

Development of a Board Game as an Innovative Learning Tool to Enhance Students' Skills in Factoring Polynomials

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Abstract: *This study developed and evaluated a board game as an innovative instructional tool to enhance Grade 8 students' skills in factoring polynomials at San Francisco National High School during the School Year 2025–2026. Using a quantitative quasi-experimental approach, specifically the one-group pretest–posttest design, the study measured students' performance before and after the implementation of the board game. The 25-item test adopted from the Department of Education Mathematics 8 Module 1A served as both the pretest and posttest, focusing on factoring common monomial factor, difference of two squares, and the sum and difference of two cubes. Descriptive statistics and a paired t-test were used to analyze the data. Results revealed that students initially demonstrated low mastery of factoring polynomials, with a pretest mean score of 76%. After the board game intervention, the posttest mean significantly increased to 87%, indicating improved understanding and problem-solving skills. The paired t-test result ($t = 12.40, p < 0.05$) led to the rejection of the null hypothesis, confirming a significant difference between pretest and posttest scores. Observations during implementation also showed increased student participation, collaboration, and confidence while engaging in the board game activities. Based on these findings, the developed board game proved to be an effective, low-cost, and interactive instructional material aligned with the K to 12 Curriculum. It is recommended that teachers integrate similar game-based strategies in teaching algebra to enhance engagement and learning outcomes. Future studies may include a control group, larger sample size, and extended intervention period to further validate the effectiveness of board game-based learning in mathematics.*

Keywords: board game, factoring polynomials, Grade 8 mathematics, quasi-experimental design, game-based learning

1. Introduction

Mathematics is among the most tricky subject to most learners especially in topics like factoring of polynomials. Despite the numerous efforts that have been put to improve teaching and learning processes, several students still find it difficult to practically implement the mathematics concepts. This leads to the significance of innovative methods of teaching mathematics in order to make it more interesting.

Challenges in Mathematics Learning and National Performance

The success of the Filipino students in mathematics has remained an issue. According to OECD's Program for International Assessment 2022 results, only 16% of the Filipino students reached at least Level 2 proficiency in mathematics. It means many of the students struggle with basic problem-solving tasks and simple mathematical processing. The Philippines also ranked sixth-lowest in mathematics and reading. It shows that Filipino students are behind compared to students from other countries.

According to Alexander Socalit, a senior education program specialist at the Department of Education (DepEd), Filipino learners are behind by about five to six years of schooling compared to other countries. This gap has created difficulties in teaching mathematics especially in algebra and polynomials. The country's results in the 2022 cycle also showed very little improvement from the 2018 Program for International Assessment performance, which results in the urgency of addressing this issue.

Research from different settings supports the idea that game-based learning can help improve mathematics performance. For an instance, Gomez et al. (2023) reviewed several game-

based assessments and found that many studies used games to measure STEM content, cognitive skills, and soft skills. Lozano et al. (2023) also created a mobile game using the Octalysis framework to help learners practice mathematical patterns and structures. Together, these literature and studies justify exploring innovative strategies, such as game-based learning, to improve students' mathematical proficiency.

Effectiveness of Game-Based Learning in Mathematics

To improve both student engagement and understanding in mathematics, game-based learning can be a very effective way. Smith & Golding (2018) emphasize that board games often encourage learners to think critically, make decisions, and reflect on the outcomes of their actions. These activities help develop problem-solving skills that are important in algebra. Studies also suggest that games make learning more engaging and interesting. Using games creates a more engaging learning experience which can increase students' motivation and participation, according to Pramuditya et al. (2018). In the same way, as it is observed by Botes (2022), the abstract concepts can be made more accessible and help students easier grasp the information through interactive and meaningful activities like board games.

There are researches that support the beneficial effect of game-based learning. The review of many interventions in the field of science, technology, engineering, mathematics, and education conducted by Gomez et al. (2023) indicated that the use of games to enhance cognitive and analytical abilities is effective. Lozano et al. (2023) designed a mobile game to practice mathematical patterns that increased the engagement and improved the performance. Using the Planning-Action-Observation-Reflection cycle, Yonwilad et al. (2025) created a board game, which enhanced engagement and

understanding of mathematical concepts in junior learners in high schools.

It is possible to merge literature and empirical research, and it becomes obvious that learning through board games can improve, as well as promote collaborative learning. According to Smith and Golding (2018), peer learning takes place through the discussion and the teamwork within games. Pramuditya et al. (2018) explain that math anxiety is reduced by fun activities that usually impair performance. As Yonwilad et al. (2025) affirm, properly designed game interventions have the potential to increase enthusiasm and success. These sources can be taken together which confirms the idea to use board games as one of the promising strategies to enhance the knowledge of the students on the complicated matters within mathematics.

Board Games as an Intervention for Factoring Polynomials

Although the general game-based learning is widely researched, not many interventions are aimed at the factoring of polynomials. Constructivism theory suggests that learners learn by experience, and John Dewey believes that practical lessons are the best way to learn. Enhanced Basic Education Act of 2013 (RA 10533), and the K-12 Mathematics Curriculum further stress that approaches need to be learner-centred and that learning algebraic skills is important. These papers contain the factoring of common monomials, the difference of two squares and the sum and difference of two cubes. This literature reiterates the importance of instructional tools that must be interactive, accessible, and relevant to the curricular standards.

Board games have been shown to be effective in algebra learning using empirical studies. Another example is the board game made by Andini and Yunianta (2018) and called The Adventure of Algebra, using the ADDIE model, significantly enhanced the student interest and algebraic skills. Phanphon et al. (2023) established that the students who played math-based board games scored better than the students who were taught through conventional methods. Yonwilad et al. (2025) also specified that structured board games enhanced involvement and interest of the participants in problem-solving activities proving that games can have a beneficial effect on the learning process even in relatively less advanced technological environments.

The teaching of factoring of polynomials with the use of board games overcomes the issue of engagement and accessibility. This is effective in constructivist and experiential learning theories where learners take advantage of the active exploration and reflection process. Students are able to experiment with strategies and learn by themselves, as they manipulate algebraic expressions at any point and make mistakes without detriment in the game. Such approaches are also consistent with the DepEd Order No. 8, s. 2015, which promotes formative assessment. Altogether, incorporating a board game into mathematics education is a low-budget, feasible and efficient approach that can help learners to master the process of factoring polynomials and make the learning process enjoyable.

2. Present Study

The associated research all underscores the use of educational games as means of improving mathematical performance of students. Other studies established that students who used board games were more motivated, engaged, and demonstrated higher levels of skills than their peers who were taught through the conventional methods. The latter games convert abstract mathematical ideas into concrete and participatory challenges by making them more relevant. Specifically, a study in a junior high school and a senior high school environment found that tools based on board games helped students to practice more complex algebraic operations as they offered a certain level of control, the possibility of making decisions, and instant feedback.

Other studies created board games based on the principles of algebraic reasoning, and they used the models of ADDIE or PAOR to assess their performance. Generally, these studies indicated positive results, not only academic but also confidence and interests of learners. Informal assessment tools such as educational board games can also be used, as the teacher can determine how students think when they are playing.

Nonetheless, the majority of the existing research is focused on general algebra, simple operations, or patterns. Few of the board games are explicitly aimed at the factoring of polynomials, and few still aimed at Grade 8 students in the Philippine setting. There are also studies that are based on digital tools, and these tools are not always available in the general schools.

These gaps indicate that there is a necessity to create a non-digital board game, which is affordable and directly aligned with Grade 8 factoring skills. That is the need this study will satisfy because it will create a board game that is based on the curriculum and responsive to the needs of the students learning polynomials. It provides a contextualized educational tool that allows an instructor and a student to address one of the more challenging topics in algebra.

This research paper is dedicated to the creation and testing of a board game as a didactic activity to teach the concept of factoring the polynomials to Grade 8 students of the San Francisco National High School of the school year of 20252026. It dealt not only with the chosen topics of factoring, common monomial factors, difference of two squares, sum and difference of two cubes, but omitted other lessons in algebra. The assessment was determined with the help of pre- and post-tests, which were found in the textbook. Only Grade 8 of one section of the school was used in the study, which disqualified other grade levels as well as learners in other schools. The researchers could not control other variables, including those associated with the classroom conditions, motivation of the students, or the effect of the teacher, which were not the focus of the study.

3. Objectives of the Study

This study aims to develop and evaluate a board game as an instructional tool for teaching factoring polynomials among Grade 8 students. Specifically, it aims to (1) determine the level of students' performance in factoring polynomials, (2)

develop a board game that will help students learn and practice factoring polynomials, and (3) determine the effectiveness of the board game using pre-test and post-test.

The study tests the following null hypothesis at a 0.05 level of significance. It proposes that there is no significant difference between the pretest and posttest scores of students before and after using the developed board game on factoring polynomials.

Definition of Terms

This section explains the key terms used in the study. The first part of each definition presents the conceptual meaning of the term based on established literature, while the second part describes how the term is specifically applied in this research. Only essential terms are included to help readers clearly understand the study's content.

Board Game. Conceptually, the board game is an educational tool, which makes learning easier by providing the form of play, clear rules, and the possibility of group or competition (Uribe and Cobos, 2022). In the current research, the term will be used to denote the instructional board game that the researcher will have created to help eighth-grade students train and perfect their abilities in factoring polynomials using guided and interactive methods.

Factoring Polynomials. According to College Algebra (OpenStax) defines factoring polynomials as the process of writing the expression as the product of simpler factors of a formula. With the focus of this study, it is the ability of the students to use methods like the factoring of a common monomial, the difference of squares, the sum and the difference of two cubes.

Engagement. Conceptually, engagement refers to the learners' active involvement in educational activities, which includes their behavior, thinking, and emotional investment—such as participation, mental effort, and interest (Lan & Hew, 2020). In this study, it relates to the Grade 8 students' level of motivation, focus, and participation while using the board game on factoring polynomials. This includes how attentive, interested, and involved they are throughout the gameplay and related class activities.

4. Methodology

This chapter discusses the research design, the participants and sources of data, the research instrument used, the procedures for data collection, and the methods employed for data analysis.

Research Design

This study was conducted to develop and evaluate the effectiveness of a board game in improving students' skills in factoring polynomials. To achieve this, a quantitative, quasi-experimental approach was used, specifically the one-group pretest–posttest design. This design was chosen because it allowed the researchers to observe and measure the impact of the board game in an actual classroom setting, where randomly assigning students to groups was not possible. By administering a pretest, the researchers were able to establish a baseline of students' skills, and the posttest allowed them to

determine how much learning occurred after using the board game. The main data collection instruments in this study were the students of the 8th grade of San Francisco National High School who played in the board-games. The results of the pretest and posttest provided them with first hand evidence of the board game in shaping their factoring polynomial skills.

Source of Data

The primary sources of data for this study were the Grade 8 students of San Francisco National High School who participated in the board game activities. Their performance in both the pretest and posttest provided direct evidence of how the board game affected their skills in factoring polynomials. Secondary sources were used to support the study and guide the development of the board game. These included the Mathematics 8 Module 1A: Factoring Polynomials (DepEd, 2021), which contains exercises, examples, and test items suitable for Grade 8 learners. This module served as the basis for the assessment instrument in this study.

Research Instrument

The main tool that has been used in this research was a test of 25 items on factoring polynomials given to the eighth-grade students as a pretest and as a posttest. The exam was taken over by the DepEd Mathematics 8 Module 1A: Factoring Polynomials (DepEd, 2021). As the questions were taken directly out of a formal DepEd module, they were already appropriated to the eighth-grade students, not to mention that they were corresponding to the lessons they already had to master.

The test contained questions on factoring a common monomial factor, the difference of two squares, and the sum and difference of two cubes which are the exact topics that were discussed in the module. The adoption of this DepEd based instrument made the assessment to be appropriate and fair to the students. The instrument has content validity since the items used in the test are borrowed items based on an official DepEd module as congruent with Grade 8 Mathematics Curriculum Guide. The fact that test items are aligned to the particular learning competencies is a guarantee that factoring skills of the students are measured properly by the assessment.

Data Collection

The sample on which the data of this study were gathered included the students of eighth grade of San Francisco national high school. The researcher had to seek permission with the school principal and the mathematics teacher before she could start the data collection process. They were provided with a clear explanation of the purpose of the study and the utilization of the board game and the tests. After receiving the approval, the researcher notified the students about the activity and promised them that the process would be voluntary and the information provided would not be disclosed to anybody.

Sampling was conducted in their normal classroom when they had a mathematics lesson. It started with the administration of the pretest which helped the researcher determine the level of initial proficiency of the students in factoring polynomials. The students were also presented with the instructional board

game that was prepared to carry out the study after the pretest. They had time to get familiar with the mechanics, then there were several sessions of guided gameplay where they practiced factoring by the activities incorporated in the board game. At the end of the period of intervention, the posttest was conducted with the same 25 items test which was taken up in the module of DepEd Mathematics 8. This made it easy to measure any improvement in the performance of students after using the board game. During data collection the researcher observed ethical practices; respected the privacy of the students, did not involve any coercion and all the activities were safe, fair and related to the learning objectives of the study.

Data Analysis

Both descriptive and inferential statistics were employed in the evaluation of quantitative data. The pretest and posttest scores of the students were summarized using frequency and mean in order to describe the level of performance of the students before and after using the board game. A paired - sample t -test was used to identify the statistical significance of the change in the scores because the sample used in both tests was the same group of eighth-grade students.

5. Results and Discussions

Results

In this chapter, the author explains the results of the research on the design and the effectiveness of the board game related to the improvement of skills of eighth-grade students in factoring polynomials. Descriptive and inferential statistics were used to analyze the data. Findings are presented based on the objectives of the research.

Level of Performance in Factoring Polynomials

Pretest Scores. Pretest scores of the forty eighth-grade students were compared in order to determine their first performance in factoring polynomials. The mean of students was found to be 76% as indicated in Table 1. The best score of 15 and the worst score of 5 marked uneven information on the previous understanding. The overall amount of pretest scores was 410.

Posttest Scores. Performance of the students in terms of performance in the 25-item test was used as the measurement tool after the board-game intervention. The maximum was 23 and the minimum was 8 with an overall amount of 681. All in all, the posttest scores were higher than the pretest scores and had more variability.

Table 1: Pretest Performance of the Students

Grading Scale	Pre- test		Description
	Frequency	%	
90-100	0	0%	Outstanding
85-89	0	0%	Very Satisfactory
80-84	7	17.5%	Satisfactory
75-79	19	47.5%	Fairly Satisfactory
Below 75	14	35%	Did Not Meet Expectation
Total	40	100%	
<i>Mean Performance</i>		76%	Fairly Satisfactory

Table 1 These results demonstrate that the majority of students used the scores between 75 - 89 and below 75 on the pretest. This indicates that most of the respondents had no basic knowledge of factoring polynomials before the intervention. There are very few students who scored within the 80-84 and no students scored outstanding.

Development and Implementation of the Board Game

The board game was created and implemented to provide the interactive and involving way of letting the students rehearse the factoring of polynomials. It was used in regular mathematics lessons, in which the learners were given some planned time to engage in guided gameplay. In these lessons, the students solved problems relating to common monomial factors, difference of two squares, and sum and difference of two cubes. It was observed that students were very active, collaborated and showed interest to complete tasks.

The board game was integrated well into the classroom and aligned to the DepEd Mathematics 8 Module 1A. Students could experiment with strategies, play around with algebraic expressions and debate on their solutions in a safe and controlled environment.

Table 2: Post-Test Performance of the Students

Grading Scale	Post-test		Description
	Frequency	%	
90-100	15	37.50%	Outstanding
85-89	13	32.50%	Very Satisfactory
80-84	5	12.50%	Satisfactory
75-79	4	10%	Fairly Satisfactory
Below 75	3	7.50%	Did Not Meet Expectation
Total	40	100%	
<i>Mean Performance</i>		87%	Very Satisfactory

Table 2 The results show that the performance of students has been significantly improved after the intervention of the board game. The majority of the respondents were in the 90-100 and 85 -89 scales indicating that they are more knowledgeable about the task of factoring polynomials compared to the pretest scores.

Effectiveness of the Board Game

To determine the effectiveness of the board game, a paired t-test was conducted to compare the pretest and posttest scores. Table 2 presents the statistical results.

Table 3: Paired t-test Result of Pretest and Posttest Scores (n = 40)

Statistical Basis	Statistical Analysis
Degree of freedom	39
Level of Significance	5%
t-critical value	2.04
Computed t-value	12.4
Decision on H ₀	Reject
Conclusion	Significant

Table 3 shows that the computed value of **12.40** exceeded the critical value of **2.04** at a 0.05 level of significance. Therefore, the null hypothesis was **rejected**, showing that there was a significant difference between the pretest and posttest scores

of students. This indicates that the board game was effective in improving students' skills in factoring polynomials.

This section reported the students' performance before and after the board game intervention, the implementation process, and the statistical analysis confirming the effectiveness of the tool. All findings are based strictly on the data collected.

6. Discussion

This chapter interprets and analyzes the findings presented in the Results section in relation to the objectives of the study. The results further discuss the student performance in the factorization of polynomials, the learning process of the students through board game intervention as well as the efficiency of the board game as a learning tool. The discussion also correlates the findings to the literature available and outlines their implication to practice and research.

Students' Performance in Factoring Polynomials Before the Intervention

The pretest findings show that students in Grade 8 have a problem factorizing polynomials. The majority of the students obtained less than half of the total test items with poor knowledge of common monomial factors, difference of two squares and sum and difference of two cubes. The given result aligns with the findings of international and national reports that indicate that Filipino learners perform poorly in mathematics and, in particular, in algebraic concepts (OECD, 2022; Sucalit, 2022).

The poor performance level indicates that students need a more formal instruction and practice until they get chances to handle the skills of factoring. This is aligned with the results of Andini and Yunianta (2018), who report that the algebraic knowledge of the students is enhanced when they are taught interactive and structured learning activities. The findings suggest that pretests are important in identifying the difficulties of learners in planning effective instructional interventions.

Students' Learning Experience During the Board Game Intervention

Students show the active participation, collaboration, and motivation during the board game activity. During play, learners will be involved in problem-solving, share the strategies with other learners, and make choices. The board game gives the students a learning experience by hands-on learning to practice factoring in a nurturing environment.

Such observations go in line with the experiential theory of learning developed by Dewey that is based on active participation and contemplation. The results is also indicative of Smith and Golding (2018), who report on the idea that board games help students to think critically and learn with their peer, and Pramuditya et al. (2018), who report the idea that fun learning activities alleviate mathematics anxiety and enhance the desire to solve difficult problems. It means that interactive tools like board games are able to enhance the interest and concentration of the students in the mathematics classes in this study.

Effectiveness of the Board Game in Improving Learning Outcomes

The posttest performance of the students indicates that there is a great improvement in the students performance following the board game intervention. The pretest mean score is 76% but the posttest means score is 87% and paired t-test show that the difference between the two is significant ($t = 12.40 > 2.04$). This finding suggests that the board game helps students to understand how to factor polynomials and also boosts their confidence in solving algebraic equations.

The discovery aligns with the research of Yonwilad et al. (2025), which states that organized game-based activities raise the attendance and the understanding of mathematical concepts. The findings also confirm curriculum-related, and learner-centered methods promoted by the Department of Education (DepEd, 2021), proving that the learning process could be effective and involving.

Nevertheless, the research design adopted in the study is one-group pretest-posttest with no control group. Hence, the positive effect on the performance of the students can be observed, but the findings must be regarded with some reservations because the lack of the control group does not allow concluding about the effectiveness of the intervention based on the board game. The results may have been influenced by other factors like classroom teaching, peer contact or knowledge of the test items. Nevertheless, the results present an initial indication that board games can be an effective teaching method to be used in the learning of factoring polynomials. The future research can involve the use of control group, two or more sessions, and larger sample to enhance validity of the findings.

7. Conclusion

The researchers conclude that the board game designed within the study was effective because it assisted Grade 8 students to enhance their factoring polynomials. The students initially scored low in the pretest but when they played the board game, their performance was very high in the posttest. It also helped to make the process of learning more interesting and fun, and the students felt confident in their ability to solve problems of factoring and take an active part. In general, the board game turned out to be an effective, inexpensive, and interactive resource that would correspond to the curriculum and help students to grasp the difficult concepts of algebra. Nonetheless, the results can be applied to one group of Grade 8 students in a single school and should be viewed as the early signs of the success of the board game.

8. Recommendation

It is suggested based on these results that teachers should employ the use of board games or other interactive learning exercises in teaching algebra so as to make the lessons more interesting and enhance performance among students. To enhance learning in an entertaining manner schools and teachers can think over creating more teaching games on other areas of mathematics to enforce learning. Further studies can examine more sessions of the board game or examine its effectiveness in bigger groups as a way of

reinforcing its effects and seek methods to enhance the design.

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