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# Enhancing Independent Learning and Academic Performance in Algebra Through Photomath Application

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## Abstract

This study investigates the effectiveness of incorporating Photomath, a mobile application, in enhancing independent learning and academic performance of Grade 7 students in Algebra. The research aims to explore the potential of Photomath in improving students' understanding and retention of algebraic concepts and their ability to solve problems independently. A mixed-methods approach was employed, involving a quasi-experimental design and survey questionnaires. The results show that students who used Photomath significantly improved their academic performance and demonstrated increased confidence in solving algebraic problems. Moreover, the study reveals that Photomath's interactive features and step-by-step solutions facilitated independent learning and reduced reliance on teachers. The findings suggest that integrating Photomath into the algebra curriculum can be valuable in promoting autonomous learning and enhancing academic achievement in Grade 7 students.

## Introduction

Algebra holds substantial significance in shaping students' cognitive abilities and analytical thinking as an integral part of the mathematics curriculum (Herscovics, 2018). In secondary education, a profound understanding of algebraic concepts is essential for advanced mathematical disciplines and practical fields, extending beyond the classroom to sciences, engineering, economics, and technology (Kanbir, 2018). Proficiency in algebra equips junior high school students with skills to discover patterns, analyze data, and make informed decisions (Becker, 2005).However, studying algebra often poses a significant challenge for junior high school students due to its abstract and multifaceted nature (Beal, 2010). This challenge is accentuated by the latest results from the Program for International Student Assessment (PISA), indicating ongoing struggles in mathematics among Filipino students compared to global peers (Haw & King, 2023). The shift to online platforms for teaching presented challenges for educators in adapting their methods; however, they successfully identified strategies to turn these difficulties into opportunities for enhancing learning experiences (Corbita, 2024). This adaptive approach aligns with Antipuesto's (2020) assertion and Piaget's Cognitive Development Theory (1936), emphasising that students learn most effectively when actively engaging with their environment through experiments and observations. This perspective underlines the importance of a collaborative learning approach that fosters student support and motivation, particularly in the development of 21st-century knowledge, skills, and competencies through ICT

(Antipuesto & Tan, 2023). In online learning, this active engagement is especially crucial as it can enhance academic performance and provide flexibility. However, it also introduces challenges related to maintaining focus and motivation among students (Colegado, 2023).

Despite continuous efforts, only 19% of Filipino students met the low benchmark, signalling a pressing need for improvement (Magsambol, 2020). Capinding (2023) emphasized the crucial role of mathematics in education, yet Filipino students encounter significant challenges, evident in their performance on national and international assessments. Concepts involving equations, variables, and abstract problem-solving methods can be daunting, leading to a lack of confidence and engagement among learners. Consequently, this difficulty in comprehending algebra impedes immediate academic progress and impacts subsequent math courses, higher education opportunities, and career prospects reliant on a solid mathematical foundation (Allen, 2012).

Amidst the challenges in learning algebra, Photomath emerges as a transformative tool to alleviate barriers associated with understanding algebraic concepts among junior high school students (Saundarajan, 2020). This innovative mobile application provides a comprehensive platform for visualizing and practising algebra, transcending conventional approaches. Its intuitive interface enables students to scan and solve handwritten or printed math problems using smartphone cameras, offering step-by-step solutions, detailed explanations, and immediate feedback. Photomath empowers students to confidently approach algebra, bridging conceptual gaps and fostering deeper comprehension of algebraic concepts. Moreover, this insight underscores the potential of technological tools to enhance academic performance and foster deeper understanding among students in mathematics. This observation underscores the significant role of technological integration, particularly Photomath, in enhancing students' academic progress in mathematics. Engagement with Photomath significantly improved students' capacity to comprehend and solve mathematical problems, highlighting the potential of technological tools to boost academic performance and deepen their understanding
of mathematics.

Henceforth, this paper explores the efficacy of utilizing the Photomath application as an assessment tool to enhance algebra performance and independent learning in Grade 7 students of BukSU-SLS. Through a comprehensive review of relevant literature, analysis of empirical studies, and presentation of practical applications, this research seeks to illuminate the positive impact of employing Photomath as a formative assessment tool on students' algebraic attainment and overall academic development.

## Action Research Questions

This action research aims to examine the Grade 7 students' Algebraic performance and independence in learning by employing Photomath as a formative assessment tool at Bukidnon State University Secondary Laboratory School, Malaybalay City. The purpose of this study is to uncover answers to the following questions:

1. What is the level of students' performance in algebra when exposed to Photomath application in terms of:

a. Pre-test; and
b. Post-test

2. What is the level of students' independence in learning algebra when exposed to Photomath application in terms of:
   a. Pre-test; and
   b. Post-test

3. Is there a significant difference between the pre-test and post-test scores of students' performance in algebra when exposed to the Photomath application?

4. Is there a significant difference between the pre-test and post-test scores of students' independence in learning when exposed to the Photomath application?

## Proposed Innovation, Intervention, and Strategy

Educators in the field of mathematics have explored the challenges that students encounter when learning algebra. Historically, algebra has been a substantial challenge for most junior high school students, impacting their academic performance. Several solutions to these issues, guided by research findings, have been made and investigated for effectiveness (Warren et al., 2016). One possible solution to these problems is to use the Photomath application. Photomath is an innovative tool that has completely transformed the process of learning algebra, providing an effective way to improve the student's academic performance (Zain et al., 2023).Photomath uses smartphone cameras to scan and solve handwritten or printed math problems. Aside from its primary function as a calculator, Photomath provides step-by-step explanations that help students understand algebraic problem-solving. This application is easy to use and provides immediate feedback, which allows the students, especially those struggling. Its ability to quickly solve equations, simplify expressions, and graph functions is a valuable resource for students to confirm their answers and understand the processes involved in solving algebraic problems (Capinding, 2023).

Research investigating the effectiveness of Photomath as an intervention to enhance academic achievement has produced promising outcomes. Multiple studies have highlighted a positive link between Photomath usage and increased proficiency in algebra among junior high school students. Students who regularly used the app demonstrated improved problem-solving abilities, greater confidence, and a deeper understanding of algebraic principles than non-users. Moreover, the app's accessibility outside the traditional classroom allows continuous learning opportunities. Students can engage with algebraic problems at their convenience, creating a self-paced learning environment that provides individual learning styles and needs (Ibañez et al., 2021).

Even with the evident advantages of Photomath, concerns have occurred about excessive reliance on technology and a potential lack of conceptual understanding. Critics argue that an over-dependence on the app might impede the development of critical thinking skills essential for independent problem-solving. To address these concerns,

educators emphasize using Photomath as a complementary tool rather than a substitute for traditional teaching methods. Integrating the app into classroom instruction under teacher guidance can strike a balance between leveraging technology and nurturing conceptual understanding (Rojko, 2020).

Meanwhile, Bukidnon State University Secondary Laboratory School Junior High School researchers are exploring teaching techniques to enhance students' math performance. As observed in pre-service teaching, some students need to participate class and do not be more when teachers ask them. As a result, this study recommends the intervention of the Photomath application as a solution to enhance the student's academic performance and independent learning in mathematics. Moreover, according to Dahlan et al. (2022),

Photomath emerges as a potent intervention in boosting the academic performance of junior high school students in algebra. Its user-friendly interface, immediate solutions, and detailed explanations serve as catalysts for improving comprehension and proficiency in algebraic concepts. When employed thoughtfully in conjunction with conventional teaching approaches, Photomath has the potential to revolutionize algebra learning, enabling students to overcome mathematical challenges confidently.

The researchers, during the implementation, will use Photomath as an assessment tool to enhance independent learning and academic performance in grade 7 algebra. The following process in the intervention is below.

Step 1: During the making of the lesson plan, the teachers will integrate the use of Photomath during instruction.

Step 2: The teacher will identify the related activities that will incorporate the use of the Photomath application tool.

Step 3: The teacher will give a pretest to identify the difference between the student's performance and independence in learning algebra before and after using Photomath.

Step 4: The teacher will now start the application of Photomath in class.

Step 5: The teacher will give a post-test to identify students' progress in their academic performance and independence in learning algebra.
Here are some benefits of implementing Photomath as an assessment tool to enhance independent learning and academic performance in grade 7 algebra:

**Immediate Feedback**

Photomath as an assessment tool will help individuals receive immediate feedback on mathematical problems. This allows students to correct mistakes immediately and can enhance the learning process by using correct problem-solving methods. It creates continuous learning where students can adjust and improve their understanding after answering the mathematical problem, leading to more effective and efficient learning (Sloan-

Lynch et al., 2022).

### Engagement and Motivation

Implementing Photomath as an assessment tool in the classroom allows students to participate in their learning actively. Students can use the app to solve problems, receive feedback, and explore the concepts independently. This active engagement can lead to a deeper understanding of the material. Also, Photomath creates a positive learning environment that helps enhance students' attitudes toward mathematics (Santos, 2022).

## Method

This chapter presents the methodology of the study. It includes the research design, research locale, participants, and statistical data treatment.

### Research Design

Descriptive statistics such as frequency and mean are utilized to compute students' algebra performance and learning independence. The study employed a one-shot research design to examine the significant difference between the pretest and posttest in enhancing independent education and academic performance in algebra through the Photomath application.

The students managed a pretest on academic performance and independent learning before introducing the Photomath application. The Photomath application was implemented during the third grading period of the school year 20232024. Following a one-month session, the students were retested using the same assessment as a posttest. These tests aim to determine the difference in the student's academic performance and independent learning in Grade 7 Algebra through the Photomath Application.

### Research Locale

This study was conducted at the Bukidnon State University Secondary Laboratory School located at Fortich St., Sayre Highway, Malaybalay City, Bukidnon. The Secondary Laboratory School is an integral part of the esteemed College of Education, encompassing a comprehensive range of grade levels. The school above offers junior high school from Grades 7, 8, 9, and 10.

### Research Instrument

This study uses the Academic Performance and the Students' Independence in Algebra Scale as instruments. The researcher developed a 30-item mathematics exam on the covered topic (Algebra). A test was obtained from (see Appendix A), and the pilot was tested. The 30 items are all-in multiple-choice test types. Items are scored 1 for every correct response and 0 if otherwise. The result is interpreted using the scale below.

| Score | Percentage Score | Qualitative Rating |
|---|---|---|
| 28-30 | 90% and above | Very High |
| 26-27 | 85% - 89% | High |
| 24-25 | 80% - 84% | Moderate/Average |
| 22-23 | 75% - 79% | Low |
| 0-21 | 65% - 74% | Very Low |

The survey items for enhancing independent learning in grade 7 algebra through the Photomath application were adapted from the survey questionnaire of Arden, B., Stephen, H., Sara, D., Rebecca, M., & John, T. (2011), which was composed of statements for student's independent learning in algebra. Enhancing the independent learning model's Cronbach's alpha was significantly above the required minimum of 0.7, at 0.905 for independent learning (Arden et al., 2011). It shows a strong correlation between the statements in the variable, providing a reliable and consistent measure of the construct.

The degree of students' answers for every statement was expressed in a five-point Likert scale. The five response choices are: Strongly Disagree, Disagree, Neither Agree or Disagree, Agree, Strongly Agree. The response for the statements has a weighted score of 1, 2, 3, 4, and 5. The scoring for each dimension is as follows:

| Rating | Scale | Descriptive Rating | Qualitative Rating |
|---|---|---|---|
| 5 | 4.51 - 5.00 | Strongly Agree | Highly Independent (HI) |
| 4 | 3.51 - 4.50 | Agree | Independent (I) |
| 3 | 2.51 - 3.50 | Undecided | Fairly Independent (FI) |
| 2 | 1.51 - 2.50 | Disagree | Less Independent (LI) |
| 1 | 1.00 - 1.51 | Strongly Disagree | Not Independent (NI) |

**Participants**

The participants of this study were the Grade 7 students of Bukidnon State University Secondary Laboratory School for S.Y. 2023-2024. It is decided that Grade 7 Humility and Grade 7 Patience will be used as respondents for this study. This study aims to examine the Grade 7 students' academic achievement in algebra and independence in learning by utilizing the Photomath application as an assessment tool.

**Statistical Treatment of Data**

The study employed Jamovi statistical tools to analyze the data. Descriptive statistics were used to Descriptive using mean and standard deviation to determine the students' academic achievement in algebra. Furthermore, a paired t-test was utilized to determine the level of improvement in students' academic achievement and independent learning in algebra after utilizing the Photomath application as an assessment tool. The t-test formula involves calculating the difference between the means of the two groups while considering the variability within each group. The outcome is a value, which is subsequently compared to a critical value from a t-distribution to

determine statistical significance. If the calculated t-value falls outside a critical region, as determined by the chosen level of significance, typically denoted as alpha, the null hypothesis is rejected. This design was selected as it is a common approach for studies utilizing paired t-tests. Thus, the evaluation was conducted on the Grade 7 students of the Secondary Laboratory School, both classes in the traditional way and after the intervention.

## Results

This chapter presents the analysis and interpretation of data gathered from the student's scores relevant for testing the hypothesis of the study. The order of presentation follows the arrangement of the problems identified in the study.

**Students' Performance in Algebra when exposed to Photomath Application in terms of Pretest**

Table 1 shows the level of algebra performance of students who were exposed to the Photomath application in terms of a pre-test. Table 1 shows that 2 students, or 3.77%, had a low performance and 51 students, or 96.23%, had a very low performance. The overall mean score of students' academic achievement in algebra when exposed to the Photomath program on a pretest is 12.6 or 83%, indicating poor performance.

Table 1. Students' Performance in Algebra when Exposed to Photomath Application in Terms of Pretest

| Range | Photomath Application | | |
|---|---|---|---|
| | F | % | Interpretation |
| 90% - 100% | 0 | 0% | Very High |
| 85% - 89% | 0 | 0% | High |
| 80% - 84% | 0 | 0% | Moderate/Average |
| 75% - 79% | 2 | 3.77% | Low |
| 65% - 74% | 51 | 96.23% | Very Low |
| Total | 53 | 100% | |
| | | Mean = 12. 6 | |
| | | 83% (Very Low) | |

Legend:

| Score | Percentage Score | Qualitative Rating |
|---|---|---|
| 28-30 | 90% and above | Very High |
| 26-27 | 85% - 89% | High |
| 24-25 | 80% - 84% | Moderate/Average |
| 22-23 | 75% - 79% | Low |
| 0-21 | 65% - 74% | Very Low |

The study's findings indicate that Grade 7 students who were not exposed to the Photomath application demonstrated very low performance levels. This aligns with Cheung and Slavin's (2013) research, which similarly discovered that students in Grade 7 who lacked exposure to technology-based learning tools, like Photomath, exhibited notably poor performance. Cheung and Slavin's study explores the efficacy of technology-based

learning tools in enhancing mathematics achievement across various grade levels. Their findings may offer substantial evidence of the significant impact of technology-based interventions on students' academic performance in mathematics, thus corroborating the conclusions drawn from the current study regarding Grade 7 student's performance in the absence of Photomath exposure.

**Students' Performance in Algebra when exposed to Photomath Application in terms of Pretest**

Table 2 demonstrates the level of students' algebra performance after exposure to the Photomath program in terms of post-test. As presented in the table, the overall mean score of students' performance in algebra in terms of post-test is 19.4 or 76%, which is a descriptive interpretation of low.

Table 2. Students' Performance in Algebra when Exposed to Photomath Application in Terms of Posttest

| Range | | PHOTOMATH APPLICATION | |
|---|---|---|---|
| | F | % | Interpretation |
| 90% - 100% | 3 | 5.67% | Very High |
| 85% - 89% | 7 | 13.2% | High |
| 80% - 84% | 6 | 11.32% | Moderate/Average |
| 75% - 79% | 5 | 9.43% | Low |
| 65% - 74% | 32 | 60.38% | Very Low |
| Total | 53 | 100% | |
| | | Mean = 19.4 | |
| | | 76% (Low) | |

Legend:

| Score | Percentage Score | Qualitative Rating |
|---|---|---|
| 28-30 | 90% and above | Very High |
| 26-27 | 85% - 89% | High |
| 24-25 | 80% - 84% | Moderate/Average |
| 22-23 | 75% - 79% | Low |
| 0-21 | 65% - 74% | Very Low |

The results of this study show that the level of Grade 7 students' performance in algebra when exposed to the Photomath application had low performance. It contradicts the study of Saundarajan K. et.al. (2020) when they found out that Photomath had a positive impact on enhancing the level of students' performance in algebra. Moreover, it also contradicts the findings of Obina, J. E., et al. (2022), who stated that Photomath was effective as it helped them in their studies, resulting in a high level of academic performance.

**Students' Independence in Learning Algebra before and after Intervention**

Table 3 shows the students' independence in learning Algebra before the intervention.

Table 3. Students' Independence in Learning Algebra Before and After Intervention

| Independence in Algebra | Photomath | | | |
|---|---|---|---|---|
| | Before | | After | |
| | Mean | QI | Mean | QI |
| I prefer working alone rather than in groups when doing algebraic problems. | 2.75 | FI | 3.81 | I |
| I learn more about algebraic concepts at my own pace. | 3.40 | FI | 4.21 | I |
| When I solve algebraic problems, I look for an example that resembles the given problem and follow the same steps. | 4.04 | I | 4.30 | I |
| I can learn algebra even though our teacher doesn't explain the solutions well. | 2.57 | FI | 3.79 | I |
| Understanding algebra means being able to recall something I've read or solved. | 3.43 | FI | 3.83 | I |
| I have a lot of self-confidence when it comes to algebra. | 2.55 | FI | 3.70 | I |
| If my computation in an algebraic problem gives a result that is very different from what I'd expect, I go over the procedures or steps to check the answer. | 3.40 | FI | 3.96 | I |
| I'm trying to work harder to understand algebra topics on my own. | 3.47 | FI | 4.08 | I |
| I can solve the algebraic problem after studying the related examples and steps. | 3.47 | FI | 4.28 | I |
| I don't feel nervous talking out loud about algebraic principles in front of my classmates. | 2.49 | LI | 4.38 | I |
| I am eager to participate in a discussion that involves Algebra. | 2.83 | FI | 3.91 | I |
| I am comfortable showing my solution in algebraic class. | 2.30 | LI | 3.94 | I |
| I like to show my solution on the board during class participation or share my algebraic skills with peers in the class. | 2.38 | LI | 3.74 | I |
| I refrain from panicking after receiving complex algebraic problems. | 2.91 | FI | 3.94 | I |
| I usually come through solving difficult algebraic problems with little trouble. | 3.00 | FI | 4.15 | I |
| OVERALL Mean | 3.00 | | 4.00 | |

Legend:

| Rating | Scale | Descriptive Rating | Qualitative Rating |
|---|---|---|---|
| 5 | 4.51 - 5.00 | Strongly Agree | Highly Independent (HI) |
| 4 | 3.51 - 4.50 | Agree | Independent (I) |
| 3 | 2.51 - 3.50 | Undecided | Relatively Independent (FI) |
| 2 | 1.51 - 2.50 | Disagree | Less Independent (LI) |
| 1 | 1.00 - 1.51 | Strongly Disagree | Not Independent (NI) |

**Students' Independence in Learning Algebra before Intervention**

It was observed that the statement with the highest mean score of 4.04 was "When I solve the algebraic problem, I look for an example that looks like the problem given and follow the same steps," with an independent rating. This implies that students tend to rely heavily on examples when solving algebraic problems. They look for similarities between the given problem and examples they have seen before, then follow the steps used in those examples to solve the given problem. The following statements, "I'm trying to work harder to understand algebra topic on my own," and "I can solve the algebraic problem after studying the related examples and steps," with the second highest mean score of 3.47, rated as relatively independent, indicates that most of the students are proactive in their learning efforts and are comfortable following established procedures and examples when tackling algebraic problems.

The statement "Understanding algebra means being able to recall something I've read or solved," with a mean score of 3.43, rated as relatively independent, suggests that students may acknowledge the importance of recall in understanding algebra, they are not entirely dependent on it and likely recognise that true understanding involves deeper cognitive processes beyond mere memory. The statements "I learn more about algebraic concepts at my own pace" and "If my computation in algebraic problem gives a result which is very different from what I'd expect, I go over the procedures or steps to check the answer" with a mean score of 3.40, rated as relatively independent, implies that students value independence and self-regulation in their algebra learning journey. They prefer to learn at their own pace and are proactive in ensuring the accuracy of their problem-solving processes.

Likewise, among the items, the statement "I usually come through solving difficult algebraic problems with little trouble", with a mean score of 3.00, and "I refrain from panicking after receiving difficult algebraic problems' with a mean score of 2.91, would tell that students are fairly independent in learning algebra. Concerning independent learning in Algebra, the statements "I am eager to participate in a discussion that involves Algebra", "I prefer working alone rather than in groups when doing algebraic problems", and "I can learn algebra even though our teacher doesn't explain the solutions well", and "I have a lot of self-confidence when it comes to algebra" which has a mean score of 2.83, 2.75,2.57, and 2.55 respectively indicating a fairly independent rating. This means that students may be interested in algebra and willing to participate in discussions, prioritize independent learning approaches, and feel more confident in their abilities when they can learn autonomously.

While the statement "I like to show my solution on the board during class participation or share my algebraic skills with peers in the class" has the lowest mean score of 2.38, which was rated as less independent, indicates that students may not feel as comfortable or confident when it comes to publicly showcasing their algebraic abilities in front of their peers. They prefer to work on problems privately or share their solutions in a more controlled setting rather than in front of the entire class.

The overall mean score of Students' Independence in Learning Algebra before Intervention is 3.00. This shows that students are pretty independent in learning Algebra. Saundarajan (2020) emphasized that students may feel confident in their abilities to understand and apply algebraic principles, and they may prefer to work through

problems independently rather than relying heavily on external guidance or assistance. However, it's essential to continue supporting and fostering their independent learning skills to ensure continued growth and success in mastering algebraic concepts.

**Students' Independence in Learning Algebra after Intervention**

After the intervention, the statement "I don't feel nervous talking out loud about algebraic principles in front of my classmates" had the highest mean score of 4.38, indicating that it was highly independent. This means that students felt much more confident and comfortable speaking up in front of others. The intervention helped students feel more self-assured and independent in their studies. The following statement, "When I solve the algebraic problem, I look for an example that looks like the problem given and follow the same steps", received the second-highest mean score of 4.30, showing that it was highly independent. This suggests that students solve algebraic problems independently without much guidance. They use a strategy to find a similar situation and use the steps they already know to solve it.

Moreover, the statement "I can solve the algebraic problem after studying the related examples and steps" had a mean score of 4.28, rated as highly independent. The result indicates that students feel confident in their ability to tackle algebraic problems independently, especially after studying relevant examples and steps. The statement "I learn more about algebraic concepts at my own pace" received a mean score of 4.21, meaning it was highly independent. This indicates that students believe they can understand algebra concepts better when they study at their own pace, without feeling rushed or pressured.

Furthermore, the statement "I usually come through solving difficult algebraic problems with little trouble" gained a mean score of 4.15, indicating that it was independent. This means that students have a good level of independence and skill in their algebra abilities. The statement "I'm trying to work harder to understand algebra topic on my own" has a mean score of 4.08, rated as independent. Also, the statement "If my computation in algebraic problem gives a result which is very different from what I'd expect, I go over the procedures or steps to check the answer" has a mean score of 3.96, indicating independence. These statements mean that students can independently put more effort into learning algebra concepts.

Additionally, the statement "I am comfortable to show my solution in algebraic class" received a mean score of 3.94, "I refrain from panicking after receiving difficult algebraic problems" with a means score of 3.94, "I am eager to participate in a discussion that involves Algebra" with a means score of 3.91, "Understanding algebra means being able to recall something I've read or solved" with a means score of 3.83, "I prefer working alone rather than in groups when doing algebraic problems" with a means score of 3.81, "I can learn algebra even though our teacher doesn't explain the solutions well" with a means score of 3.79, "I like to show my solution on the board during class participation or share my algebraic skills with peers in the class" with a means score of 3.74. The statement that received the lowest means score is "I have a lot of self-confidence when it comes to algebra" with a mean score of 3.70.

The overall mean score of students' independence in learning mathematics after intervention is 4.00, which shows that the students have independence in learning mathematics. Incorporating the Photomath application facilitated the students' progress in acquiring knowledge and becoming more independent in learning mathematics. This application helps them engage more in learning and enhances their understanding of algebraic concepts. Thus, the findings align with previous research by Saundarajan (2020), demonstrating that this application helps students feel more confident, helps them understand algebra concepts better, and assists them when learning independently.

Table 4. Comparison of Students' Performance between Pretest and Posttest

| Group | | | N | Mean | SD | t-value |
|---|---|---|---|---|---|---|
| Performance | Pre-Test | | 53 | 12.6 | 3.73 | -9.42 |
| | Post Test | | 53 | 19.4 | 5.47 | |
| | | t-value | df | p | Mean Difference | SE difference |
| Pair 1 | Pretest-Posttest | -9.42 | 52 | <.001 | -6.74 | 0.715 |

Table 4 shows the Paired t-test of the pre-test and post-test scores of the treatment. As evidenced by the student's t-test ($t(52) = -9.42$, $p<0.001$). This finding indicates a substantial change in the participant's performance from before and after the intervention. Specifically, the mean difference between pre-test and post-test scores was -6.74, with a standard error of 0.715. The null hypothesis, stating that there is no significant level of improvement in a student's academic achievement in algebra after utilizing the Photomath application as an assessment tool, was rejected. Consequently, the intervention had a significant impact on the measured variables.

According to (Zain et al., 2023), the results of their study show an increase in math achievement and more interest in math subjects when they can refer to this Photomath application based on the calculations they have done. This application can be widely used as a tool to help students when they are at home and do not have a reference to refer to. The implications of this study show an increase in the respondents' achievement and interest in algebra.

Table 5 shows the Paired t-test of the pre-test and post-test scores of the treatment.

Table 5. Comparison of Students' Independence in Learning Algebra between Pretest and Posttest

| Group | | | N | Mean | SD | t-value |
|---|---|---|---|---|---|---|
| Independence in Learning | Pre-Test | | 53 | 3.00 | 0.511 | -8.74 |
| | Post Test | | 53 | 4.00 | 0.219 | |
| | | t-value | df | p | Mean Difference | SE difference |
| Pair 2 | Pretest- Posttest | -8.74 | 14.0 | <.001 | -1.00 | 0.115 |

As evidenced by the student's t-test ($t(14) = -8.74$, $p<0.001$). This finding indicates a substantial change in the participant's independence before and after the intervention. Specifically, the mean difference between pre-test

and post-test scores was -1.00, with a standard error of 0.115. The null hypothesis was rejected, stating that there is no significant improvement in a students' independence in learning algebra after utilizing the Photomath application as an assessment tool. Consequently, the intervention had a significant impact on the measured variables.

The result is supported by Mosbergen's study, which explained an application called Photomath. This application is helpful for someone learning mathematics, similar to applications: Microsoft Mathematics, Symbolab, and Desmos. In addition, the application of augmented reality in mathematics education can help students with higher self-efficacy to have more involvement with the contents to be learned towards higher level conceptions (Cai, Liu, Yang, and Liang, 2019; Coimbra, Cardoso, and Mateus, 2015).

## Conclusions

Before the intervention, Grade 7 students exhibited very low performance in algebra when not exposed to the Photomath application, and even after the intervention, their performance remained low. Before the intervention, students displayed moderate independence in arithmetic, suggesting a level of confidence with algebra. However, their ability to work autonomously on algebraic tasks improved following the intervention, indicating that utilizing the Photomath app enhanced their algebra learning experience. The study revealed a significant disparity in algebra performance among Grade 7 students before and after the intervention, highlighting the positive impact of integrating the Photomath application on their algebra learning. Furthermore, there was a notable improvement in students' independence in learning algebra after the intervention, indicating that implementing the Photomath application enhanced Grade 7 students' capacity to engage with algebraic concepts independently.

### Recommendations

The study revealed that Grade 7 students faced challenges with algebra before and after using the Photomath application, suggesting a need for exploring alternative strategies or tools to enhance algebra comprehension and practice effectively. Given the positive impact of the Photomath application on students' independence in learning algebra, further research is recommended to pinpoint the specific features of Photomath contributing significantly to this development, such as step-by-step problem-solving support or interactive learning. Additionally, a follow-up study is suggested to assess the long-term effects of using the app on Grade 7 students' algebra competence, providing insights into the sustainability of learning gains and guiding ongoing improvements in algebra teaching practices. Furthermore, future research could investigate the transferability of skills acquired through the Photomath application to other mathematical domains or academic courses, offering a comprehensive understanding of its broader impact on students' overall independence in learning.

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