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Enhancing Grade 8 Students' Mastery of Factoring Polynomials Through Interactive Multimedia

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***Abstract*—** This study explored the effectiveness of interactive multimedia on enhancing Grade 8 students' mastery of factoring polynomials. The research took place at Mapawa National High School with 60 students split evenly between two groups: the control group learned through traditional lectures and the experimental group accessed instruction via interactive multimedia. A quasi-experimental pretest-posttest design was used to evaluate student performance before and after the educational intervention. The multimedia intervention incorporated visual presentation, dynamic problem-solving with immediate feedback, scaffolding strategies, and adaptive learning pathways. Statistical tools such as class proficiency ratings, comparison of means, and t-tests were used to check the feasibility of the difference in the performance of the two groups. Pretests and posttests were administered to both groups. Pretest scores showed that control and experimental groups were comparable, with very close to a similar mean score, which represented a similar level of prior knowledge. Both groups exhibited a significant improvement in their posttest scores after the intervention; however, the experimental group registered a much higher gain score compared to the control group. The results affirm that although conventional teaching approaches can enable student advancement, the incorporation of interactive multimedia significantly enhances academic performance. This study therefore recommends the utilization of interactive multimedia as a means of enhancing mathematical achievement in the subject matter of mathematics, particularly in the teaching of abstract mathematics concepts such as polynomial factoring.

***Keywords*—** adaptive learning pathways, dynamic-problem solving with instant feedback, interactive multimedia, mathematics teaching, scaffolding, quasi-experimental design, visual presentation.

I. INTRODUCTION

In today's digital age, interactive multimedia has emerged as a powerful tool in education. It supports students' understanding of complex and abstract topics like factoring polynomials by providing visual presentations, dynamic problem solving with immediate feedback, scaffolding, and adaptive learning pathways. By making learning more engaging and interactive, it not only deepens conceptual understanding but also increases students' motivation to learn (Angraini & Fitri, 2023).

Globally, research shows that using interactive multimedia can significantly improve students' overall performance in mathematics. For instance, a study conducted in Indonesia by Nurmawati et al. (2020), with fourth graders utilizing interactive multimedia, revealed significantly better results than their counterparts taught through traditional means. The interactive multimedia provided visual presentation and text to ease understanding of some complex concepts in mathematics; it gave instant feedback for proper adjustments by the students, and it scaffolded learning through guided procedures. Although this study did not use the term adaptive learning, it employed adaptive principles by being responsive to the individual needs of the students. A further outcome of the study was that the students were engaged, motivated, and creative, which demonstrates the value of interactive multimedia as a powerful tool for math instruction.

Similar research was conducted by Zacal (2014) in the Philippine context pertaining to the effects of interactive multimedia instruction on the performance of junior high school students in Trigonometry at Daniel R. Aguinaldo National High School in Davao City. Findings showed that those students who received multimedia instruction achieved significantly higher post-test scores and learning gains than those who were instructed by traditional methods.

However, even with its success, the study was faced with a number of challenges, such as limited access to reliable technology and digital infrastructure, especially for schools that lacked a good computer laboratory setup (Atabek, 2019). Additionally, teachers experienced time constraints in preparing multimedia materials and reported inadequate training in effectively integrating digital tools for instruction (Cadizal, 2024).

Likewise, at Mapawa National High School, most Grade 8 students have difficulty factoring polynomials. The recent Mathematics Department assessment indicated that only 33 per cent of the students demonstrated understanding of this subject matter during Quarter 1.

In addition, classroom observations also suggest that most of the students are not well-equipped with the four core operations, making it even more difficult for them to grasp more complex matters such as factoring, which are based on firm foundational knowledge.

In response to these challenges, this research aims to enhance the proficiency of Grade 8 students in factoring polynomials by incorporating interactive multimedia into teaching and improving learning, motivation, and overall performance in mathematics.

Interactive multimedia, particularly developed with tools such as Lumi, offers engaged, student-centered experiences that integrate visual presentation, dynamic problem solving with immediate feedback, scaffolding, and adaptive learning pathways.

These platforms promote discovery, accommodate different learning styles, and make mathematical concepts less complex. By elevating the learning environment from passive to active, visual, and feedback-oriented, this study hopes to identify if employing interactive multimedia can significantly increase students' proficiency in factoring polynomials.

Theoretical Framework

This study is anchored on Jean Piaget's theory of cognitive constructivism (1952), where it is highlighted that students build their own knowledge and reality through experience and reflection on their experience. Piaget hypothesized that learning is an internal and constructive process that is determined by the interaction between previous cognitive structures (schemas) and new knowledge.

For Piaget, cognitive growth moves through a set of stages: sensorimotor, preoperational, concrete operational, and formal operational, each being a different mode of thinking.

For concrete operational-stage students (approximately 7–11 years old), such as Grade 8 students, thinking becomes more rational and systematic but is still extremely concrete.

Concrete operational-stage students are attuned to hands-on learning, visual demonstrations, and real-world problem situations that invite active engagement and significant construction of knowledge.

Cognitive constructivism centers on the structure of learning environments to facilitate discovery, exploration, and active participation in such a way that students are able to learn new concepts and assimilate them into their current knowledge set. Instructional approaches using interactive materials, collaborative work, and reflective thinking are facilitated by this theory and will certainly lead to increased learning and concept retention.

Within the framework of this study, Piaget's theory informs the implementation of interactive and student-active materials to help students build a higher meaning of abstract concepts like science or mathematics through discovery, self-monitoring, and idea revision.

Piaget's theory enlightens the construction of interventions to affect students' higher-order cognition by helping them interact actively with content, predict outcomes, test hypotheses, and revise ideas.

Thus, this theoretical framework serves as the foundation for pedagogical practice instruction and assessment, recognizing the learner as an active agent of his or her own cognitive growth, as defined by Piaget's meaningful learning.

The conceptual framework of this study, as illustrated in Figure 1, compares two instructional approaches: traditional discussion (control group) and interactive multimedia (experimental group).

The independent variable is the type of instructional method used, while the dependent variable is the students' mastery of polynomials, assessed through pretest and posttest results.

The interactive materials include visual presentations, dynamic problem-solving exercises with instant feedback, scaffolding techniques, and adaptive learning pathways, all aligned with Piagetian principles.

This structure highlights how varying levels of instructional interactivity impact conceptual understanding, consistent with cognitive constructivist ideals.

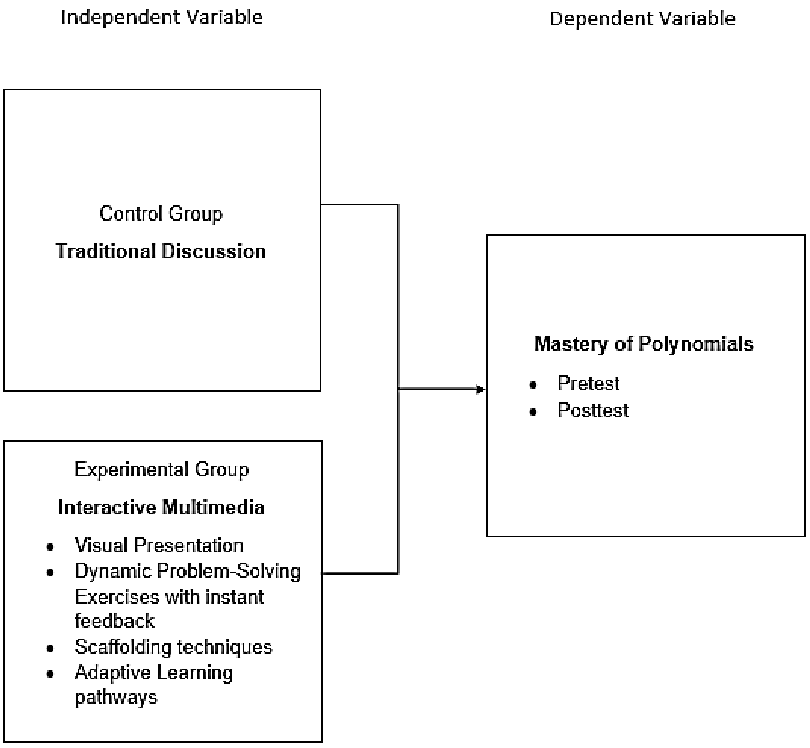

Figure 1. Conceptual Framework

Statement of the Problem

The purpose of this study was to determine the effectiveness of interactive multimedia as a teaching method in enhancing students' mastery of factoring polynomials of the grade eight students in Mapawa National High School of Maragusan East District, Division of Davao de Oro, for the school year 2024-2025.

Specifically, it sought to answer the following questions:

1. What is the class proficiency of the students as reflected in their pretest?
2. What is the class proficiency of the students as reflected in their posttest?
3. Is there a significant difference between the pretest and posttest mean scores of the control group?
4. Is there a significant difference between the pretest and posttest mean scores of the experimental group?
5. Is there a significant difference between the mean posttest scores of the students in the control group and experimental group?

Null Hypotheses

In order to treat the problems extensively and accurately, the following hypotheses were formulated:

HO_1. There is no significant difference between the mean scores of the pretest and posttest of the students in the control group.

HO_2. There is no significant difference between the mean scores of the pretest and posttest mean scores of the students in the experimental group.

HO_3. There is no significant difference between the posttest mean scores of the students in the control group and the experimental group.

Scope and Delimitation

This study is delimited to the investigation of the effectiveness of interactive multimedia on the competency of the students in factoring polynomials in the mathematics topic of Grade 8 students of Mapawa National High School. The study was done on a total of 60 students of the Sampaguita and Rafflesia sections of the school for the school year 2024–2025. These participants would be divided into two groups: a control group comprising 30 students and an experimental group of 30 students. The study is focused on specific strategies in polynomial factoring, including factoring by the greatest common monomial factor, the difference of two squares, the sum and difference of two cubes, perfect square trinomials, and general quadratic trinomials, in accordance with the Most Essential Learning Competencies (MELCs).

The intervention lasted for two weeks, from March 24 to April 11 of the year 2025, following the recommended duration in the MELC, and was implemented solely in the classroom. The experimental group was taught through the use of interactive multimedia, while the control group was taught the regular way. The research assessed students' performance based on an adopted pretest and posttest from the Department of Education's Alternative Delivery Mode (ADM) Quarter 1 – Module 1: Factoring Polynomials, which gauged their mastery level prior to and after the intervention.

Additionally, the research did not involve other topics in mathematics aside from factoring polynomials and did not consider long-term retention or the effect of prolonged usage of interactive materials because the research was meant to evaluate immediate results of learning within a set instructional time frame.

II. METHOD

A. Research Design

The quasi-experimental approach was utilized by the study in collecting data for the research. The quasi-experimental design was proposed by Donald T. Campbell for generalizing causal inference in cases where random assignment is not feasible. The study applied a two-group quasi-experimental pretest-posttest design in which both the control and experimental groups took pretests before and posttests after the intervention period (Oribhabor, 2020). The data were collected from the results of the pretest and posttest that had been given prior to and following the two-week treatment duration, which was intended to assess students' mastery of factoring polynomials.

B. Research Locale

The study was conducted in Mapawa National High School, a public secondary school in Barangay Mapawa, Maragusan, Davao de Oro, Philippines. As the largest school in the East District of Maragusan, it serves about 550 students and the K to 12 Basic Education Curriculum with Academic and Technical-Vocational-Livelihood strands.

It is committed to academic excellence and holistic learner development. It offers co-curricular and extracurricular activities such as journalism, scouting, and the Supreme Secondary Learners Government (SSLG). It is also renowned for its award-winning cultural dance company, Tribu Mapawa. It is closely linked with DepEd, local partners, and civic groups and continues to improve its facilities as well as implement programs such as the School-Based Feeding Program and Gulayan sa Paaralan to further improve students' learning and well-being.

C. Population and Sample

The subjects of the study were 60 Grade 8 students from Mapawa National High School, with 30 students assigned to the experimental group and 30 to the control group. These subjects were selected from the two Grade 8 sections, Sampaguita and Rafflesia, which are heterogeneous in terms of academic performance and learning capabilities.

Table 1
Subjects of the Study

Group	Total N	Total %
Control	30	50
Experimental	30	50
Total	60	100

For the research, these two sections were assigned to act as the experimental and control groups. Particularly, 30 students from Section Sampaguita were purposively chosen to constitute the experimental group, and 30 students from Section Rafflesia were purposively chosen as the control group. Both groups are equally matched, with each representing half the sample size of the total. This even distribution guarantees that the comparison between the control group, which adheres to the conventional teaching method, and the experimental group, which employs interactive multimedia, will be unbiased and credible.

D. Research Instrument

The instrument used for data collection in this study was a 40-item multiple-choice test adapted from the Department of Education's Alternative Delivery Mode (ADM) – Quarter 1, Module 1: Factoring Polynomials. The test covered essential factoring concepts such as factoring the greatest common monomial factor, difference of two squares, perfect square trinomials, sum and difference of cubes, and general quadratic trinomials.

Before developing the test items, a Table of Specifications (TOS) was constructed to ensure appropriate distribution of questions across various cognitive levels, as prescribed by the Revised Bloom's Taxonomy. Both the experimental and control groups took the same validated test before and after the intervention, allowing for a comparison and assessment of the effectiveness of the interactive materials in reinforcing students' proficiency in factoring polynomials.

E. Data Collection

To conduct this study, the following steps were considered by the researcher:

The thesis proposal, which included Chapters 1 and 2, was first submitted to the Ethics Committee for review to ensure that the research adhered to established ethical standards. Following this, the research instrument, accompanied by a Table of Specifications (TOS), was submitted for panel validation. A group of internal and external validators reviewed the instrument to evaluate its content accuracy, clarity, alignment with the Most Essential Learning Competencies (MELCs), and appropriateness in measuring the intended learning outcomes.

After validation, the researcher prepared and submitted an authorization letter requesting permission to conduct the study. This letter was initially submitted to the Schools Division Superintendent's Office of Davao de Oro and, upon approval, was endorsed to the District Head of Maragusan East and the Principal I of Mapawa National High School, where the study was implemented. Once official approval was secured, the researcher sought consent from the participating students and their parents or guardians. Informed consent was obtained after explaining the study's purpose, procedures, and voluntary nature of participation, ensuring ethical transparency and respect for participants' rights.

A pilot test of the research instrument was conducted among students who were not included in the actual study to assess the reliability of the test. After ensuring the instrument's reliability, all necessary materials were organized and prepared, including the validated research instruments, five interactive multimedia for the experimental group, and five corresponding lesson plans for the control group.

Both the experimental and control groups took a pre-test to establish baseline data on their proficiency in factoring polynomials. During the two-week intervention, the control group received conventional instruction using textbooks, lectures, and standard exercises, while the experimental group engaged with the interactive multimedia developed by the researcher using Lumi. On the last day of the intervention period, both groups were administered the same post-test to measure learning gains and determine the effectiveness of the interactive multimedia in improving students' mastery of factoring polynomials.

C. Statistical Tool

The data were structured and compiled in order to produce readable findings. In order to accurately analyze and interpret the various data collected in this study, SPSS was utilized, and the following statistical tests were used.

Mean. The mean was computed to determine the level of mastery of each student in both the control and experimental groups based on their pre-test and post-test scores in factoring polynomials.

Class Proficiency. Class proficiency levels were determined by interpreting the average scores of each group based on the Department of Education's proficiency scale. This helped categorize student performance into levels such as Outstanding, Very Satisfactory, Satisfactory, Fairly Satisfactory, and Did Not Meet Expectation.

T-Test. T-tests were conducted to determine whether there was a significant difference between the pre- and post-test scores within each group and between the two groups.

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Paired T-Test. This test was used to compute the t-value between the pre-test and post-test scores within each group. It aimed to determine if there was a significant difference in students' scores after the intervention.

Independent T-Test. This test was used to compute the t-value between the post-test scores of the control and experimental groups. It aimed to determine whether a significant difference existed between the two groups' performances after the intervention.

III. RESULTS

This chapter presents the findings, analysis, and intervention based on the study conducted. Data is given in tabular as well as textual forms. Inferential results were tested and interpreted at a significance level of 0.05. Data and preliminary information have also been shown as a basis for the computation, as well as interpretations of the results. These results were calculated employing SPSS software.

Competency Level of the Pretest Scores of the Groups

Table 2
Competency Level of the Pretest Scores of Control and Experimental Group

Pre-test	No. of Students	Mean	Class Proficiency	Competency Level
Control	30	11.70	29.25%	Did Not Meet Expectation
Experimental	30	11.73	29.33%	Did Not Meet Expectation

The above table indicates the performance level of the students prior to studying in the two groups. Both groups have 30 students as subjects of the study. Class proficiency indicates that the experimental group achieved 29.33%, and the control group, which achieved 29.25%, but both groups failed to reach the expected competency level. Control and Experimental have a mean score of 11.70 and 11.73, respectively. The two groups have a mean score difference of 0.03. It indicates that the groups are comparable.

Competency Level of the Posttest Scores of the Groups

Table 3
Competency Level of the Posttest Scores of Control and Experimental Group

Pre-test	No. of Students	Mean	Class Proficiency	Competency Level
Control	30	14.60	36.50%	Did Not Meet Expectation
Experimental	30	19.23	49.08%	Did Not Meet Expectation

The above table indicates the performance level of the students after the intervention was administered to the two groups. Class proficiency reveals that the experimental group achieved 49.08%, while the control group obtained 36.50%. Despite the higher-class proficiency in the experimental group, both groups did not meet the expected competency level. The experimental group's mean score was 19.23, while that of the control group was 14.60. The difference between mean scores of 4.63 indicates that the experimental group outperformed the control group and that there was a positive effect of the intervention employed.

Difference between the mean scores of the pretest and posttest mean scores of the students in control group

Table 4
Comparison of the Achievement of the Students in the Control Group

	Mean	p-value	Decision
Pretest	11.70	0.000	Significant
Posttest	14.60		

The table shows a comparison of the achievement of the students in the Control Group. The average reveals that the pretest achieved 11.70 and the posttest achieved 14.60. Thus, the p-value is 0.000 less than 0.05, so the decision is significant. There is strong evidence against the null hypothesis. Thus, the null hypothesis was rejected, and it confirms there was a difference between the achievements of the students when teaching factoring polynomials using the conventional method (chalk and talk).

Difference between the mean scores of the pretest and posttest mean scores of the students in the experimental group

Table 5
Comparison of the Achievement of the Students in the Experimental Group

	Mean	p-value	Decision
Pretest	11.73	0.000	Significant
Posttest	19.23		

The table indicates the comparison of the performance of the students in the Experimental Group. The mean indicates that the pretest achieved 11.73 and the posttest achieved 19.23. Consequently, the p-value is 0.000 below 0.05, which indicates that the decision was significant. There is very strong evidence against the null hypothesis. Hence, the null hypothesis was rejected, and there was a significant difference between students' mastery when using interactive multimedia to teach factoring polynomials.

Difference between the posttest mean scores of the students in control group and the experimental group

Table 6
Comparison of the Achievement of the Students between the Control and Experimental Group

Posttest	Mean	p-value	Remarks
Control	14.60	0.005	Significant
Experimental	19.23		

Table 6 indicates the performance level of the students after the study of the two groups. An independent t-test was conducted to determine the difference between the two groups' posttest. The mean verifies that the Control Group scored 14.60 while the Experimental Group scored 19.23. The p-value is 0.005, which is less than 0.05, verifying that it is significant. The null hypothesis was thus rejected, and there was a significant difference in the students' achievements between the experimental and the control group as indicated on their posttest scores.

IV. DISCUSSIONS

Competency Level of the Pretest Scores of Control and Experimental Group.

Pretest scores of the control and experimental groups show a low level of proficiency in factoring polynomials, with the experimental group scoring slightly higher. These are low levels of skill and indicate that a majority of the students have a minimal background in the basics of factoring. This is no surprise when considering the wide range of underlying learning difficulties inherent to learning algebra.

As per Didis and Erbas (2015), students are likely to have difficulty with factoring because of a lack of understanding of the structural characteristics of quadratic expressions, which causes confusion in identifying patterns or the use of the right techniques. Likewise, Burhanzade and Aygör (2015) pointed out that most students have procedural misconceptions and mistakes in algebra, such as confusion regarding the distributive property or the zero-product property, which are crucial in factoring procedures. These cognitive barriers result in low performance and suggest the need for more supportive and effective instructional strategies.

Other research supports the observation that factoring polynomials is extremely difficult for students. For instance, Wahyuni et al. (2020) established that secondary school students tend to struggle to shift from arithmetic to algebraic thinking, especially when performing factorization problems, because variables are abstract. In like manner, a study conducted by Simanski (2023) revealed that students fail to recognize efficient factoring strategies and employ a trial-anderror strategy with no understanding of the principles. The findings highlight the significance of conceptual knowledge and strategic thinking instruction interventions in the learning of factoring polynomials.

Competency Level of the Posttest Scores of Control and Experimental Group.

Posttest scores showed that there was a significant difference between the performance of the experimental and control groups, which was the result of the differential instructional strategies used in learning factoring polynomials. The experimental group that employed interactive multimedia showed greater improvement in performance compared to the control group that was taught with non-interactive strategies. This indicates that interactive strategies may be used to enhance an in-depth understanding of algebraic principles. Etyarisky and Marsigit (2020) also reported the same results, stating that students instructed by interactive learning multimedia demonstrated large positive gains in math performance and motivation.

Although there was improvement as indicated, both groups remained at the "Did Not Meet Expectations" level of competency. This demonstrates that most students did not master the skill fully, even though gains were made on posttests. The finding suggests that although interactive materials improve learning, they cannot necessarily fill all learning deficits of students without extra teaching assistance. Good mathematics teaching is more than motivating content; it is active learning that incorporates cognitive, social, and physical aspects. Understanding that learners acquire knowledge differently, active processes like teamwork activities and mobility help deepen understanding, promote reflection, and develop a friendly setting for learning mathematical concepts (Vale & Barbosa, 2023).

Some of the reasons why there was an inappropriate level of competency could be students' poor foundational skills in algebra, minimal time being dedicated to concept reinforcement, and the fairly short intervention period. As de Boer et. al (2014) assert, the instructional intervention's effectiveness depends largely on its duration and intensity, as longer and more intensive interventions have been found to lead to greater gains in students' learning outcomes. In addition, a lack of differentiated instruction could have prevented some of the students from completely understanding the content, according to Onyishi and Sefotho (2020), who posited the need for addressing the unique needs of students in inclusive classrooms.

However, the enhanced posttest achievement of the experimental group confirms the application of student-centered and interactive instructional practices in increasing mathematical comprehension. Murad et al. (2019) reported that the students involved in technology-enhanced learning environments not only performed better but also showed higher levels of motivation and enthusiasm. The findings indicate the potential of interactive materials in positively influencing the academic performance of students.

Comparison of the Achievement of the Students in the Control Group.

The control group, which received traditional instruction, did show some improvement in their understanding of factoring polynomials, but the progress was relatively modest. While this suggests that conventional teaching methods can lead to learning gains, the overall impact on students' mastery of the topic was limited. This outcome is not entirely unexpected, given the nature of traditional instruction, which often relies heavily on lectures, memorization, and repetitive drills.

There are several likely reasons why the improvement was minimal. Traditional methods tend to follow a one-size-fits-all approach that may not align with the diverse learning styles present in a classroom. Some students may struggle to stay engaged or to connect abstract mathematical procedures with real understanding. Lessani et al. (2017) found that students taught using discovery learning and problem-solving strategies significantly outperformed those who were taught through conventional methods, highlighting the limitations of passive instruction when it comes to building deep, transferable mathematical knowledge.

Moreover, the lack of interactivity in traditional instruction can hinder student engagement and participation. Learning becomes something done to students rather than something experienced with them. Ghavifekr et al. (2015) emphasized that integrating technology into lessons can foster greater interaction and improve learning outcomes, particularly in subjects like mathematics that benefit from visual and hands-on approaches. When students are not actively involved in constructing their own understanding, their learning can be shallow and short-lived.

Comparison of the Achievement of the Students in the Experimental Group.

The experimental group, which was taught using interactive teaching materials, showed a marked improvement in their performance in factoring polynomials. While their pre-test results indicated limited prior knowledge and low proficiency, the post-test scores revealed substantial gains after the intervention. This improvement suggests that the use of engaging, hands-on learning tools can have a powerful impact on students' understanding of complex algebraic concepts.

This outcome aligns with the findings of Decker-Woodrow et al. (2023), who reported that students using game-based learning platforms like DragonBox 12+ demonstrated significantly higher achievement in algebra post-tests compared to those who received traditional instruction. The game's interactive design, immediate feedback, and progressive challenges likely contributed to deeper learning and sustained motivation. Similarly, Montales (2023) found that Grade 8 students who learned factoring through Problem-Solving Maps, a visual and student-centered method, outperformed peers taught with conventional strategies. These students not only solved problems more accurately but also reported a better understanding of the logic behind each step.

Interactive multimedia tends to create a more stimulating classroom environment by encouraging active participation, critical thinking, and collaboration (Etyarisky & Marsigit, 2022). Unlike static textbook methods, these tools often include visual aids, digital platforms, games, or manipulatives that make abstract concepts more accessible (Ukaigwe & Goi-tanen, 2022). They also offer students multiple ways to approach a problem, catering to different learning styles and helping to build confidence through exploration and self-discovery (Montales, 2023).

Comparison of the Achievement of the Students between the Control and Experimental Group.

The result of the study reveals a substantial difference in the learning attainment of the experimental and control groups. The control group, which was exposed to conventional teaching methods, recorded only a small improvement in their performance from the pre-test to the post-test. This slight progress suggests that while traditional instruction may provide some educational benefit, it may not always be sufficient in helping students deeply engage with and understand complex algebraic concepts like factoring polynomials.

One possible reason for this is that conventional methods often rely heavily on direct instruction, rote memorization, and repetitive exercises. While these strategies can reinforce basic skills, they may not engage students at a deeper conceptual level (Lessani et al., 2017). As a result, students might struggle to apply what they've learned in unfamiliar or more complex problem-solving situations (Didis & Erbas, 2015). The limited interaction and student-centered engagement in traditional instruction may also contribute to reduced motivation and participation (Ghavifekr et al., 2015).

In contrast, the experimental group taught using interactive multimedia demonstrated a significant improvement in their performance from the pre-test to the post-test. These tools provided students with dynamic opportunities to interact with the content, offering immediate feedback, interactive problem-solving environments, and visual representations of abstract mathematical ideas. These features may have contributed to a more thorough understanding of factoring.

Supporting evidence from related studies strengthens this observation. Nurmawati et al. (2020) found that interactive multimedia significantly improved students' mathematical performance and motivation in algebra. Likewise, Ukaigwe and Goi-tanen (2022) noted that computer-aided instruction resulted in better academic outcomes in mathematics, largely due to increased student participation and the ability for learners to work at their own pace.

V. CONCLUSIONS

The findings reveal that the application of interactive multimedia significantly improves students' performance and understanding in mathematics, especially in factoring polynomials. Both the experimental and control groups started with the same low mastery levels, as indicated by their pre-test scores. But the experimental group, who learned with the assistance of interactive multimedia, achieved a much greater increase in post-test score compared to the control group, who learned with the conventional method of instruction.

This implies that the use of traditional pedagogical techniques alone might not be adequate to enable students to learn abstract algebraic concepts. Interactive multimedia utilizing visual support, instant feedback, adaptive learning paths, and problem-solving activities can enhance student motivation, conceptual knowledge, and academic performance.

Thus, teachers are urged to use interactive and student-oriented pedagogies to make abstract mathematical concepts more accessible, interactive, and effective for secondary school students. The results of this study support the continued application of technology-enhanced resources within the mathematics classroom to facilitate greater understanding and enhanced learning achievements.

VI. RECOMMENDATIONS

Based on the conclusions derived from the findings of the study, the following recommendations are hereby presented:

1) Teachers must incorporate interactive resources such as visual tools, dynamic problem-solving tools, and adaptive exercises into standard math lessons to further enhance student interaction and conceptualization of algebra content, such as factoring polynomials.

2) Professional development courses should be provided to teachers to enable them with the skills and capabilities to include interactive and digital learning materials effectively.

3) Educational institutions and curriculum developers need to develop and provide interesting learning materials aligned with the K–12 curriculum to be used in subject matter presentation.

4) Future research and pedagogy would need to extend the application of interactive material to other challenging math topics (e.g., rational expressions, quadratic equations) and determine whether they are effective in enhancing overall mathematical ability.

5) Instructors and researchers could also provide delayed post-tests or retention tests to assess the long-term effect on students' proficiency in factoring and other algebraic manipulations.

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