

Effectiveness of SpinGebra: A drill for Mastering Fundamental Operations on Algebraic Expressions in One Variable

Rufino M. Lorejo, Nabel M. Cosain, Michelle O. Dahan

Bohol Island State University-Main Campus

Abstract

Introduction: According to Amazing Global App (2022), Spin the Wheel is a common game or decision-making mechanism in which a wheel is rotated and a pointer is used to randomly select a value or outcome from a set of possible options. This game can be a fun alternative to the traditional approach used by teachers typically in solving mathematics. The game SpinGebra was developed based on the concept of monomial algebraic expressions in one variable. The name SpinGebra combines "spin" and "algebra," reflecting its purpose. The study aimed to master fundamental operations related to monomial algebraic expressions and observed the integration of the Cartesian coordinate system in assigning signs to terms based on quadrants.

Objectives: The main thrust of this study was to introduce SpinGebra and determine the effectiveness of the SpinGebra as a drill in mastering the fundamental operations on monomial algebraic expressions in one variable of the Grade 8 students of Dr. Cecilio Putong National High School for the School Year 2023 – 2024. Specifically, it aimed to determine the pretest and posttest performances of the control and experimental groups.

Methods: This study used Two a group pre-test-posttest design. The questionnaire had undergone pilot testing and item analysis. Then, it was administered to both groups before and after exposure to Flashcard Drill (control) and SpinGebra Drill (experimental). Each group has 45 respondents which was formed by matching the obtained scores during the pretest. The control group was exposed to Flashcard Drill while the experimental group was exposed to SpinGebra Drill. The gathered data were analyzed and interpreted using the arithmetic mean. The result shows that there was a significant difference between the posttest performance of both groups.

Results: A drill for mastering fundamental operations on algebraic expressions in one variable can be done using the idea of Spin Wheel divided into four quadrants where the signs of the four quadrants are considered in performing operations of algebraic expressions wherever the spin stops. It was revealed that both groups got an average of 8.93 categorized as Fair in their pre-test scores but in the post -test scores, SpinGebra Drill group attained excellent scores compared to the Flash card Drill group which obtained the score that is Very Satisfactory. Further, the difference between the pre-test and post-test scores of each group were significant. It showed that the students from the control group who were exposed to Flashcard Drill and the students from the experimental group who were exposed to SpinGebra Drill had progress in their performance in solving fundamental operations on monomial algebraic expression in one variable.

Conclusions: The researchers concluded that the SpinGebra Drill is an effective drill for mastering monomial algebraic expressions in one variable compared to the traditional flash card drill. The change of learning that students can get from the SpinGebra drill is higher than that of the Flash card Drill. The mathematics teachers may use the SpinGebra Drill to catch the students' interest and have better learning outcomes. It can be an alternative to the traditional drill of mastering the fundamental operations on monomial algebraic expression. Future researchers may conduct a parallel study to further verify the effectiveness of SpinGebra as a drill.

Keywords: SpinGebra, Monomial algebraic expression, one variable, Effectiveness, Spin Wheel

1. Introduction

Mathematics is perceived difficult and challenging subject. Gafoor and Kurukkan (2015) found that among 51 students surveyed, 82% disliked mathematics, with 75% finding it difficult. Reasons included challenges in understanding the subject,

inadequate instruction, and the need for more time to grasp concepts. Algebra is one of the various branches of mathematics.

Specifically, Algebra is acknowledged as a crucial aspect of school mathematics, yet many students

struggle with basic concepts such as variables, expressions, and equivalences (Koirala, Hari, 2005). On the other hand, (Marpa, 2019) mentioned that in determining the degree of algebraic expressions, the rules and functions of exponents were hardly recalled. Despite this recognition, there is a lack of understanding regarding the specific nature of these challenges and their contributing factors.

Various games used in learning mathematics used spin the wheel. Tikkanen (2020) defines "spin the wheel" as a decision-making process involving rotating a wheel and using a pointer to randomly select an outcome from various possibilities, manually or mechanically. Its purposes vary from entertainment to decision-making and overcoming teaching challenges in education. In games and competitions, such devices are common, with the indicated section upon landing determining the winner. In education, spinning wheels engage students, making learning enjoyable and enhancing problem-solving skills through entertaining activities. Demers, Michael (2017) explains that Cartesian coordinate system uses set of unique values of (X) and (Y) as coordinate pairs used to locate a point in a two dimensional plane.

Additionally, it is noted that coordinate systems serve as a method for specifying the position of points on the Earth. Dilao (2013) explains that most coordinate systems utilize two numbers, known as coordinates, to locate a point, where each number represents the distance between the point and a fixed reference point called the origin. Rene Descartes, a 17th-century French mathematician and philosopher, introduced the Cartesian coordinate system, dividing a plane into four quadrants using perpendicular horizontal and vertical lines. Quadrants are labeled I to IV in a counterclockwise direction, starting from the upper right. The x-axis (horizontal) and y-axis (vertical) are the two number lines, and their intersection forms the origin (0). Quadrant I has positive values for both axes, while Quadrant II has a negative x-axis and a positive y-axis. Quadrant III has negative values for both axes and Quadrant IV has a positive x-axis and a negative y-axis. This system forms the coordinate plane.

Jupri et al. (2014) identified mathematization as the key challenge in both written tests and interviews, involving the ability to bridge between real-world problems and mathematical concepts, alongside issues such as understanding algebraic expressions, applying arithmetic operations, grasping variables, and interpreting the equal sign. Sugiarti and Retnawati (2019) discovered that students struggle with solving algebraic problems involving concepts and principles. Challenges include difficulty in identifying variables and constants, applying division in algebra, understanding definitions of variables and constants, and applying principles like addition, reduction, multiplication, factoring, and solving algebraic word problems.

It has been a practice to use flash cards as game in math and at the same time enriching learning in mathematics. Poncy and Duhon (2017) discuss the effectiveness of flashcard drills and practice (D&P) in education, noting its ability to enhance students' skills in identifying numbers and solving simple math problems. Through frequent practice, students improve their accuracy and fluency in these target abilities. Flashcard D&P involves presenting flashcards, eliciting responses, and providing feedback, leading to enhanced learning outcomes. On the other hand, Plass, et. al (2023) believed that an increase in performance of the game is attributed to the competitive mode compared to the individual play while collaborative play resulted in employing a less efficient way of solving problems.

For a design that is meaningful and rich, Adipat, S., Laksana, K., Busayanon, K., Asawasowan, A., & Adipat, B. (2021) emphasized that a game will be focused to the content based on good academic philosophies so that it can help students and to be educational in nature. This is useful to gain learning out of fun.

This led to the creation of the game SpinGebra, which is based on the mathematical learning concept of monomial algebraic expressions. SpinGebra is derived from two English terms, namely; Spin and Algebra. The study focuses on mastering the fundamental operations involving monomial algebraic expressions. Moreover, it observes and considers the integration of the Cartesian coordinate system concept in assigning signs to integers based on the Quadrants.

2. Objectives

The main thrust of this study was to introduce and determine the effectiveness of SpinGebra as a drill in mastering the fundamental operations of monomial algebraic expression in one variable of the Grade 8 students of Dr. Cecilio Putong National High School during the School Year 2023 – 2024. Specifically, this research seeks to explain what SpinGebra and how it will be played and what the performance of the students in mastering the fundamental operations on monomial algebraic expression in one variable using the flashcard drill (control group) and the SpinGebra (experimental group) as reflected in pretest and posttest.

3. Methods

The study utilized a Two- Group pre-test-posttest design, specifically a matching-only design, to create experimental and control groups with similar respondent characteristics. Both groups underwent pretests, experimentation, and post-tests, with the control group receiving Flashcard Drill and the experimental group receiving SpinGebra Drill. This was conducted at Dr. Cecilio Putong National High School in Tagbilaran City, the study involved 90 Grade 8 students selected through Purposive Sampling. Respondents were divided into groups based on pretest results to ensure comparability. The study underwent several phases in data collection.

First, permission was obtained from school authorities and respondents. Then, a pilot test was conducted, followed by item analysis and questionnaire modification. A pretest was administered to group respondents based on knowledge levels. Grouping was done using a matching method to ensure fairness. The experiment involved two sessions: Flashcard Drill for the control group and SpinGebra Drill for the experimental group, including two categories of gameplay. A posttest was administered to both groups using a similar questionnaire. Finally, the pretest and posttest results of the control and experimental groups were analyzed using statistical methods. Performance was evaluated using a percentage formula, and the Arithmetic Mean formula determined the level of performance.

4. Results

The researchers discovered a game called SpinGebra which is a combination of Spin and Algebra. The game was played like the standard Spin the Wheel game. The Game is made of a circle divided into four quadrants which have in total 16 sectors for each of the operations in every quadrant (Fig.1). One of the tools in the game that may be used to determine the first fate (first term) and the second fate (second term) in the equation. This is placed in the box with an x variable and a coefficient ranging from 1 to 20. There would be a total of 20 chips in each of the boxes for the first and second fates. To recognize the term in the equation, it must be color-coded (ex. yellow for the first fate and blue for the second fate) (Fig.2).

It is to be played by a group of students in which each player will be given an answer sheet. The game has two categories – The time is Up (TIU) Category and Quick Response Time (QRT) Category. If the player chooses to play the Quick Response Time (QRT) Category, the game must include at least two participants but no more than four. If the game comes under the Time is Up (TIU) category, the number of players should not exceed fifty, or a regular class size. The player with the highest number of stars at the end of the game is declared the winner. This instrument will only be exposed to the experimental group during the treatment.

Table 1. Pretest Performance of the Flash Card Drill and SpinGebra Drill in mastering the fundamental operations on monomial algebraic expression (N=90)

Range Score	Description	Flash Card Drill		SpinGebra Drill	
		f	%	f	%
21-25	Excellent	0	0	0	0
16-20	Very Satisfactory	0	0	0	0
11-15	Satisfactory	17	37.78	17	37.78
6-10	Fair	16	35.56	16	35.56
0-5	Poor	12	26.67	12	26.67
Average Score		8.93		8.93	
Description		Fair		Fair	

Table 1 presents the results of the pretest performance of the students in mastering the fundamental operations on monomial algebraic

expression in one variable in both the Flash Card Drill and the SpinGebra Drill. In the pretest of the Flash Card Drill and the SpinGebra Drill, 17 out of 45 students were described as "satisfactory," and 12 out of 45 students were described as "poor." As also reflected in the table, it was revealed that both groups got an average score of 8.93, which was marked as "fair." The result shows that the students have a fair foundation on the concepts of Algebra. The pretest was the basis of groupings, and the students were equally distributed to each group. This is why the students' performance in each group before the exposure to the Flash Card Drill and SpinGebra Drill, respectively, are the same.

Table 2. Post-test Performance of the Flash Card Drill and SpinGebra Drill in mastering the fundamental operations on monomial algebraic expression (N=90)

Range Score	Description	Flash Card Drill		SpinGebra Drill	
		f	%	f	%
21-25	Excellent	17	37.78	20	44.44
16-20	Very Satisfactory	19	42.22	18	40
11-15	Satisfactory	7	15.56	7	15.56
6-10	Fair	2	4.44	0	0
0-5	Poor	0	0	0	0
Average Score		18.4		20.56	
Description		Very Satisfactory		Excellent	

Table 2 shows the results of the post-test performance of students. It reveals the students' performance improvement in mastering the fundamental operations of monomial algebraic expression in one variable after exposure to the Flash Card Drill and the SpinGebra Drill. In the Flash Card Drill, only 18.4 of the students who got the performance described it as "very satisfactory," while in the SpinGebra Drill, 20.56 of the students who got the performance described it as "excellent." It can be inferred that the SpinGebra Drill yields an effective result better than the Flash Card Drill, which merely sticks to a plain traditional drill.

According to philosopher and theorist John Dewey, in his concept of progressive education, students learn best through physical and intellectual activities. Students learn best if they are actively engaged in learning activities aided by a drill that promotes active engagement and interaction with others through hands-on experiences. It is considered one of the best ways to deliver lessons in Algebra since it involves several senses. SpinGebra Drill allows the students to actively participate in solving the task rather than merely passive learners. Though both the Flash Card Drill and the SpinGebra Drill received equivalent treatment, it cannot be denied that the students who played the game became more active as they solved mentally against their opponents.

Table 3. Difference between the Pretest and Post-test Performance of the Flash Card Drill (N=45)

Means	Mean Difference	t-value	df	p-value	Decision	Interpretation
Pre-test = 8.93	-9.467	-12.144	44	0.000	Reject Ho	Significant
Post-test = 18.4						

Table 3 compares the results of the pretest and post-test performance of the students in mastering the fundamental operations on monomial algebraic expression in one variable in the Flash Card Drill. Based on the information provided in the table, it is evident that the p-value of 0.000 is lower than the predetermined significance level of 0.05. Therefore, the null hypothesis is rejected based on the presence of 44 degrees of freedom. This signifies a significant difference between the performances of the Flash Card Drill in their pretest and post-test scores. The Flash Card Drill effectively solves

fundamental operations on monomial algebraic expression since the student's scores improved significantly

Table 4. Difference between the Pretest and Posttest Performance of the SpinGebra Drill (N=45)

*Reject at p-value < 0.05

This is supported by Dewey's Progressivist Philosophy, which asserts that intellectual and physical activities promote the best learning for students. Throughout the game's demonstration, students were able to interact and collaborate. Students were encouraged to be active participants during class time through an activity, increasing their engagement. In addition, the "Law of Exercise" by Thorndike, which states that repetition of experience increases the likelihood of a correct response, provides additional insight into this. The students could focus more and engage repeatedly with the stimulus without getting bored. Thus, the student's academic performance is enhanced as the amusement derived from playing the game subdues any negative perceptions they may have.

Table 5. Significant Difference between the Post-tests Performance of Both Groups (N=88)

*Reject at p-value < 0.05

Means	Mean Difference	t-value	d	p-value	Decision	Interpretation
Flashcard=18.4 SpinGebra=20.56	-2.156	-2.704	88	0.008	Reject H ₀	Significant

Table 5 compares the students' post-test results in solving the fundamental operations on monomial algebraic expression in one variable across the two groups. The results of the Independent Sample T-test indicate that the null hypothesis is rejected, as evidenced by a statistically significant t-value of -2.704 and a p-value of 0.008, which is less than the predetermined significance level of 0.05. Hence, this indicates a significant difference in the posttest results between the students. This finding suggests that the SpinGebra Drill utilized in the instructional

process exhibits greater efficacy than the traditional Flash Card Drill.

5. Discussion

The use of traditional drill method using Flashcards is still an effective drill to master mathematical

Means	Mean Difference	t-value	D	p-value	Decision	Interpretation
Pre-test = 8.93 Post test = 20.56	-11.622	-19.737	44	0.000	Reject H ₀	Significant

concepts since it gives significant increase of performance between pre-test and post test scores. The same happens to the drill that is the use of SpinGebra which also resulted to a significant change of scores when pre-tests scores are compared with the post- tests scores. Considering that the student's performance in the math concept in two methods are the same when their pre-test scores are compared and each method arrived at a significant increase to the student's post test scores, it is can be concluded that the use of SpinGebra is significantly better to be used than that of the traditional Flashcards method which is effective in enhancing students' performance in solving algebraic expressions.

The mathematics teachers may use the SpinGebra Drill to catch the students' interest and have better learning outcomes. It can be an alternative to the traditional drill of mastering the fundamental operations on monomial algebraic expression. Students may use the drill as a pastime, playing against each other. This may help them master the concept and to master the fundamental operations on monomial algebraic expression in one variable to improve their mathematical ability and strategic thinking. Math organizations may utilize SpinGebra

Drill to run a remedial classes or contests on Algebraic expressions concepts. Students may utilize SpinGebra Drill as well to enhance their skills in mastering algebraic expression mentally. Future researchers may conduct parallel studies, re-conduct this study, or further improve the game to verify its effectiveness and improve the design for better outcomes.

6. References

- [1] Adipat, S., Laksana, K., Busayanon, K., Asawasowan, A., & Adipat, B. (2021). Engaging students in the learning process with game-based learning: The fundamental concepts. *International Journal of Technology in Education (IJTE)*, 4(3), 542-552. <https://doi.org/10.46328/ijte.169>
- [2] Demers, Michael. (2017). Cartesian Coordinate Systems. 10.1002/9781118786352.wbieg0221.
- [3] Dilao, S. (2013). Intermediate Algebra. (J, Bernabe, Ed.) (Revised Edition). SD Publications, Inc.
- [4] Gafoor, A. and Kurukkan N. (2015). Why High School Students Feel Mathematics Difficult? An Exploration of Affective Beliefs. Retrieved from <https://files.eric.ed.gov/fulltext/ED560266.pdf>.
- [5] Jupri, A., Drijver P. and Panhuizen, M. (2014). Difficulties in Initial Algebra Learning in Indonesia. Retrieved from <https://link.springer.com/article/10.1007/s13394-013-0097-0>.
- [6] Koirala, Hari. (2005). THE EFFECT OF MATHMAGIC ON THE ALGEBRAIC KNOWLEDGE AND SKILLS OF LOW-PERFORMING HIGH SCHOOL STUDENTS.
- [7] Marpa, Eliseo. (2019). Common Errors in Algebraic Expressions: A Quantitative-Qualitative Analysis. *International Journal on Social and Education Sciences*. 1. 63-72. 10.46328/ijonses.11.
- [8] Plass, Jan & O'Keefe, Paul & Homer, Bruce & Case, Jennifer & Hayward, Elizabeth & Stein, Murphy & Perlin, Ken. (2013). The Impact of Individual, Competitive, and Collaborative Mathematics Game Play on Learning, Performance, and Motivation. *Journal of Educational Psychology*. 105. 1050-1066. 10.1037/a0032688.
- [9] Poncy, B. and Duhon, G. (2017). Flashcard Drill and Practice Intervention. Retrieved from <https://brianponcy.wixsite.com/mind/flashcard-drill-intervention>.
- [10] Sapit, C. (2016). Problems and Difficulties Encountered by Grade 10 Students in the District of Mariveles Towards Mastering Learning Competencies in Mathematics: Basis for Mathematics Enhancement Program. Retrieved from <https://www.termpaperwarehouse.com/essay-on/Problems-And-Difficulties-Encountered-By-Grade/502643>
- [11] Sugiarti, L. and Retnawati, H. (2019). Analysis of Student Difficulties on Algebra Problem Solving in Junior High School. Retrieved from <https://iopscience.iop.org/article/10.1088/1742-6596/1320/1/012103/meta>
- [12] Tikkanen, A. (2020). Spin the Wheel. Retrieved from <https://spinthewheel.cc/>
BYJU'S. (2020). Integers. Retrieved from <https://byjus.com/maths/integers/>