptual comprehension and improved problem-solving performance (Hill et al., 2020; Fitriani & Novita, 2023). Thus, improving student achievement in mathematics requires instructional practices that not only enhance student engagement but also strengthen teachers' understanding of mathematical concepts.

One instructional approach that addresses these concerns is the flipped classroom model. In flipped learning, students access direct instruction before class through videos, reading materials, or guided modules, while classroom time is devoted to interactive learning activities such as collaborative problem-solving, discussion, and clarification of misconceptions. This reorganization allows learners to actively apply concepts and enables teachers to monitor students' thinking processes more closely. Studies on flipped mathematics instruction have reported increased engagement, improved participation, and higher achievement compared with lecture-based teaching. Furthermore, increased interaction between teachers and students during class discussions enables teachers to deepen their understanding of mathematical concepts and facilitate learning (Eriyagama & Mohammed, 2024).

Despite these advantages, implementing flipped learning in the Philippine context presents practical challenges. Many teachers have limited training in technology integration and rely primarily on basic digital tools (Moreno et al., 2021). Infrastructure limitations such as unstable internet connectivity, insufficient devices, and limited access to digital platforms affect the feasibility of technology-dependent instruction (Department of Education, 2022). These constraints are more evident in rural areas where schools often depend on printed modules and offline learning materials. Consequently, instructional innovations must be designed to remain effective even in low-technology environments.

In rural districts such as Tinambac South District, many learners have limited access to reliable internet connections and digital devices outside the classroom. Therefore, implementing a fully online flipped classroom model may not be feasible. However, researchers emphasize that flipped learning does not necessarily require sophisticated technology; it can also be implemented through low-tech strategies such as printed instructional materials, offline videos stored on flash drives, teacher-recorded lessons played during scheduled viewing sessions, and structured pre-class reading activities. Such adaptations allow the core principles of flipped learning, pre-class exposure to content, and in-class active learning to be applied even in resource-constrained

settings. This low-tech implementation ensures that rural schools can still benefit from innovative instructional strategies without depending heavily on advanced technology.

Another concern is that instructional innovations are often evaluated solely by student achievement scores, without examining their influence on teachers' knowledge. Improvement in learning outcomes may not be sustained if teaching practices remain procedural and teachers do not deepen their own understanding of mathematical concepts. Therefore, it is important to determine whether flipped instruction not only improves student learning but also enhances teachers' Mathematical Content Knowledge. Measuring both teacher and student performance before and after implementation provides clearer evidence of instructional effectiveness and sustainability.

The central problem, therefore, involves the interaction of three conditions: continued reliance on procedural traditional instruction, limited teacher Mathematical Content Knowledge, and contextual constraints of rural low-technology classrooms. While flipped learning presents a promising alternative, its effectiveness in rural elementary mathematics classrooms and its relationship to teacher knowledge and student learning remain insufficiently examined.

Thus, this study investigates a contextualized low-tech flipped classroom model in teaching Patterns and Algebra among Grade 6 learners in Tinambac South District. Specifically, it examines changes in teachers' Mathematical Content Knowledge and student learning outcomes before and after implementation in a rural setting with limited ICT resources. By aligning instructional strategies with teachers' capacity and local realities, the study aims to develop a sustainable and adaptable flipped classroom model to enhance mathematics teaching and learning in rural elementary schools.

MATERIALS AND METHODS

Research Design

This study employed a sequential explanatory mixed-methods research design, wherein quantitative data were collected and analyzed first, followed by qualitative data to explain and deepen the initial results. This design was appropriate as the study aimed not only to determine the effect of the flipped classroom model on students' mathematics performance in Patterns and Algebra but also to understand the underlying teaching and learning experiences associated with its implementation. The quantitative phase focused on measuring performance outcomes, while the qualitative phase provided contextual explanations of how and why these outcomes occurred.

The quantitative phase utilized a pre-experimental one-group pretest–posttest design to examine changes in students' mathematics performance before and after the implementation of the flipped classroom model. Grade 6 learners were assessed using pretest and posttest measures in terms of procedural fluency, problem-solving skills, and conceptual understanding. Due to the nature of the data, non-parametric statistical tests were employed. The Wilcoxon Signed-Rank Test was used to determine significant differences between pretest and posttest scores within the same group, while the Mann-Whitney U Test was used to compare the posttest performance of students exposed to the flipped classroom model and those taught using traditional instruction.

The qualitative phase followed the quantitative phase and adopted a grounded theory approach with ethnographic elements to generate a model based on the lived experiences of teachers implementing the flipped classroom. Grounded theory was used to systematically develop a theoretical model grounded in actual data, while ethnographic elements provided contextual insights into classroom practices, interactions, and instructional behaviors. Data were collected through semi-structured interviews and focus group discussions, allowing participants to share their experiences, challenges, and reflections.

The analysis of qualitative data followed grounded theory procedures. Initially, open coding was conducted to identify significant statements and generate initial codes from the data. These codes were then grouped into broader categories through axial coding, establishing relationships among concepts such as teaching adaptation, student engagement, and instructional challenges. Finally, selective coding was employed to integrate and refine

these categories into core themes, thereby developing a proposed flipped classroom model. To enhance the clarity of the presentation, the findings were organized through thematic mapping or diagrammatic representation, illustrating the relationships among themes and their contributions to teaching and learning outcomes.

The integration of quantitative and qualitative findings occurred during the interpretation stage. The quantitative results demonstrated the effectiveness of the flipped classroom model, while the qualitative findings explained the processes and experiences that shaped these outcomes, particularly regarding teaching practices, student engagement, and Mathematical Content Knowledge (MCK). This integration ensured methodological triangulation, thereby strengthening the validity, depth, and overall credibility of the study.

Sampling Design

This study employed a structured sampling design to ensure that both teachers and students were appropriately represented in the implementation and evaluation of the flipped classroom model in teaching Grade 6 Patterns and Algebra. The sampling process involved 10 Grade 6 mathematics teachers and their respective intact classes, resulting in a total of 216 student respondents from selected schools in the Tinambac South District. The teachers and students were divided into two instructional groups: the conventional instructional approach and the flipped classroom model, with each group comprising five teachers and their respective classes.

As shown in Table 1, the participating teachers were assigned specific instructional roles depending on the teaching approach implemented in their classes. Five teachers implemented a traditional teacher-centered instructional approach, in which lessons were delivered primarily through lectures and guided demonstrations.

Table 1. Role of Teachers

Group	Role	Number of Teachers	Responsibilities
Traditional	Implement standard teacher-centered lessons	5	Deliver 7 lessons in Patterns and Algebra using lecture-based methods; assign exercises; observe student participation.
Flipped Classroom	Implement flipped classroom lessons	5	Facilitate pre-class instruction using digital materials, guide in-class discussions and collaborative problem-solving; monitor student engagement.

These teachers were responsible for teaching seven lessons in Patterns and Algebra, assigning exercises to students, and observing their participation during classroom activities. In contrast, the other five teachers implemented the flipped classroom model, where instructional delivery was reorganized to promote student-centered learning. In this approach, teachers facilitated pre-class learning using prepared digital and printed materials and focused classroom time on interactive discussions, collaborative problem-solving activities, and monitoring student engagement. This division of roles allowed the study to examine differences in instructional processes and student outcomes between the two teaching approaches.

The distribution of student respondents is presented in Table 2. The study involved a total of 216 Grade 6 students from 10 intact class sections, which were maintained to preserve the natural classroom structure and learning environment.

Table 2 Distribution of Student Participants by Instructional Approach and Section

Instructional Approach	Section	Number of Students
Traditional Approach	A	29
	B	27
	C	25
	D	8
	E	7
Subtotal		96

Flipped Classroom Model	A	29
	B	25
	C	22
	D	24
	E	20
Subtotal		120
Total Respondents		216

The traditional instructional group consisted of 96 students across five sections, with section sizes ranging from 7 to 29. Meanwhile, the flipped classroom group consisted of 120 students across five sections, with class sizes ranging from 20 to 29 students. Although class sizes varied slightly, the intact class grouping ensured that the study reflected authentic classroom conditions and avoided disrupting the existing school organization.

The use of intact classes also supports the ecological validity of the study, as it allowed the instructional strategies to be implemented within real classroom contexts. Maintaining intact classes is common in educational research because it preserves established teacher-student relationships, classroom dynamics, and existing learning routines. This approach ensured that the comparison between the traditional approach and the flipped classroom model reflected actual teaching practices rather than artificially constructed learning groups.

Furthermore, the inclusion of multiple teachers and class sections strengthened the reliability and representativeness of the sample. By involving teachers from different schools and varying class sizes, the study captured diverse instructional contexts and student learning conditions within the district. This diversity allowed the research to examine how the flipped classroom model functions across different classroom environments while maintaining consistent lesson content, which focused on seven lessons in Patterns and Algebra during the third grading period.

Overall, the sampling design ensured that both instructional approaches were implemented systematically across multiple classrooms, enabling meaningful comparisons of student learning outcomes in procedural fluency, problem-solving skills, and conceptual understanding. At the same time, the participation of multiple teachers provided valuable insights into how instructional strategies influence student learning in authentic classroom settings. The combination of teacher roles, intact class sampling, and a substantial number of student respondents provided a solid methodological foundation for evaluating the effectiveness of the flipped classroom model in elementary mathematics instruction.

Subjects of the Study

The participants in this study comprised 10 Grade 6 mathematics teachers and 216 Grade 6 students from selected elementary schools in the Tinambac South District. These participants were chosen to examine the implementation and effectiveness of the flipped classroom model in teaching Patterns and Algebra during the third grading period. Including both teachers and students enabled the study to capture not only students' measurable learning outcomes but also the instructional practices of teachers who implemented the two teaching approaches.

The teacher participants were 10 Grade 6 mathematics teachers who participated in the study and facilitated the implementation of the instructional strategies. Before the implementation phase, all teachers attended training and orientation on the flipped classroom model, ensuring they shared a common understanding of the teaching procedures, lesson structures, and learning materials to be used in the study. The teachers were then divided into two groups based on the instructional approach used in their classes. Five teachers facilitated lessons using the traditional teacher-centered approach, while the other five teachers implemented the flipped classroom model. Each teacher was responsible for delivering seven lessons in Patterns and Algebra and guiding students throughout the learning activities.

The student participants were 216 Grade 6 learners enrolled in the classes taught by the participating teachers. The students were grouped according to the instructional approach used in their respective classes. As shown in the distribution of participants, 96 students belonged to the traditional instructional group, while 120 students

were part to the flipped classroom group. The students remained in their intact class sections to preserve the natural classroom environment and avoid disrupting the school's regular instructional structure. Maintaining intact classes also ensured that the classroom dynamics, peer interactions, and teacher-student relationships remained consistent throughout the study.

Student participation in the study was based on specific inclusion criteria. Students were required to be officially enrolled in Grade 6 under the participating teachers, willing to participate in the research activities, and able to complete both the pre-test and post-test assessments. These assessments measured their learning performance in Patterns and Algebra with respect to procedural fluency, problem-solving skills, and conceptual understanding. Students who were absent for more than two instructional sessions or who did not complete the required assessments were excluded from the final data analysis to maintain the validity of the results.

Including both teachers and students as respondents provided a comprehensive perspective on the teaching and learning processes in the flipped classroom model. While the students contributed quantitative data through their assessment results, the teachers provided insights into the implementation of the instructional approaches. This combination of respondents allowed the study to examine how the flipped classroom model influenced both student learning outcomes and classroom instructional practices in the context of Grade 6 mathematics education.

Data Gathering Procedure

Pre-Implementation Phase

The researcher first secured formal approval from the Schools Division Superintendent (SDS) and the school heads of the Tinambac South District. An orientation was conducted for all participating Grade 6 teachers to explain the study's purpose, research procedures, and ethical considerations, including informed consent, voluntary participation, and data confidentiality.

Before full implementation, pilot testing was conducted with a small group of students and teachers to validate the learning materials, pre-tests, post-tests, and monitoring tools. Feedback from the pilot allowed the researcher to refine instructional materials and data collection instruments for clarity and reliability.

Following pilot testing, all ten (10) teachers underwent a structured training program on the flipped classroom model, covering preparation of pre-class materials, facilitation of interactive in-class activities, and strategies for engaging and monitoring student learning. Teachers were then grouped as follows: Traditional approach (5 teachers): Deliver lessons using conventional teacher-centered instruction. Flipped classroom approach (5 teachers): Implement lessons using the flipped classroom approach, acting primarily as facilitators.

Teachers completed an objective test to assess mastery of Patterns and Algebra concepts and instructional strategies. Students also completed a pre-test to establish baseline performance in procedural fluency, problem-solving, and conceptual understanding, and were oriented on the flipped classroom process, including their roles in pre-class independent learning and in-class collaborative activities.

Implementation Phase

During the intervention, teachers applied their assigned instructional methods. In the flipped classroom approach, students engaged with pre-class materials such as instructional videos, reading modules, or interactive digital activities. In-class sessions focused on collaborative learning, including guided discussions, problem-solving exercises, and performance-based tasks, with the teacher facilitating the learning process.

The traditional teaching approach relied on conventional classroom instruction, using the same learning package to ensure consistent content coverage. A monitoring sheet was used to track student progress, task completion, and participation throughout the implementation. The researcher also conducted classroom observations to document teaching practices, student engagement, and teacher-student interactions. All ten teachers and selected students participated in semi-structured interviews to share experiences, perceptions, and challenges during the learning process.

Post-Implementation Phase

After the intervention, all students took a post-test to assess improvements in procedural fluency, problem-solving, and conceptual understanding. Pre-test and post-test results were compared to determine the effectiveness of the flipped classroom relative to traditional instruction.

Teachers also participated in reflective interviews and completed evaluation forms to provide feedback on teaching approaches, including strengths, challenges, and perceived impact on student learning.

All quantitative and qualitative data, including teacher objective test results, student pre- and post-test scores, observation notes, and interviews, were triangulated and analyzed. Insights from this process will guide the development of a contextualized flipped-classroom model tailored to Patterns and Algebra in Philippine elementary education.

Research Instrument

The primary instrument employed in this study was a researcher-made objective test designed to assess learners' understanding and skills in Patterns and Algebra. The test was divided into three main components: Procedural Fluency, which measured learners' ability to perform basic operations and recognize numerical patterns; Problem-Solving Skills, which evaluated learners' ability to apply mathematical concepts to real-life situations; and Conceptual Understanding, which assessed learners' comprehension of algebraic ideas such as variables, coefficients, expressions, and equations. The test items were developed to align closely with the Grade 6 Mathematics Curriculum, ensuring that both the content and cognitive demands were appropriate for the learners' level.

To ensure the instrument's validity, the pre-test and post-test for learners, as well as the researcher-made test, were reviewed and validated by five Master Teacher in Elementary Education. The validation process examined each item for clarity, accuracy, relevance, and alignment with the intended learning objectives. Suggestions from the master teacher were incorporated to refine the test items and ensure that they effectively measured procedural, problem-solving, and conceptual skills. The validation sheets are attached in the appendices of the research paper to provide documented evidence of expert review.

In addition to validity, the reliability of the researcher-made test was established through a pilot testing procedure. The results yielded a Cronbach's alpha coefficient of 0.851, indicating high internal consistency. This implies that the instrument is reliable and consistently measures the intended constructs across learners.

To complement the test, a sample lesson guide was prepared to illustrate instructional delivery under the two teaching models: Traditional and Flipped Classroom. The lesson guide, presented in Table 3, outlines the activities, teacher roles, and learner roles for both approaches.

Table 3 Sample Lesson Guides Showing the Traditional Approach and the Flipped Classroom Approach

Lesson Model	Topic	Sample Lesson Activities / Procedures	Teacher's Role	Learners' Role
Traditional Approach	Patterns and Algebra, Recognizing Arithmetic Sequences	<ol style="list-style-type: none"> 1. Teacher delivers a lecture on rules of arithmetic sequences. 2. Teacher demonstrates how to find the next terms in given sequences. 3. Learners practice exercises individually. 4. Teacher checks answers and provides immediate feedback. 	Present concepts, explain procedures, monitor learners' work, and provide guidance.	Listen attentively, take notes, complete exercises, and answer teacher questions.

<p>Flipped Classroom Approach</p>	<p>Patterns and Algebra, Recognizing Arithmetic Sequences</p>	<ol style="list-style-type: none"> 1. Learners watch a pre-recorded video or digital material on arithmetic sequences at home. 2. In class, learners engage in collaborative problem-solving activities. 3. Teacher facilitates group discussions and clarifies misconceptions. 4. Learners participate in reflection or exit quizzes to assess understanding. 	<p>Facilitate learning, guide discussions, clarify doubts, and encourage active participation.</p>	<p>Watch instructional materials before class, collaborate with peers, participate in discussions, and apply concepts to problem-solving activities.</p>
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Data Analysis

The quantitative data in this study were analyzed to determine the effectiveness of the flipped classroom model in enhancing students' mathematics performance in Patterns and Algebra, particularly in terms of procedural fluency, problem-solving skills, and conceptual understanding. Prior to conducting inferential statistical analyses, a normality test using the Shapiro-Wilk test was performed to assess whether the data followed a normal distribution. The results indicated that the data were not normally distributed; therefore, non-parametric statistical tests were employed as they do not require the assumption of normality and are appropriate for the given dataset.

Descriptive statistics, including the mean, median, standard deviation, minimum, and maximum values, were used to summarize students' performance before and after the implementation of the flipped classroom model. These measures provided an overview of students' achievement levels and variability across the three domains of mathematics performance.

To answer Research Question 1, which examined whether there was a significant difference in students' performance before and after the implementation of the flipped classroom model, the Wilcoxon Signed-Rank Test was used. This test is suitable for comparing paired observations and was applied to determine significant changes in procedural fluency, problem-solving skills, and conceptual understanding.

To answer Research Question 2, which determined whether there was a significant difference between students taught using the flipped classroom model and those taught using traditional instructional methods, the Mann - Whitney U Test was employed. This test is appropriate for comparing two independent groups and was used to analyze differences in posttest performance across the same three domains.

All hypotheses were tested at a 0.05 level of significance. A p-value less than 0.05 led to the rejection of the null hypothesis, indicating a significant difference, while a p-value greater than or equal to 0.05 indicated no significant difference.

For Research Questions 3 and 4, which focused on the experiences of teachers and students, qualitative data gathered through semi-structured interviews and focus group discussions were analyzed using grounded theory procedures. The analysis involved open coding to identify initial concepts, axial coding to group related categories, and selective coding to develop core themes. These themes were further organized through thematic mapping to illustrate relationships and patterns in teaching practices, student engagement, and learning experiences.

Finally, the findings from both quantitative and qualitative phases were integrated to address Research Question 5, providing a comprehensive basis for developing a flipped classroom model grounded in statistical results and participants' lived experiences. This integration ensured a more holistic interpretation of the effectiveness of the flipped classroom approach.

RESULTS AND DISCUSSIONS

Results

Significant Difference in the Students' Mathematics Performance in Patterns and Algebra Before and After the Implementation of the Flipped Classroom Model

Table 4 presents the students' mathematics performance in Patterns and Algebra before and after the implementation of the flipped classroom model. The assessment consisted of 60 items administered as a pre-test and a post-test, measuring procedural fluency, problem-solving skills, and conceptual understanding.

In terms of procedural fluency, both groups demonstrated comparable baseline performance during the pre-test, with mean scores of 12 and medians of 12, which fall under the "Good" category according to the legend. Standard deviations were 2.07 for Group 1 and 2.02 for Group 2, with minimum scores ranging from 6 to 7 (Below Average) and maximum scores from 17 to 18 (Very Good). After the intervention, improvements were observed in both groups. Group 1 (Flipped Classroom) achieved a mean of 17 and a median of 18 (Very Good), while Group 2 (Traditional) obtained a mean of 14 and a median of 14 (Good). The standard deviations were 1.88 and 2.34, respectively, indicating consistent gains, with post-test scores ranging from 11 (Average) to 20 (Very Good) for Group 1 and 8 (Average) to 20 (Very Good) for Group 2. These results suggest that the flipped classroom approach had a greater positive effect on students' ability to perform mathematical procedures accurately and consistently.

Table 4 Students' Mathematics Performance in Patterns and Algebra Before and After the Flipped Classroom Intervention

	Group	Mean	Median	SD	Minimum	Maximum
Pre_Procedural	1	12	12	2.07	6	17
	2	12	12	2.02	7	18
Post_Procedural	1	17	18	1.88	11	20
	2	14	14	2.34	8	20
Pre_Problem Solving	1	10	10	2.00	5	15
	2	10	10	2.22	3	15
Post_Problem Solving	1	15	15	2.42	9	20
	2	12	12	2.46	4	18
Pre_Conceptual	1	7	7	2.13	1	14
	2	7	7	2.13	1	11
Post_Conceptual	1	12	12	2.48	6	18
	2	9	9	2.39	1	14

Legend:0-3 Poor, 4-7 Below Average, 8-11 Average, 12-15 Good, 16-20 Very Good

For problem-solving skills, both groups initially showed average performance, with pre-test mean scores of 10 and medians of 10. Standard deviations were 2.00 for Group 1 and 2.22 for Group 2, and scores ranged from 3 (Poor) to 5 (Below Average) at the minimum and up to 15 (Good) at the maximum. Following the intervention, both groups demonstrated improvements. Group 1 achieved a post-test mean and median of 15 (Good), with scores ranging from 9 (Average) to 20 (Very Good), while Group 2 scored a mean and median of 12 (Good), with a range of 4 (Below Average) to 18 (Very Good). The findings indicate that the flipped classroom model enhanced students' ability to analyze and solve mathematical problems more effectively than traditional instruction.

Regarding conceptual understanding, the pre-test results showed below-average performance for both groups, with mean and median scores of 7 and standard deviations of 2.13. Minimum scores were 1 (Poor), and maximum scores ranged from 11 (Average) to 14 (Good), reflecting limited understanding of algebraic concepts and patterns before the intervention. Post-test results demonstrated notable improvements, particularly for the flipped classroom group. Group 1 achieved a mean and median of 12 (Good), with scores ranging from 6 (Below

Average) to 18 (Very Good), whereas Group 2 scored a mean and median of 9 (Average), with a range of 1 (Poor) to 14 (Good).

Table 5 presents the overall descriptive statistics of students’ mathematics performance in Patterns and Algebra before and after the implementation of the flipped classroom intervention. The assessment consisted of 60 items administered as a pre-test and a post-test, measuring procedural fluency, problem-solving skills, and conceptual understanding.

In terms of procedural fluency, students initially demonstrated a good level of ability, with a pre-test mean of 12, median of 12, and standard deviation of 2.07. After the implementation of the flipped classroom model, performance improved significantly, with a post-test mean of 18, median of 18, and standard deviation of 1.88, reflecting very good accuracy and consistency in applying mathematical procedures related to Patterns and Algebra.

Table 5 Students’ Mathematics Performance Before and After the Flipped Classroom Intervention

	Mean	Median	SD
Pre Procedural	12	12	2.07
Post Procedural	18	18	1.88
Pre Problem Solving	10	10	2.00
Post Problem Solving	15	15	2.42
Pre Conceptual	7	7	2.13
Post Conceptual	12	12	2.48

Legend:0-3 Poor, 4-7 Below Average, 8-11 Average, 12-15 Good, 16-20 Very Good

Regarding problem-solving skills, the pre-test results showed an average level of ability, with a mean and median of 10 and a standard deviation of 2.00. Following the flipped classroom intervention, students’ post-test scores increased to a mean of 15, median of 15, and standard deviation of 2.42, indicating enhanced proficiency in analyzing problems, applying strategies, and reasoning through mathematical solutions.

For conceptual understanding, students’ baseline performance was below average, with a pre-test mean of 7, a median of 7, and a standard deviation of 2.13. After the intervention, post-test scores improved to a mean of 12, median of 12, and standard deviation of 2.48, demonstrating a good level of comprehension of mathematical concepts and the relationships between patterns and algebraic expressions.

Table 6 presents the results of the Wilcoxon Signed-Rank Test used to determine the differences in students’ mathematics performance before and after the flipped classroom intervention. The analysis compared the pre-test and post-test scores in the three areas of mathematical proficiency: procedural fluency, problem-solving skills, and conceptual understanding.

Table 6 Differences in Students’ Mathematics Performance Before and After the Flipped Classroom Intervention

Pre-test	Post-test	Statistic		p
Pre Procedural	Post Procedural	Wilcoxon W	0.00	< .001
Pre Problem Solving	Post Problem Solving	Wilcoxon W	0.00	< .001
Pre Conceptual	Post Conceptual	Wilcoxon W	0.00	< .001

The results show a statistically significant difference in procedural fluency between the pre-test and post-test scores, with a Wilcoxon W value of 0.00 and a p-value of < .001. This indicates that students’ procedural fluency scores significantly improved after the implementation of the flipped classroom intervention.

Similarly, the findings indicate a statistically significant difference in problem-solving skills, with a Wilcoxon W value of 0.00 and a p-value of < .001. This result shows that students significantly improved their ability to solve mathematical problems after participating in the flipped classroom activities. In addition, the results show

a statistically significant difference in conceptual understanding between the pre-test and post-test scores, with a Wilcoxon W value of 0.00 and a p-value of $< .001$. This finding indicates that students' conceptual understanding of Patterns and Algebra significantly increased after the intervention.

Significant Difference in the Mathematics Performance of Students Taught Using the Flipped Classroom Model and Traditional Instructional Methods

Table 7 presents the mathematics performance of students in the Flipped Classroom and Traditional groups in Patterns and Algebra. The assessment consisted of 60 items administered as a pre-test and a post-test, measuring procedural fluency, problem-solving skills, and conceptual understanding. The results indicate that students taught using the flipped classroom model consistently outperformed those taught through traditional instructional methods. In procedural fluency, the flipped classroom group achieved a mean score of 18 (Very Good), a median of 18, and a standard deviation of 1.88, whereas the traditional group obtained a mean of 14 (Good), a median of 14, and a standard deviation of 2.34.

For problem-solving skills, students in the flipped classroom group scored a mean of 15 (Good), median of 15, and standard deviation of 2.42, compared to the traditional group's mean of 12 (Good), median of 12, and standard deviation of 2.46.

Table 7 Flipped Classroom and Traditional Groups' Mathematics Performance

	Group	Mean	Median	SD
Procedural	Flipped	18	18	1.88
	Traditional	14	14	2.34
Problem Solving	Flipped	15	15	2.42
	Traditional	12	12	2.46
Conceptual	Flipped	12	12	2.48
	Traditional	9	9	2.39

Legend: 0-3 Poor, 4-7 Below Average, 8-11 Average, 12-15 Good, 16-20 Very Good

Regarding conceptual understanding, the flipped classroom group obtained a mean and median of 12 (Good), with a standard deviation of 2.48, while the traditional group scored a mean and median of 9 (Average), with a standard deviation of 2.39.

Table 8 presents the comparison of mathematics performance between students taught using the Flipped Classroom and those taught using Traditional instruction. The Mann-Whitney U test was conducted to determine whether the mean performance of the Flipped Classroom group was significantly greater than that of the Traditional group ($H_a: \mu_1 > \mu_2$). The analysis yielded U-values of 1165.50 for procedural fluency, 1840.00 for problem-solving skills, and 2389.00 for conceptual understanding, with all results reaching statistical significance at $p < 0.001$. These findings indicate that students in the Flipped Classroom group performed significantly better than their peers in the Traditional instruction group across all three components of mathematics proficiency.

Table 8 Mathematics Performance Between Flipped Classroom and Traditional Instruction

		Statistic	p
Procedural	Mann-Whitney U	1165.50	$< .001$
Problem Solving	Mann-Whitney U	1840.00	$< .001$
Conceptual	Mann-Whitney U	2389.00	$< .001$
Note. $H_a \mu_1 > \mu_2$			

Teachers' Experiences Using the Flipped Classroom Model

Based on the teachers' responses, several themes emerged from their experiences using the flipped classroom model in mathematics instruction. These themes include: (1) adaptation to new teaching roles, (2) professional

growth in mathematical understanding, (3) improved lesson planning and resource development, (4) using student interaction as a reflection tool, and (5) navigating challenges and strategies in implementing flipped learning. The responses describe how teachers experienced changes in their instructional practices while implementing the flipped classroom approach.

Adaptation to New Teaching Roles

The responses indicate that teachers shifted from traditional lecture-based instruction to a more facilitative role in the classroom. Instead of focusing primarily on delivering lectures, teachers described guiding students as they worked through learning activities and class discussions.

One participant shared:

“Kailangan naming maging facilitator sa halip na puro lecture lang, kaya natututo rin kaming mag-adjust sa bagong paraan ng pagtuturo.” At times, we have to act as facilitators instead of only lecturing, so we also learn to adjust to new teaching methods. (Participant 1)

Another participant noted that the flipped classroom allowed students to explore their own approaches to solving problems:

“Mas natutuhan naming pakikinig ang mga estudyante at bigyan sila ng pagkakataon na mag-explore ng sarili nilang paraan.” We have learned to listen to students more and give them opportunities to explore their own methods. (Participant 2)

Teachers also mentioned that their role included helping students become more independent learners. As one participant explained:

“Hindi lang kami nagtuturo ng lessons kundi nagtuturo rin kami kung paano maging independent ang mga estudyante.” We don’t just teach lessons; we also teach students how to become independent learners. (Participant 3)

Some teachers described the challenge of adjusting to the new instructional approach. One participant shared:

“Minsan mahirap i-release ang control, pero natutuhan naming hayaan silang matuto sa kanilang sariling pace.” Sometimes it’s hard to let go of control, but we learned to allow students to learn at their own pace. (Participant 4)

Other teachers described acting as guides when students worked in groups or participated in classroom activities. One participant stated:

“Kailangan naming maging tagapag-guide sa bawat grupo, hindi lang basta nagbibigay ng sagot.” We need to act as guides for each group, not just provide answers. (Participant 5)

Teachers also reported that implementing the flipped classroom required flexibility in managing time and teaching strategies. As one participant expressed:

“Natutuhan naming maging mas flexible sa oras at paraan ng pagtuturo dahil iba ang approach ng flipped classroom at nagsasagawa rin kami ng mga games upang mas maging epektibo ang pagtuturo.” We learned to be more flexible in managing time and teaching methods because the flipped classroom approach is different, and we also conduct games to make teaching more effective. (Participant 6)

Several teachers also observed changes in classroom activities, noting that discussions and student participation increased compared to traditional lecture-based classes. One participant shared:

“Dati puro lecture lang, ngayon mas marami kaming discussions at aktibidad na kasama ang estudyante.” Before, it was pure lecture; now we include more discussions and activities with the students. (Participant 7)

Another participant described the experience of facilitating student-centered learning:

“Minsan nakaka-stress maging facilitator sa halip na magturo lang, pero nakikita naming mas aktibo ang estudyante.” Sometimes it’s stressful to be a facilitator instead of just teaching, but we see students being more active. (Participant 8)

The responses show that teachers experienced changes in their instructional roles when implementing the flipped classroom model. Their statements highlight shifts toward facilitating learning, guiding student activities, and allowing learners to participate more actively during class sessions.

Professional Growth In Mathematical Understanding

Teachers’ responses revealed that using the flipped classroom model contributed to the development of their Mathematical Content Knowledge (MCK). Many participants shared that preparing lessons, creating instructional materials, and guiding students during learning activities encouraged them to review mathematical concepts more carefully and explore different ways of explaining them.

Some teachers described studying mathematical topics more thoroughly before presenting them to students. One participant stated:

“Dahil sa flipped classroom, mas pinag-aaralan ko ang bawat konsepto bago ituro sa klase para mas malinaw sa mga estudyante.” The flipped classroom makes me study each concept more thoroughly before teaching it to ensure clarity for students. (Participant 10)

Another participant shared that the approach encouraged them to develop different explanations for mathematical ideas:

“Natuto akong mag-isip ng iba’t ibang paraan para ipaliwanag ang mathematical problems sa mga estudyante.” I learned to think of different ways to explain mathematical problems to students. (Participant 2)

Teachers also noted that preparing for possible student questions encouraged them to strengthen their understanding of mathematics. One participant explained:

“Mas lumalim ang aking kaalaman sa math dahil kailangan kong maging handa sa mga tanong ng estudyante.” My math knowledge deepened because I need to be ready for students’ questions. (Participant 7)

Another teacher described how their perspective on mathematical concepts changed as they prepared lessons under the flipped classroom model:

“Dati, simple lang ang approach ko sa pagtuturo, ngayon mas naiintindihan ko ang reasoning sa likod ng bawat concept.” Before, my teaching approach was simple; now I understand the reasoning behind each concept better. (Participant 9)

Several participants also mentioned learning from students’ responses and mistakes during class discussions. One teacher shared:

“Natutuhan kong suriin ang mga pagkakamali ng estudyante para mapabuti rin ang aking sariling understanding sa math.” I learned to examine students’ mistakes to improve my own understanding of math. (Participant 5)

Some teachers explained that creating instructional materials, particularly videos used in the flipped classroom, required them to review lessons more carefully. One participant stated:

“Ang paggawa ng instructional videos ay nakatulong sa akin na mas mapag-aralan at mas maintindihan ang bawat lesson.” Creating instructional videos helped me study and understand each lesson more deeply. (Participant 6)

Other participants expressed that the approach helped them feel more prepared when teaching complex topics. One teacher noted:

“Mas confident akong magturo ng challenging topics dahil mas handa ako at alam ko ang bawat detalye.” I am more confident teaching challenging topics because I am better prepared and know the details. (Participant 3)

Overall, the teachers’ responses indicate that the flipped classroom model involved reviewing mathematical concepts, preparing instructional materials, and responding to students’ questions and ideas during class activities. Their statements describe how these experiences were part of their teaching practices while implementing the flipped classroom approach.

Improved Lesson Planning And Resource Development

Teachers’ responses revealed that implementing the flipped classroom model influenced their lesson planning practices and the development of instructional resources. Participants described preparing pre-class materials, organizing lesson activities, and using various resources to support students’ understanding of mathematical concepts.

Some teachers mentioned that the flipped classroom required them to structure their lessons more carefully. One participant shared:

“Mas naging maayos ang aking lesson plan dahil kailangan kong i-structure ang bawat activity sa flipped classroom.” My lesson plans became more organized because I need to structure each activity for the flipped classroom. (Participant 12)

Another participant described using a variety of instructional resources to support the lesson:

“Natutuhan kong gumamit ng iba't ibang resources tulad ng videos, slides, at online exercises para mas maintindihan ng estudyante ang lesson.” I learned to use different resources like videos, slides, and online exercises to help students understand the lesson better. (Participant 9)

Some teachers explained that planning the lesson required them to prepare materials that students would use before attending class. One participant stated:

“Kailangan kong planuhin ang bawat detalye para maging handa ang estudyante bago pumasok sa klase.” I need to plan every detail to ensure students are prepared before entering the class. (Participant 2)

Another participant mentioned that creating pre-class materials helped clarify the sequence of lesson activities:

“Ang paggawa ng pre-class materials ay nakatulong sa akin na maayos at malinaw ang bawat step ng lesson.” Creating pre-class materials helped me organize and clarify each step of the lesson. (Participant 5)

Teachers also reported developing additional learning materials such as worksheets and exercises aligned with the lesson objectives. One participant shared:

“Mas naging creative ako sa pagbuo ng worksheets at exercises na naaayon sa lesson objectives.” I became more creative in developing worksheets and exercises aligned with lesson objectives. (Participant 9)

Another participant described planning lesson sequences that combine different types of learning activities:

“Natuto akong magplano ng sequence ng lesson na may combination ng lecture, practice, at discussion.” I learned to plan lesson sequences that combine lecture, practice, and discussion. (Participant 10)

Overall, the responses show that teachers described preparing pre-class materials, organizing lesson activities, and using different instructional resources while implementing the flipped classroom model. Their statements

highlight how lesson preparation and resource development were part of their teaching practices in the flipped classroom approach.

Using Student Interaction As A Reflection Tool

Teachers' responses indicated that student interaction played an important role in implementing the flipped classroom model. Participants described observing students' responses, listening to their questions, and examining their problem-solving approaches during class activities.

Some teachers mentioned that observing students while they worked on mathematical problems helped them recognize which concepts students found difficult. One participant shared:

"Kapag nakikita kong nahihirapan ang estudyante sa isang problema, natututo rin ako kung alin sa konsepto ang kailangan kong ipaliwanag ng mas malinaw." When I see a student struggling with a problem, I also learn which concept I need to explain more clearly. (Participant 2)

Another participant explained that asking questions and listening to students' responses helped guide the focus of the lesson:

"Ang pagtatanong at pakikinig sa sagot ng estudyante ay nagtuturo sa akin kung saan ako dapat mag-focus sa lesson." Asking questions and listening to students' answers teaches me where I should focus in the lesson. (Participant 4)

Some teachers also mentioned that student feedback during class discussions helped them review and adjust their teaching strategies. One participant stated:

"Nakakatulong ang feedback ng estudyante para mapabuti ko ang instructional strategies ko sa susunod na klase." Student feedback helps me improve my instructional strategies for the next class. (Participant 8)

Other participants described observing students' correct and incorrect answers during activities. One teacher shared:

"Kapag nakikita kong tama at mali ang sagot ng estudyante, natututo rin ako sa common misconceptions nila." When I see students' correct and incorrect answers, I also learn about common misconceptions. (Participant 10)

Overall, the responses show that teachers described observing students' responses, listening to questions, and examining problem-solving strategies during classroom activities while implementing the flipped classroom model. Their statements highlight how student interaction formed part of their classroom experiences during the use of the flipped learning approach.

Navigating Challenges And Strategies In Implementing Flipped Learning.

Teachers' responses revealed several challenges encountered while implementing the flipped classroom model. Participants mentioned difficulties related to student engagement with pre-class materials, time required for preparation, technology-related concerns, and classroom management during group activities. Teachers also described various approaches they used to address these challenges during the implementation of flipped learning.

Some teachers reported that students sometimes experienced difficulty understanding the pre-class instructional materials. One participant shared:

"Minsan nahihirapan ang mga estudyante sa pre-class videos, kaya kailangan kong gumawa ng mas simpleng paliwanag at dagdag nahalimbawa." Sometimes students struggle with the pre-class videos, so I need to create simpler explanations and additional examples. (Participant 1)

Another participant noted that preparing materials for the flipped classroom required additional time compared to traditional teaching:

*“Ang oras ng preparasyon para sa flipped classroom ay mas mahaba kaysa sa tradisyonal na klase, kaya kailangan kong planuhin ang schedule nang maayos.”*Preparation time for the flipped classroom is longer than traditional classes, so I need to plan my schedule carefully. (Participant 4)

Some teachers mentioned that not all students consistently accessed the online learning materials. As a result, alternative resources were sometimes provided. One participant explained:

*“May mga estudyante na hindi regular nag-a-access sa online materials, kaya nagbigay ako ng printed resources bilang alternatibo.”*Some students do not regularly access online materials, so I provided printed resources as an alternative. (Participant 6)

Teachers also described challenges related to managing classroom activities, particularly during group work. One participant stated:

*“Minsan challenging ang pag-manage ng class habang may group activities, kaya kailangan ko ng clear instructions at rules.”*Sometimes managing the class during group activities is challenging, so I need clear instructions and rules. (Participant 7)

Another teacher mentioned the need to balance teaching responsibilities with the preparation of flipped classroom materials:

*“Nakakapagod sa simula dahil kailangan kong balansehin ang teaching at preparation, pero natutuhan kong i-prioritize ang mahahalagang materials.”*It is tiring at first because I have to balance teaching and preparation, but I learned to prioritize important materials. (Participant 8)

Some participants also noted that technology-related issues occasionally affected lesson delivery. One participant shared:

*“May pagkakataon na hindi compatible ang technology sa klase, kaya nag-develop ako ng alternative ways to deliver lessons.”*Sometimes technology is not compatible in class, so I developed alternative ways to deliver lessons. (Participant 10)

Another teacher mentioned preparing alternative strategies in case technical problems occurred:

*“Minsan may technical problems sa devices, kaya mas nagiging handa ako sa backup strategies.”*Sometimes there are technical problems with devices, so I become more prepared with backup strategies. (Participant 8)

Overall, the responses show that teachers described several challenges related to the use of pre-class materials, preparation time, technology access, and classroom management during flipped learning implementation. Their statements also highlight different approaches they used while addressing these situations during their classroom experiences with the flipped classroom model.

Table 9 shows, the analysis of teachers' experiences with the flipped classroom model revealed five key themes that highlight its impact on enhancing Mathematical Content Knowledge (MCK).

First, teachers reported an adaptation to new teaching roles, shifting from traditional lecturers to facilitators who guide students' independent learning. This role change required them to rethink instructional strategies and classroom dynamics. Second, the model fostered professional growth in mathematical understanding, as teachers engaged more deeply with content while preparing flipped lessons. Third, teachers noted improved lesson planning and resource development, creating more organized, creative, and student-centered materials to support learning. Fourth, student interaction served as a reflection tool, allowing teachers to evaluate the effectiveness

of their instruction and adjust strategies accordingly. Finally, teachers shared experiences of navigating challenges and developing strategies to overcome obstacles such as time management, student readiness, and technology use. Overall, these themes demonstrate that the flipped classroom model not only enhances teachers' MCK but also promotes reflective practice, professional growth, and innovative teaching approaches.

Table 9 Summary Theme of Teachers' Experience Using the Flipped Classroom Model

Theme	Description
Adaptation to New Teaching Roles	Teachers experienced a shift in their roles, transitioning from traditional lecturers to facilitators who guide students' independent learning.
Professional Growth in Mathematical Understanding	Teachers reported an enhancement in their Mathematical Content Knowledge (MCK) through preparing flipped lessons and engaging with concepts more deeply.
Improved Lesson Planning and Resource Development	The flipped classroom model encouraged teachers to design more organized, creative, and student-centered lesson materials and learning resources.
Using Student Interaction as a Reflection Tool	Teachers observed student responses and interactions to reflect on their teaching effectiveness and adjust instructional strategies accordingly.
Navigating Challenges and Strategies in Implementing Flipped Learning	Teachers identified difficulties such as time management, student readiness, and technology use, and developed strategies to overcome these challenges.

Students' Experiences In Learning Through The Flipped Classroom Model

The following themes emerged from the responses of the twelve (12) selected Grade 6 students regarding their experiences in learning through the flipped classroom model. Their narratives revealed meaningful insights into how this instructional approach influenced their engagement, understanding, confidence, and overall mathematical performance. Through careful analysis of their responses, five major themes were identified are: (1) Increased Learning Autonomy and Responsibility, (2) Enhanced Conceptual Understanding Through Active Engagement; (3) Improved Confidence and Mathematical Self-Efficacy; (4) Flexible Learning Pace and Accessibility of Materials; (5) and Collaborative Learning and Peer Support. These themes collectively highlight how the flipped classroom model enhanced students' mathematical performance.

Increased Learning Autonomy and Responsibility

The responses of the selected Grade 6 students reflect their experiences related to increased learning autonomy and responsibility while participating in the flipped classroom model. Many students described how the approach required them to complete pre-class learning tasks such as watching instructional videos, taking notes, and preparing questions before attending the lesson. For several students, this shift from teacher-centered instruction to more independent preparation initially created challenges as they adjusted to managing their own learning responsibilities.

Some students shared that they experienced difficulty at the beginning because they were not accustomed to studying lessons independently at home before the classroom discussion. One participant explained:

“Noong una, nahirapan ako kasi kailangan kong manood ng lesson sa bahay bago pumasok.” At first, I had difficulty because I needed to watch the lesson at home before coming to class. (Participant 3)

Similarly, another student expressed that independent learning was unfamiliar at the start of the implementation:

“Sa simula, hindi ako sanay mag-aral mag-isa kaya nahirapan ako.” At first, I was not used to studying on my own, so I found it difficult. (Participant 4)

Some participants also described challenges related to managing their time in completing pre-class learning tasks. One student stated:

“Sa simula, hindi ko agad nagagawa ang pre-class task kasi hindi ako sanay mag-manage ng oras.” At first, I could not complete the pre-class task immediately because I was not used to managing my time. (Participant 10)

Another participant admitted that motivation to engage with the instructional videos was initially low:

“Noong una, tinatamad akong manood ng video, pero natutunan kong maging responsable.” At first, I felt lazy watching the video, but I learned to be responsible. (Participant 5)

In addition, some students described the challenge of completing multiple tasks simultaneously while watching the lesson materials. One participant shared:

“Nahirapan ako noong simula kasi kailangan kong mag-take notes habang nanonood.” I had difficulty at the beginning because I needed to take notes while watching. (Participant 11)

Despite these initial challenges, the students' responses reveal a gradual adjustment to the learning structure introduced by the flipped classroom model. Over time, many students reported becoming more accustomed to watching lesson videos, preparing notes, and organizing their learning tasks before class discussions. This process allowed them to develop a greater sense of responsibility in completing academic tasks and managing their study routines.

Enhanced Conceptual Understanding Through Active Engagement

The responses of the selected Grade 6 students describe their experiences of participating in classroom activities during the implementation of the flipped classroom model. Students mentioned engaging in group discussions, practicing mathematical problems, asking questions, and participating in interactive activities during class.

Some students shared that group discussions helped them understand the lesson more clearly. One participant stated:

“Mas naiintindihan ko po ang lesson kapag may group discussion kami sa klase.” I understand the lesson better when we have group discussions in class. (Participant 1)

Another participant described how practicing mathematical problems during class activities supported their understanding of the lesson:

“Kapag nagpa-practice kami ng problems sa klase, mas malinaw sa akin ang mga konsepto.” When we practice problems in class, the concepts become clearer to me. (Participant 3)

Some students mentioned that asking questions and discussing answers during the lesson were part of their classroom experiences. One participant shared:

“Mas natututo ako kapag nagtatanong kami at nagdedebate tungkol sa sagot.” I learn more when we ask questions and discuss answers. (Participant 5)

Other participants described engaging in hands-on or interactive classroom activities. One student explained:

“Noong may hands-on activities, mas madaling maintindihan ang topic.” When we had hands-on activities, it was easier to understand the topic. (Participant 7)

Some students also noted that observing the solution process during classroom discussions helped them follow the steps involved in solving mathematical problems. One participant stated:

“Kapag nakikita ko ang solution step-by-step sa klase, naiintindihan ko agad ang prosesong.” When I see the solution step-by-step in class, I immediately understand the process. (Participant 9)

Another participant described participating actively in classroom activities during the lesson:

“Mas madaling ma-retain ang knowledge kapag active ang participation namin sa klase.” It’s easier to retain knowledge when we actively participate in class. (Participant 11)

Overall, the responses indicate that students participated in group discussions, practiced mathematical problems, asked questions, and engaged in interactive activities during classroom sessions in the flipped classroom model. Their statements reflect how these classroom experiences formed part of their learning process during the implementation of flipped learning in mathematics.

Improved Confidence and Mathematical Self-Efficacy

The selected Grade 6 students shared experiences indicating that the flipped classroom model helped improve their confidence and self-efficacy in Mathematics. Students reported that pre-class preparation, in-class practice, and collaborative activities enabled them to approach problems with greater confidence and trust in their own understanding.

Some students indicated increased confidence in solving mathematical problems:

“Mas kumpiyansa po ako ngayon sa Math kasi naiintindihan ko na ang mga problema.” I feel more confident in Math now because I understand the problems. (Participant 2)

Others described overcoming initial hesitation in participating during class:

“Noong una po, natatakot akong sumagot sa klase, pero ngayon mas nagtiwala ako sa sarili ko.” At first, I was afraid to answer in class, but now I trust myself more. (Participant 4)

Some students emphasized the role of guided practice in building certainty:

“Mas nagiging sure po ako sa mga sagot ko kapag nagpa-practice kami sa klase.” I become more certain of my answers when we practice in class. (Participant 5)

Several students noted that they learned to ask questions when they did not understand a concept:

“Noong una po, nahihiya akong magtanong, pero natutunan kong magtanong kapag may hindi ako maintindihan.” At first, I was shy to ask questions, but I learned to ask when I don’t understand. (Participant 7)

One participant shared that seeing correct solutions enhanced confidence:

“Kapag nakikita ko po na tama ang sagot ko, mas tumataas ang kumpiyansa ko.” When I see that my answer is correct, my confidence increases. (Participant 10)

Overall, the students’ responses indicate that engagement in pre-class preparation, guided practice, and collaborative classroom activities contributed to increased confidence and self-efficacy in Mathematics. Many students reported a transition from initial hesitation or fear of answering questions to greater self-assurance and more proactive participation, problem-solving, and seeking clarification during lessons.

Flexible Learning Pace and Accessibility of Materials

The responses of the twelve Grade 6 students describe how the flipped classroom model allowed them to learn at their own pace and access learning materials outside of class. Students reported that the ability to replay videos, pause lessons, and review challenging topics at home helped them understand mathematical concepts and prepare for in-class activities.

Some students noted the benefits of replaying lessons:

“Mas naiintindihan ko po ang lesson kasi pwede kong ulitin ang video hanggang maintindihan ko.” I understand the lesson better because I can replay the video until I understand it. (Participant 1)

Others highlighted the usefulness of step-by-step explanations in videos:

“Mas madali po sa akin mag-aral kasi nakikita ko ang step-by-step solution sa video.” It’s easier for me to study because I can see the step-by-step solution in the video. (Participant 3)

Several students shared that reviewing lessons at home helped them process difficult topics:

“Kapag hindi ko maintindihan, puwede ko po ulitin ang lesson sa bahay.” When I don’t understand, I can repeat the lesson at home. (Participant 4)

One participant described managing their study time independently:

“Mas magaan po ang pag-aaral kasi puwede kong i-adjust ang oras ko sa pag-review ng lesson.” Studying is easier because I can adjust my time to review the lesson. (Participant 11)

Overall, students’ responses indicate that flexible learning pace and easy access to instructional materials allowed them to control their learning, revisit difficult concepts, and prepare effectively for in-class problem-solving and discussions. The narratives consistently emphasize self-paced study, review of step-by-step solutions, and independent management of learning time as central features of their flipped classroom experience.

Collaborative Learning and Peer Support

The responses of the twelve Grade 6 students indicate that collaborative learning and peer support played a significant role in enhancing their understanding of Mathematics. Students reported that working with classmates through group activities, discussions, and peer explanations clarified concepts, reinforced understanding, and increased their confidence in problem-solving.

Some students highlighted the benefits of group collaboration:

“Mas naiintindihan ko po ang lesson kapag nagtutulungan kami sa grupo.” I understand the lesson better when we work together in a group. (Participant 1)

Peer questioning was also noted as helpful:

“Kapag nagtatanong kami sa isa’t isa, mas malinaw po sa akin ang sagot.” When we ask each other questions, the answers become clearer to me. (Participant 4)

Several students emphasized the comfort and clarity provided by peer support:

“Mas komportable po ako magtanong kapag may peer support sa klase.” I feel more comfortable asking questions when there is peer support in class. (Participant 7)

“Mas nagiging malinaw po ang lesson kapag nakikinig ako sa paliwanag ng kaklase ko.” The lesson becomes clearer when I listen to my classmate’s explanation. (Participant 9)

Students also noted that collaborative projects enhanced learning:

“Mas natututo ako kapag nagtutulungan kami sa group projects.” I learn more when we collaborate on group projects. (Participant 10)

Overall, students’ responses reveal that peer interaction and cooperative tasks helped them understand mathematical concepts more deeply, provided multiple perspectives on problem-solving, and increased confidence in participating in class. Collaboration made abstract ideas more concrete and reduced anxiety, fostering both engagement and comprehension.

Table 10 presents the experiences of Grade 6 students learning mathematics through the flipped classroom model and how these experiences contributed to improved mathematical performance. The analysis revealed five major themes.

First, students demonstrated greater learning autonomy and responsibility, becoming more independent in managing their tasks and preparing for lessons, thereby improving their engagement and overall performance. Second, enhanced conceptual understanding through active engagement was evident: participating in flipped lessons enabled students to grasp mathematical concepts more deeply, thereby improving problem-solving skills. Third, students showed improved confidence and mathematical self-efficacy, reflecting a stronger belief in their ability to handle mathematical tasks. Fourth, the flexible learning pace and accessible materials enabled students to review content at their own pace, clarify doubts, and reinforce their learning, which positively influenced their assessment outcomes. Finally, collaborative learning and peer support fostered discussion and sharing of ideas, enhancing comprehension and application of mathematical concepts.

Table 10 Summary of Students’ Experience Using the Flipped Classroom Model

Theme	Description
Increased Learning Autonomy and Responsibility	Students became more independent in managing their learning, taking responsibility for completing tasks and preparing for lessons, which improved engagement and performance.
Enhanced Conceptual Understanding Through Active Engagement	Active participation in flipped lessons helped students grasp mathematical concepts more deeply, leading to better problem-solving and understanding.
Improved Confidence and Mathematical Self-Efficacy	Positive experiences in the flipped classroom increased students’ confidence in tackling mathematical tasks and strengthened their belief in their abilities.
Flexible Learning Pace and Accessibility of Materials	Students could review lesson materials at their own pace, allowing them to reinforce understanding, clarify doubts, and perform better in assessments.
Collaborative Learning and Peer Support	Working with classmates encouraged discussion, sharing of ideas, and mutual support, enhancing comprehension and application of mathematical concepts.

Proposed Flipped Classroom Model

Figure 1 presents the Proposed Contextualized Flipped Classroom Model for Mathematics, specifically designed to enhance procedural fluency, problem-solving skills, and conceptual understanding among Grade 6 learners in Patterns and Algebra. The model was developed based on the study’s findings, incorporating both teachers’ experiences and student learning outcomes observed during the implementation of flipped learning strategies. It presents a structured instructional process that emphasizes active engagement, learner-centered instruction, and responsiveness to students’ learning needs.

The model begins with teacher preparation, highlighting the importance of instructional readiness before implementing the flipped classroom approach. Teacher feedback from the study revealed that effective flipped instruction requires careful planning, preparation of instructional materials, and the ability to facilitate student-centered learning activities. This stage ensures that teachers develop the pedagogical and organizational competencies needed to manage classroom

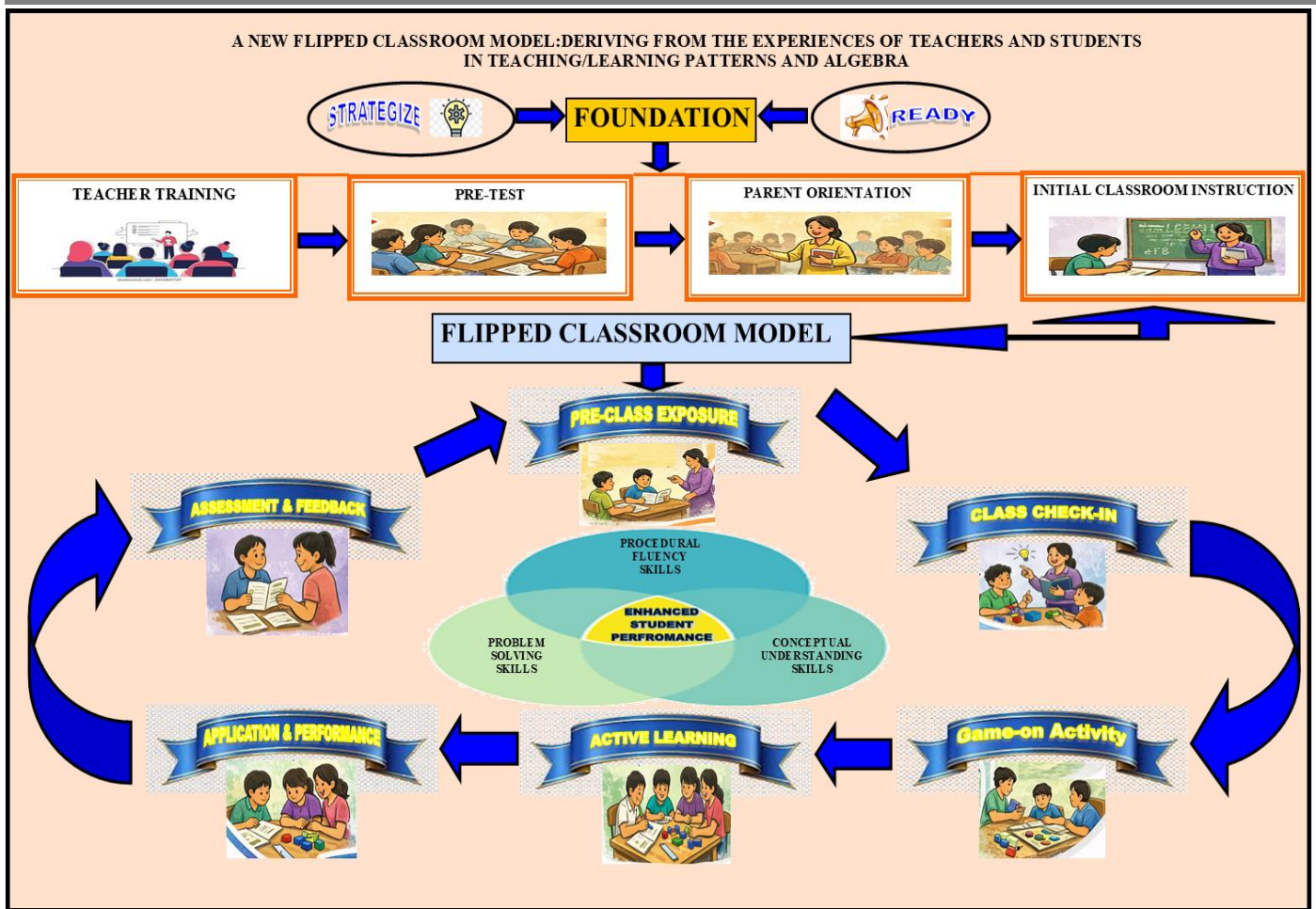


Figure 1. Flipped Classroom Model for Mathematics dynamics, guide collaborative learning, and effectively integrate interactive instructional strategies.

Following teacher preparation, the model incorporates a pre-assessment stage to determine students' prior knowledge and baseline understanding of the lesson topic. The study's findings indicated that students initially demonstrated lower levels of conceptual understanding than of procedural and problem-solving skills. As a result, the diagnostic assessment becomes a critical component of the model, enabling teachers to identify learning gaps, misconceptions, and areas that require additional instructional support. The information gathered from the pre-assessment guides the design of targeted learning activities to strengthen conceptual understanding.

The in-class learning stage forms the core of the flipped classroom model. Student feedback emphasized that active participation, peer interaction, and hands-on learning were key factors that helped them understand mathematical concepts more clearly. In response to these findings, the model integrates game-embedded activities, collaborative exercises, and guided problem-solving tasks within the classroom. These activities transform abstract mathematical ideas into engaging learning experiences, enabling students to explore patterns, test different strategies, and analyze relationships among mathematical concepts. Through collaborative discussions and interactive challenges, learners are encouraged to explain their reasoning and develop deeper conceptual understanding while simultaneously strengthening their procedural and problem-solving abilities.

In addition to in-class activities, the model incorporates independent learning tasks, including pre-class preparation and home-based activities. Students reported that having access to learning materials outside the classroom allowed them to study at their own pace, review lessons, and practice mathematical procedures more confidently. These independent learning opportunities promote self-directed learning, responsibility, and increased confidence, enabling students to reinforce their understanding and apply mathematical procedures independently.

The model concludes with a post-assessment stage that evaluates students' learning outcomes following the instructional intervention. This assessment measures improvements in procedural fluency, problem-solving

skills, and conceptual understanding. By comparing pre-assessment and post-assessment results, teachers can determine the effectiveness of the instructional strategies used and identify areas that may require further improvement or reinforcement.

A significant feature of the proposed model is its adaptability to low-resource educational environments. Unlike traditional flipped classroom models that rely heavily on digital videos and online platforms, this contextualized model integrates printed learning modules, classroom discussions, hands-on activities, and game-based learning strategies. This design ensures that the flipped classroom approach remains accessible and effective even in settings where internet connectivity and technological resources are limited.

Overall, the Contextualized Flipped Classroom Model is a research-based instructional framework derived from this study's findings. By integrating diagnostic assessment, interactive learning activities, collaborative engagement, and flexible independent practice, the model addresses the identified challenges in conceptual understanding while strengthening procedural and problem-solving skills. As a result, the model provides a practical and inclusive strategy for improving Grade 6 students' mathematical performance in Patterns and Algebra, particularly in educational contexts with limited technological resources.

DISCUSSIONS

Significant Difference in the Students' Mathematics Performance in Patterns and Algebra Before and After the Implementation of the Flipped Classroom Model

The results indicate that the implementation of the flipped classroom model led to significant improvements in students' mathematics performance in Patterns and Algebra across procedural fluency, problem-solving skills, and conceptual understanding. These findings suggest that shifting from a teacher-centered approach to a student-centered learning environment enhances not only procedural competence but also deeper conceptual understanding. The initial gap observed between procedural fluency and conceptual understanding reflects a common issue in traditional mathematics instruction, where emphasis is often placed on correct procedures rather than meaningful comprehension. The improvement across all domains implies that the flipped classroom model effectively addressed this imbalance by promoting more active and engaged learning.

From a theoretical perspective, these findings can be explained through constructivist learning theory, which posits that learners actively construct knowledge through experience and interaction. The flipped classroom model supports this by allowing students to engage with content before class and apply their understanding through guided activities during class. In addition, active learning principles help explain the improvement in procedural fluency, as students benefit from immediate feedback and structured practice. The enhancement of problem-solving skills is further supported by social learning theory, which emphasizes the importance of collaboration, discussion, and shared reasoning in developing higher-order thinking skills.

The improvement in procedural fluency indicates that guided in-class practice is more effective than independent practice alone. When students perform tasks under teacher supervision, misconceptions can be corrected immediately, resulting in more accurate and sustained learning. This suggests that mathematics instruction should prioritize structured, interactive classroom activities rather than relying heavily on passive lecture-based approaches.

Similarly, the development of problem-solving skills highlights the value of combining pre-class preparation with collaborative and inquiry-based learning. Students are given more opportunities to analyze problems, explore different strategies, and justify their reasoning. This implies that problem-solving is strengthened through interaction and guided exploration rather than isolated individual work. Teachers, therefore, should create learning environments that encourage discussion, reasoning, and peer engagement.

The most notable improvement was observed in conceptual understanding, which was initially the weakest area. This indicates that the flipped classroom model is particularly effective in addressing abstract mathematical concepts. Through hands-on activities, peer collaboration, and game-based learning, students were able to visualize relationships and construct meaning rather than rely on memorization. This reinforces the idea that conceptual understanding develops more effectively when learners are actively involved in the learning process.

The use of game-based and interactive tasks further supports learner engagement and motivation. This suggests that meaningful learning occurs when students are actively participating and are cognitively engaged in the process. For educators, this highlights the importance of integrating experiential and interactive strategies, especially when teaching complex and abstract topics in mathematics.

In terms of practical implications, the findings demonstrate that the flipped classroom model can be effectively implemented even in low-resource environments. Unlike many previous studies that rely on advanced digital technologies, this study utilized accessible and low-cost alternatives such as offline video materials, printed modules, and mobile-friendly content. This represents a key difference from existing literature and suggests that the effectiveness of flipped learning depends more on instructional design and teacher facilitation than on the availability of technology.

The sustainability of the contextualized flipped classroom model is also influenced by teacher preparedness, resource adaptability, and institutional support. Teachers must be equipped with the skills to facilitate student-centered learning, while schools should promote collaboration in developing and sharing instructional materials. In low-resource contexts, sustainability can be achieved through the use of locally available materials and gradual integration of technology. This implies that long-term success is rooted in pedagogical flexibility and contextual responsiveness rather than technological dependence.

The findings of this study are consistent with existing literature on flipped classrooms and mathematics education. Similar to Hung (2021), the results show that collaborative and guided in-class activities enhance conceptual understanding. Likewise, Li and Chen (2022) found that student-centered approaches improve both procedural fluency and problem-solving skills, which aligns with the present findings. The use of interactive and game-based strategies also supports the conclusions of Al-Samarraie et al. (2023), who emphasized the role of engagement in improving learning outcomes. Furthermore, the increased participation and confidence observed among students are consistent with the findings of Baepler et al. (2020) and Chen et al. (2022), who reported that flipped classrooms promote active learning and self-efficacy.

However, in contrast to studies conducted in technology-rich environments, this study demonstrates that the flipped classroom model remains effective even with limited technological resources. This difference highlights the model's adaptability and underscores the importance of contextualizing instructional strategies based on learners' needs and available resources.

Overall, the findings suggest that the contextualized flipped classroom model provides a comprehensive and adaptable framework for improving mathematics instruction. By integrating procedural practice, problem-solving, and conceptual learning through interactive and student-centered approaches, the model addresses diverse learning needs and promotes deeper understanding. Its applicability in low-resource settings further emphasizes its potential for broader implementation in similar educational contexts.

Significant Difference in the Mathematics Performance of Students Taught Using the Flipped Classroom Model and Traditional Instructional Methods

The results indicate a significant difference in the mathematics performance of students taught using the flipped classroom model and those taught through traditional instructional methods, with the flipped classroom group demonstrating higher performance in procedural fluency, problem-solving skills, and conceptual understanding in Patterns and Algebra. These findings suggest that the structure of the flipped classroom, where content exposure occurs prior to class and class time is devoted to active engagement, creates a more effective learning environment than conventional lecture-based instruction. In contrast, traditional approaches tend to limit students to passive reception of information, reducing opportunities for active processing and application of mathematical concepts.

From a theoretical standpoint, these findings are supported by constructivist learning theory, which emphasizes that knowledge is actively constructed through experience rather than passively received. The flipped classroom model aligns with this principle by enabling students to interact with content and engage in meaningful tasks during class. Furthermore, active learning theory explains the improved procedural fluency observed in the

flipped group, as students benefit from guided practice, immediate feedback, and continuous engagement. The enhanced problem-solving performance can also be explained by social learning theory, which highlights the importance of collaboration, discussion, and shared reasoning in developing higher-order thinking skills.

The higher procedural fluency demonstrated by students in the flipped classroom suggests that structured and supervised practice is more effective than independent practice alone. Immediate feedback and teacher guidance allow students to correct misconceptions as they arise, leading to more accurate and consistent execution of procedures. This implies that classroom time should be restructured to prioritize guided practice rather than extended lectures, particularly in mathematics where mastery requires continuous reinforcement and clarification.

In terms of problem-solving skills, the flipped classroom model provides opportunities for collaborative learning, reflective thinking, and strategy development. Students engage in discussions, justify their reasoning, and explore multiple approaches to solving problems. This contrasts with traditional instruction, where problem-solving is often completed independently with minimal support. These findings suggest that problem-solving is more effectively developed in interactive environments that promote dialogue and critical thinking. For instructional practice, this highlights the importance of designing tasks that encourage exploration, reasoning, and peer interaction.

The most notable difference between the two instructional approaches is evident in conceptual understanding. Students in the flipped classroom group demonstrated deeper comprehension of algebraic concepts, likely due to the integration of visual representations, contextualized examples, and interactive learning activities. These strategies enabled learners to connect abstract concepts to concrete experiences, making learning more meaningful. In contrast, students exposed to traditional instruction showed greater difficulty in grasping underlying concepts, which may be attributed to limited opportunities for active engagement. This suggests that conceptual understanding is best developed through experiential and student-centered learning approaches.

From a practical perspective, the findings demonstrate that the effectiveness of the flipped classroom model is not dependent on advanced technology. Unlike many studies conducted in technology-rich environments, this study shows that flipped learning can be successfully implemented in low-resource settings using accessible alternatives such as offline video lessons, printed modules, and mobile-friendly materials. This difference highlights the adaptability of the flipped classroom model and suggests that its success is largely driven by instructional design and teacher facilitation rather than technological resources.

The sustainability of the flipped classroom model in such contexts depends on teacher preparedness, availability of flexible instructional materials, and institutional support. Teachers must be equipped to design and facilitate student-centered learning experiences, while schools should promote collaboration in developing and sharing resources. Additionally, materials should be reusable and adaptable to both digital and non-digital formats. These considerations imply that long-term implementation relies on pedagogical flexibility and contextual responsiveness rather than reliance on technology alone.

The findings of this study are consistent with existing literature. Similar to Hung (2021), the results indicate that flipped classrooms enhance conceptual understanding through active engagement and peer interaction. Likewise, Li and Chen (2022) found that student-centered approaches improve procedural fluency and problem-solving skills, which supports the higher performance observed in the flipped classroom group. The use of interactive and experiential strategies also aligns with Al-Samarraie et al. (2023), who emphasized their role in improving learner motivation and conceptual retention. Furthermore, the increased engagement and confidence among students reflect the findings of Baepler et al. (2020), who reported that flipped learning promotes active participation and self-efficacy.

However, in contrast to studies that rely heavily on digital platforms, this study demonstrates that similar positive outcomes can be achieved using low-cost and context-appropriate resources. This distinction underscores the importance of adapting instructional strategies to the local context and reinforces the idea that effective teaching is not solely dependent on technology.

Overall, the observed difference in performance between the two groups suggests that the flipped classroom model provides a more comprehensive and effective instructional framework than traditional methods. By promoting active learning, collaboration, and meaningful engagement, the model enhances both academic performance and deeper understanding. These findings imply that educators should consider adopting and adapting flipped classroom strategies, particularly when teaching complex and abstract mathematical concepts, to create more responsive and effective learning environments.

Teachers' Experiences Using the Flipped Classroom Model

The analysis of teachers' experiences implementing the flipped classroom model revealed several interconnected themes reflecting both instructional transformation and professional growth. A key finding was the significant shift in teachers' roles from being primary sources of knowledge to facilitators of learning. Instead of relying on lecture-based instruction, teachers guided students in exploring concepts, engaging in discussions, and applying problem-solving strategies during class time. This transition required teachers to become more flexible and responsive, particularly in managing collaborative activities, integrating game-based tasks, and sustaining student engagement. In practice, this suggests that effective flipped classroom implementation depends not only on instructional materials but also on the teacher's ability to facilitate active and student-centered learning environments.

Another important theme that emerged was the enhancement of teachers' Mathematical Content Knowledge (MCK). The process of preparing pre-class materials, anticipating possible student misconceptions, and designing varied instructional strategies encouraged teachers to revisit and deepen their understanding of mathematical concepts. This indicates that the flipped classroom model serves not only as a teaching strategy but also as a form of continuous professional development, where teachers refine both their content knowledge and pedagogical skills. In practical terms, this implies that teachers become more effective when they actively engage in lesson design and reflective practice rather than relying solely on prescribed instructional materials.

Improved lesson planning and instructional organization also emerged as a critical component of the flipped classroom experience. Teachers reported the need for more structured preparation, including the development of pre-class resources, aligned in-class activities, and assessment tasks that support learning objectives. While this initially increased preparation time, it ultimately led to more coherent and purposeful instruction. This suggests that careful planning is essential in flipped learning, as the success of classroom activities depends heavily on the quality and clarity of pre-class materials. Over time, the reuse and refinement of these materials can reduce workload and contribute to the approach's sustainability.

Teachers also utilized student interaction as a reflective tool for improving instruction. By observing students' responses, participation, and problem-solving processes during collaborative activities, teachers were able to identify misconceptions and adjust their teaching strategies accordingly. This highlights the importance of formative assessment within the flipped classroom, where real-time feedback and observation guide instructional decisions. In practice, this means that teachers are better able to tailor instruction to students' needs, resulting in more responsive and effective teaching.

Despite these positive outcomes, teachers encountered several implementation challenges, including inconsistent student engagement with pre-class materials, increased preparation time, limited access to technology, and managing active classroom environments. These challenges are particularly relevant in resource-constrained contexts, where not all students have equal access to digital tools or stable internet connectivity. To address these issues, teachers adopted practical strategies such as providing printed or offline materials, simplifying digital content for mobile access, establishing clear classroom routines, and preparing alternative activities when needed. These adaptations demonstrate that the flipped classroom model can be contextualized and made flexible, allowing it to function effectively even in resource-constrained settings.

In terms of sustainability, the experiences of teachers suggest that long-term implementation of the flipped classroom model requires institutional support, collaborative practices, and resource adaptability. Schools can support teachers by providing training, encouraging the sharing of instructional materials, and allocating time for collaborative planning. Additionally, developing reusable, low-cost instructional resources, such as printed

modules, offline videos, and activity guides, can help ensure the model remains practical and accessible. This indicates that sustainability is not solely dependent on technology but on the ability of educators to adapt strategies to their specific teaching contexts.

The findings of this study are consistent with existing literature on flipped learning. Previous studies have shown that flipped classrooms promote shifts in teaching roles toward facilitation and active learning (Hung, 2021), while also enhancing teachers' content knowledge and instructional practices (Li & Chen, 2022). The importance of structured planning and interactive strategies aligns with the work of Al-Samarraie et al. (2023), who emphasized that well-designed learning activities are critical to the success of flipped instruction. Furthermore, the challenges encountered by teachers, particularly regarding time, resources, and student preparedness, are similarly reported in studies by Baepler et al. (2020), highlighting the need for support systems and adaptive strategies. These corroborations strengthen the validity of the findings and confirm that the experiences observed in this study are consistent with broader trends in flipped classroom implementation.

Overall, the teachers' experiences demonstrate that the flipped classroom model fosters meaningful changes in instructional practices, enhances professional competencies, and supports student-centered learning. While challenges exist, particularly in resource-limited environments, the model's adaptability and teachers' strategic responses suggest it can be effectively sustained. These findings imply that successful implementation of flipped learning requires not only innovative instructional design but also continuous teacher development, collaborative support, and context-sensitive strategies.

Students' Experiences In Learning Through The Flipped Classroom Model

The analysis of students' experiences in learning through the flipped classroom model revealed several interconnected themes that highlight how this instructional approach supports active, self-directed, and meaningful learning in mathematics. One of the most prominent findings was the development of students' learning autonomy and responsibility. Through pre-class activities such as watching instructional videos, reviewing materials, and preparing questions, students became more accountable for their own learning. This shift from passive reception to active preparation suggests that students are more likely to engage deeply with content when they are given structured opportunities to take ownership of their learning. In practice, this implies that teachers should design pre-class tasks that are clear, purposeful, and manageable to encourage consistent student participation.

Another key theme was enhancing active engagement and conceptual understanding during in-class activities. Students reported that group discussions, guided problem-solving, and hands-on exercises helped them better understand mathematical processes and relationships. Unlike traditional instruction, where learners often follow procedures without fully grasping underlying concepts, the flipped classroom allowed students to interact with content, ask questions, and clarify misunderstandings in real time. This indicates that conceptual understanding is strengthened when students actively participate in constructing knowledge rather than passively receiving information. For classroom practice, this underscores the importance of designing interactive and inquiry-based activities that promote discussion and exploration.

The study also found that the flipped classroom model increased students' confidence and mathematical self-efficacy. As learners engaged in pre-class preparation and received support during in-class activities, they became more confident in solving problems, explaining their reasoning, and asking questions when needed. This suggests that confidence develops when students are provided with both preparation and support, allowing them to approach tasks with greater assurance. In practical terms, this highlights the value of creating a supportive classroom environment in which mistakes are treated as learning opportunities and students are encouraged to participate actively.

Another significant advantage identified by students was the flexibility of learning at their own pace. Access to instructional materials outside the classroom enabled students to revisit lessons, pause or replay videos, and spend more time on challenging topics. This self-paced learning approach allowed students to process information according to their individual needs, which is particularly beneficial in mathematics, where learners

often progress at different rates. This finding implies that providing flexible access to learning materials can help accommodate diverse learning styles and improve overall comprehension.

The role of collaborative learning and peer support was also evident in enhancing students' understanding and engagement. Working in groups allowed students to exchange ideas, explain concepts to one another, and clarify misconceptions through discussion. This not only improved comprehension but also reduced anxiety, as students felt more comfortable learning alongside their peers. The findings suggest that learning is more effective when it is socially supported and that peer interaction plays a crucial role in reinforcing understanding. For teachers, this emphasizes the importance of incorporating structured group activities and fostering a collaborative classroom culture.

In the context of limited resources, students' experiences demonstrate that the flipped classroom model can still be implemented effectively with accessible, low-cost alternatives. While some students may have limited access to internet connectivity or digital devices, learning materials can be provided through printed modules, offline videos, or mobile-friendly formats that require minimal data. Students can also share resources or access materials through community or school-based support systems. This suggests that the success of flipped learning does not depend entirely on advanced technology but on how well instructional strategies are adapted to the learners' context.

Sustainability of the flipped classroom model from the students' perspective depends on the continued availability of accessible learning materials, consistent teacher guidance, and opportunities for collaboration. Ensuring that materials can be reused, easily distributed, and accessed both online and offline can support long-term implementation. Additionally, fostering independent learning habits and peer support systems can help sustain engagement even in resource-constrained environments. These findings indicate that a contextualized and flexible approach is essential in maintaining the effectiveness of flipped learning over time.

The findings of this study are consistent with existing literature on flipped classrooms. Similar to Bishop and Verleger (2013) and Chen et al. (2020), students in this study demonstrated increased autonomy, deeper conceptual understanding, and improved confidence as a result of pre-class preparation and active in-class participation. The emphasis on interactive and collaborative learning aligns with Hung (2015) and Lo et al. (2019), who reported that student-centered approaches enhance engagement, higher-order thinking, and retention of mathematical concepts. Furthermore, the connection between student engagement and teacher facilitation supports findings by Zainuddin and Halili (2016), which highlight the role of flipped learning in improving both student outcomes and instructional practices. These corroborations strengthen the validity of the results and confirm that the observed student experiences are consistent with established research in the field.

Overall, the students' experiences indicate that the flipped classroom model provides a learner-centered and adaptable framework that enhances not only academic performance but also engagement, confidence, and independence. By promoting active participation, flexible learning, and collaborative support, the model addresses diverse learning needs and fosters a deeper understanding of mathematical concepts. These findings suggest that educators should continue to adopt and refine flipped classroom strategies, particularly in teaching complex topics such as Patterns and Algebra, while ensuring that implementation remains responsive to students' contexts and available resources.

Proposed Flipped Classroom Model

The proposed Contextualized Flipped Classroom Model for Grade 6 Patterns and Algebra was developed based on the study's findings and integrates both teacher and student experiences to improve learners' procedural fluency, problem-solving skills, and conceptual understanding in Mathematics. The model provides a structured instructional framework that supports effective teaching and promotes active student engagement.

Recognizing the importance of instructional readiness, the model begins with a teacher preparation stage that focuses on developing teachers' pedagogical and technological competencies needed to implement the flipped classroom approach. This stage addresses common challenges identified in the study, including lesson planning,

instructional pacing, learning materials preparation, and classroom management. By ensuring that teachers are adequately prepared, the model supports the effective facilitation of student-centered learning activities.

The model then incorporates a pre-assessment stage to determine students' baseline knowledge and identify learning gaps prior to instruction. Findings from the study revealed that students initially demonstrated relatively low conceptual understanding compared with their procedural and problem-solving abilities. Through diagnostic assessment, teachers can identify misconceptions and areas requiring additional instructional support, enabling them to design targeted learning activities that strengthen conceptual understanding.

The in-class learning stage focuses on promoting active engagement through hands-on learning activities, collaborative problem-solving, and game-embedded instructional tasks. These activities transform abstract mathematical concepts into concrete and interactive learning experiences, enabling students to explore patterns, test strategies, and deepen their understanding of mathematical relationships. Collaborative discussions and guided problem-solving further encourage students to explain their reasoning, build confidence, and develop stronger mathematical thinking skills.

To reinforce learning beyond the classroom, the model integrates independent pre-class and home learning tasks. These activities allow students to revisit instructional materials, practice mathematical procedures, and review lesson concepts at their own pace. This component promotes learner autonomy, responsibility, and self-regulated learning, helping students deepen their understanding and build confidence in solving mathematical problems.

The instructional process concludes with a post-assessment stage that evaluates students' progress following implementation of the flipped classroom approach. This assessment measures improvements in procedural fluency, conceptual understanding, and problem-solving skills, providing teachers with feedback on the effectiveness of the instructional strategies and identifying areas for further improvement.

An important feature of the proposed model is its adaptability to low-resource educational settings. Rather than relying exclusively on digital platforms, the model combines printed modules, interactive classroom activities, collaborative discussions, and selected digital resources. This flexible design ensures that the flipped classroom approach remains accessible and effective even in environments where technological resources may be limited.

Overall, by strategically integrating teacher preparation, diagnostic assessment, student-centered instructional activities, independent learning opportunities, and outcome evaluation, the proposed Contextualized Flipped Classroom Model offers a research-informed framework that addresses identified learning gaps and promotes a deeper understanding of Patterns and Algebra among Grade 6 learners.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Significant Difference in the Students' Mathematics Performance in Patterns and Algebra Before and After the Implementation of the Flipped Classroom Model

Based on the findings, it can be concluded that the implementation of the flipped classroom model significantly enhanced Grade 6 students' mathematics performance in Patterns and Algebra across procedural fluency, problem-solving skills, and conceptual understanding. Students demonstrated notable improvements in performing mathematical procedures accurately, applying problem-solving strategies effectively, and developing deeper comprehension of algebraic concepts, with all post-test gains found to be statistically significant. These outcomes affirm the study's theoretical grounding in constructivist learning, where knowledge is actively constructed through engagement, interaction, and meaningful learning experiences. The integration of pre-class preparation and interactive in-class activities enabled learners to move beyond passive reception toward active participation and knowledge construction.

Furthermore, the findings suggest that the contextualized flipped classroom model is sustainable beyond its use as a research intervention, as it can be adapted to varying classroom conditions, including resource-limited environments. The use of flexible, low-cost instructional materials, such as printed modules, offline videos, and collaborative learning strategies, enables the model to be implemented continuously without heavy reliance on

advanced technology. Sustainability is further supported by the development of teacher capacity, reusable learning resources, and student independence, which collectively contribute to the approach's long-term viability in real classroom settings.

It is therefore recommended that teachers adopt the flipped classroom approach in teaching Patterns and Algebra by integrating interactive, collaborative, and experiential learning activities that promote conceptual understanding. Teachers are encouraged to provide structured pre-class materials that support self-paced learning and to use diverse, accessible instructional resources suited to their context. Additionally, continuous assessment and reflective teaching practices should be employed to address students' learning needs and sustain engagement. Schools may also support implementation through professional development and collaborative resource sharing to ensure the effective and sustainable use of flipped learning in mathematics instruction.

Significant Difference in the Mathematics Performance of Students Taught Using the Flipped Classroom Model and Traditional Instructional Methods

The findings indicate that the flipped classroom model significantly outperforms traditional instructional methods in enhancing students' mathematics performance in Patterns and Algebra, particularly in terms of procedural fluency, problem-solving skills, and conceptual understanding. Students exposed to the flipped classroom approach demonstrated higher levels of accuracy, strategic thinking, and conceptual comprehension, with all differences statistically significant. These results affirm the study's grounding in constructivist and student-centered learning principles, where knowledge is actively constructed through engagement, interaction, and meaningful learning experiences rather than passive reception. The integration of pre-class preparation and interactive in-class activities enabled students to maximize learning time for application, discussion, and feedback, resulting in deeper understanding and improved performance compared to traditional lecture-based instruction.

Moreover, the results suggest that the flipped classroom model is sustainable and adaptable across varying instructional contexts, including those with limited technological resources. The approach can be effectively implemented with low-cost, flexible materials such as printed modules, offline instructional content, and collaborative classroom activities. Its sustainability is further supported by its emphasis on reusable learning resources, teacher facilitation, and student independence, which reduce reliance on continuous technological input and make the model viable for long-term classroom use.

It is therefore recommended that mathematics teachers adopt and contextualize the flipped classroom approach to enhance students' procedural, problem-solving, and conceptual competencies. Teachers are encouraged to integrate interactive and collaborative strategies, including guided discussions, hands-on and visual materials, and structured learning tasks that promote active participation and conceptual clarity. Additionally, the development of accessible pre-class materials and contextualized learning activities is recommended to support self-paced learning, peer interaction, and real-life application of mathematical concepts. Schools may further support this approach by providing professional development opportunities and fostering collaboration among teachers to ensure consistent and sustainable implementation.

Teachers' Experiences Using the Flipped Classroom Model

The teachers' experiences indicate that implementing the flipped classroom model led to significant transformations in instructional practices and professional development. Educators transitioned from traditional lecture-based teaching to a more facilitative and student-centered role, where they guided learners in exploring concepts, engaging in discussions, and applying problem-solving strategies. This shift supports the study's grounding in constructivist learning principles, emphasizing that knowledge is actively constructed through interaction, collaboration, and meaningful engagement. In addition, teachers reported enhanced Mathematical Content Knowledge (MCK), as the process of preparing pre-class materials, anticipating student responses, and designing varied instructional strategies required a deeper understanding of mathematical concepts. Improvements in lesson planning and resource development were also evident, as teachers adopted more structured and intentional approaches to organizing instruction.

Furthermore, teachers utilized student interactions as reflective tools to inform and refine their teaching practices. Observing students' responses, participation, and problem-solving processes enabled them to identify misconceptions and adjust instruction accordingly, resulting in more responsive and effective teaching. Despite these benefits, teachers encountered challenges related to student compliance with pre-class tasks, increased preparation time, and limited access to technology. However, these challenges were addressed through adaptive strategies such as providing alternative materials, simplifying instructional resources, and establishing clear classroom routines.

The findings suggest that the flipped classroom model is sustainable beyond its implementation as a research intervention, as it promotes the development of reusable instructional materials, strengthens teacher facilitation skills, and encourages reflective teaching practices. Its adaptability to low-resource contexts, through the use of printed materials, offline content, and collaborative activities, further supports its long-term viability in diverse educational settings.

It is therefore recommended that teachers gradually adopt the flipped classroom approach with adequate support in instructional design, time management, and context-appropriate technology integration. Professional development programs should focus on enhancing facilitation skills, developing engaging and accessible pre-class materials, and designing interactive, student-centered classroom activities. Teachers are also encouraged to continuously use student feedback and classroom interactions as bases for reflective practice, enabling them to adjust instruction, provide differentiated support, and address learning gaps. Additionally, the preparation of contingency plans and the use of flexible, low-cost resources are recommended to ensure effective and sustainable implementation of flipped learning regardless of technological constraints.

Students' Experiences In Learning Through The Flipped Classroom Model

The experiences of the Grade 6 students indicate that the flipped classroom model significantly enhanced their learning in Mathematics by promoting autonomy, active engagement, confidence, flexibility, and collaboration. These findings support the study's grounding in constructivist and learner-centered principles, where students actively construct knowledge through participation, interaction, and self-directed learning. Through structured pre-class preparation, students developed greater responsibility and accountability for their learning, while in-class activities such as guided practice, discussions, and hands-on tasks deepened their conceptual understanding and strengthened their problem-solving skills. The opportunity to learn at their own pace through accessible instructional materials further supported comprehension and retention, particularly for complex topics in Patterns and Algebra. Moreover, collaborative learning and peer support fostered a supportive learning environment that enhanced students' confidence, reduced anxiety, and encouraged active participation. These experiences demonstrate that the flipped classroom model effectively improves both the cognitive and affective dimensions of students' mathematical learning.

The findings also suggest that the flipped classroom approach is sustainable beyond its use as a research intervention, as it promotes independent learning habits, peer-supported learning, and the use of flexible and accessible instructional materials. Even in resource-constrained contexts, the model can be maintained through printed modules, offline content, and collaborative classroom strategies, ensuring that all learners can benefit regardless of their technological access. The development of student autonomy and self-regulation further contributes to sustainability, as learners become less dependent on direct instruction and more capable of managing their own learning.

It is therefore recommended that teachers continue integrating flipped classroom strategies into Mathematics instruction to further develop students' autonomy, engagement, and conceptual understanding. Educators are encouraged to provide structured and accessible pre-class materials, such as step-by-step instructional content and guided exercises, to support independent learning. The integration of collaborative activities, guided discussions, and hands-on tasks is also recommended to enhance understanding and problem-solving abilities. Additionally, teachers should monitor students' progress, provide timely feedback, and promote peer support to strengthen confidence and self-efficacy. Maintaining flexible pacing and utilizing context-appropriate, low-cost learning resources will further ensure inclusive and sustainable implementation of the flipped classroom model across diverse learning environments.

Proposed Flipped Classroom Model

This study developed a Contextualized Flipped Classroom Model for Grade 6 Patterns and Algebra, based on findings from implementing flipped learning strategies and the experiences of both teachers and students. The results indicated that integrating structured instructional stages, including teacher preparation, diagnostic assessment, interactive in-class activities, independent learning tasks, and post-assessment, contributed to improvements in students' procedural fluency, problem-solving skills, and conceptual understanding in Mathematics.

The findings revealed that conceptual understanding was initially the weakest area among the learners, highlighting the need for instructional strategies that promote deeper mathematical thinking rather than focusing solely on procedural skills. The integration of game-embedded activities, hands-on learning tasks, and collaborative problem-solving provided students with opportunities to actively explore mathematical patterns and concepts, thereby strengthening their engagement, confidence, and understanding.

Furthermore, the results emphasized the importance of teacher preparedness in successfully implementing the flipped classroom approach. Adequate preparation in instructional design, classroom facilitation, and the use of interactive learning strategies enabled teachers to effectively guide students toward meaningful learning experiences.

Another significant finding was the value of independent learning opportunities. Allowing students to review lessons and practice skills outside the classroom supported self-paced learning, encouraged autonomy, and reinforced conceptual understanding.

Based on the study's findings and conclusions, several recommendations are proposed to support the effective implementation of the Contextualized Flipped Classroom Model in mathematics instruction.

First, mathematics teachers may adopt a contextualized flipped-classroom approach to improve students' conceptual understanding, procedural fluency, and problem-solving skills. Teachers are encouraged to integrate interactive activities, collaborative tasks, and game-based learning strategies to make mathematical concepts more engaging and meaningful for learners.

Second, school administrators and educational leaders may provide professional development opportunities that help teachers strengthen their competencies in flipped classroom instruction, particularly in instructional material development, classroom facilitation, and learner-centered teaching strategies.

Third, curriculum planners and program developers may consider incorporating contextualized flipped-learning approaches into mathematics instruction, especially for topics that require deeper conceptual understanding, such as Patterns and Algebra.

Fourth, schools with limited technological resources may still implement flipped learning by using printed modules, guided learning activities, and structured classroom interactions, ensuring that students benefit from active, student-centered instruction regardless of technological constraints.

Finally, future researchers may explore the application of the contextualized flipped classroom model to other mathematics topics or grade levels and investigate its long-term effects on students' mathematical achievement, motivation, and learning engagement.

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