Hands-on Games in Learning Selected Topics in Geometry: Effects on Students' Engagement and Performance

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ABSTRACT

Geometry is one of the basic branches of mathematics, which usually proves to be challenging for students because of its abstract nature, leading to disengagement and poor performance. This study investigates the effects of integrating hands-on games in learning selected topics in geometry, focusing on their impact on student engagement and performance. A single-group quasi-experimental design was used, involving forty Grade 10 students. Performance was measured by pre-test and post-tests, while survey questionnaires assessed engagement levels before and after the intervention. The results indicated better engagement and performance on the part of the respondents. In terms of engagement level, the mean increased from 3.51 ("Engaged") before the intervention to 3.86 ("Engaged") after the intervention, thereby indicating a 0.35-point improvement. Similarly, mean performance scores improved by 16.357 points, while all the participants passed the post-test, indicating a significant improvement compared to the pre-test. This research has proved that interactive games help in making geometric concepts learned by students interesting and tangible with the help of understanding about Circles. Additionally, hands-on games become a very precious teaching methodology that helps improve the engagement as well as the performance of the students towards geometry. Moreover, findings point to an important role in involving interactive and experiential learning in geometry teaching, the given information here proving useful to curriculum developers, teachers, and school administrations in setting up a more engaging setting within the classroom.

Keywords: hands-on games, student engagement, geometry performance, interactive learning, circles

INTRODUCTION

Geometry is the application of mathematics in many disciplines and is often considered one of the most difficult parts of mathematics. According to Alghadari and Herman (2018), this perception is due to several reasons, such as limited students' mathematical reasoning in geometry, ineffective teaching methods, insufficient background knowledge, lack of visualization abilities, and weak understanding of geometric proofs. The problems are further complicated by the lack of connection between geometry and real-life contexts and limited opportunities for students to engage with locally available geometric objects and develop hands-on skills. Thus, introducing something new could engage students and enhance the learning process, such as through the integration of hands-on games in teaching.

Hands-on game is a process of learning through activities or games that involve the physical use of hands. It is mainly focused on learning by doing or through personally experiencing the topic rather than being just told about it. In the case of the Mathematics subject, integration of something new or fun could make the class lively and create an interactive learning environment. According to Yang (2016), geometry is the field of mathematics that discusses points, lines, shapes, and space, focusing on spatial reasoning and geometric properties. This study focuses on the topic of Circles. The significance of learning Circles was demonstrated in the variety of its applications in everyday life. Learning Circles begins with its basic units, which are the radius, diameter, and properties, up to its applications (Arnigo et al., 2018). It means that students need more practice and experience in lower-level skills, in this instance definitions and relationships, before they can proceed to reasoning in high levels of difficulty, such as its application.

The idea of using hands-on activities as learning instruments has been traced back to the ancient philosophers such as Plato and Aristotle, who appreciated the advantage of experiential learning. In modern education, hands-on learning has been supported by many scholars as a useful way to improve student motivation, attitudes, confidence, teamwork, and communication, thus promoting a more participatory and applied learning environment. For example, it has been identified through a study conducted by Ekwueme et al. (2015) that practical hands-on activities while teaching math led to enhanced learning on the part of the students. Instructing students on the principles of geometric concepts using games is among those with added relevance nowadays.

This educational innovation remakes the traditional classroom as an engaged, cooperative, and critical space of learning. Experiential games enable a rich-textured learning environment through interactive and sensory engagement that surpasses the effectiveness of traditional pedagogy. Christensen et al. (2015) proved in their study that interactive, experiential learning significantly improves the scientific knowledge and academic performance of students. The only major deficiency of current research is the absence of adequate intensive studies of the differential effects of experiential games on different education levels and topics. As research has begun to detect positive influences of hands-on games, there is insufficient examination of how these influences may vary across different stages of high school mathematics, particularly for geometric topics like circles.

A study by Ekwueme et al. (2015) emphasized the need for further research on the impact of hands-on methods on students' academic performance in mathematics and science. Responding to this gap, the present study investigates the effects of hands-on games on student engagement and performance in learning circles, providing teachers with valuable information. The findings necessitate further research to identify whether the benefits are across education levels and areas of study, and thus, properly assessing the impact of experiential games on student participation and performance.

In this light, this study highlighted the importance of integrating hands-on games in the learning and instruction of geometric concepts, including circles, to promote students' engagement and performance. The findings illustrate the potential of active learning strategies to increase the accessibility of abstract concepts by addressing the difficulties students encounter when learning mathematics, particularly geometry. The results allow the teacher to understand whether the hands-on games can effectively work in many areas of learning and levels, thereby indicating whether such methods would improve academic performance, critical thinking, and teamwork. This study thus contributes to more effective teaching approaches in the classroom.

A. Statement of the Problem

Generally, this study aimed to determine the effects of hands-on games in learning Circles on students' engagement and performance. Specifically, this study sought to answer the following research questions:

1. What is the participants' level of engagement before the intervention?
2. What is the participants' level of engagement after the intervention?
3. What is the participants' performance before the intervention?
4. What is the participants' performance after the intervention?
5. What is the significant difference between participants' level of engagement before and after the intervention?
6. What was the significant difference between participants' performance before and after the intervention?

REVIEW OF RELATED LITERATURE

This section presents the related literature on the effects of hands-on games in education, highlighting their role in improving student engagement and performance, particularly in geometry.

Foundations of Hands-on Games in Education

As Plass et al. (2015) state, although different areas of psychology—cognition, motivation, emotions, and sociocultural aspects—contribute to game design, their applicability to educational game design is subject to various conditions. These include the subject matter of the game, the learning outcomes intended by the game, and the category of game employed. Consequently, insights drawn from particular topics, game purposes, or genres may not be broadly applicable across different contexts. Instead of relying solely on general guidelines or design principles, using game design patterns is more effective. These patterns offer adaptable, high-level solutions that must be tailored to fit the specific needs of each project.

The importance of hands-on games in education has also been justified using behavioral theory. According to Stone (2024), Bandura's self-regulation theory and Skinner's operant conditioning theory are the behavioral foundation of the study. The human mind is a black box. Because of this, students can be conditioned and rewarded. In a game-based learning, the students are forced to succeed and hence learn to be rewarded. In a game-based learning, students can be overdependent on the rewards.

Hands-on games in the learning process are well supported by behavioral theories such as Bandura's self-regulation and Skinner's operant conditioning, which focus on the role of conditioning and reinforcement in learning. However, Smiderle et. al. (2020) conclude that learners respond positively to games, which helps to increase the motivation and interest of introverted students. Game-based learning is particularly beneficial for introverted students who may hesitate to participate in traditional classroom discussions. Engaging in structured, interactive activities allows these students to build confidence and contribute actively to the learning process. When students are engaged in a game, they show increased levels of concentration, motivation, and engagement, which ultimately enhances their overall learning experience.

Hands-on Games and Student Engagement

According to Smith (2018), learners have a positive attitude toward games, which promotes student inspiration and aids learners in obtaining a positive response during the teaching process. It is claimed that games and tricks help with statement and motor coordination. Prensky (2002) emphasizes the importance of removing barriers to learning in the classroom and creating a positive learning environment. Teaching students through hands-on games or amusement is likely to be beneficial to their learning in this regard. Educational games encourage students, particularly timid students, to participate actively, which has a direct impact on a student's motivation, concentration, and engagement in learning Circles.

Jääskä et al. (2022) identify that game-based learning techniques can increase project management education satisfaction by inducing pleasant emotional experiences. Students in their quasi-experiment study experienced fun, achievement, and enjoyment. Furthermore, unplanned challenges, game complexity, and the threat of running out of time created a type of positive stress that sustained students' engagement throughout the learning process. Integrating game-based techniques in project management education can therefore contribute to increased student satisfaction and enhanced learning. Through the balance of enjoyable experience and substantial challenge, teachers can promote a more lively and efficient learning environment.

Hands-on Games and Academic Performance

Moreover, Elshemy (2017) describes how the use of hands-on games can effectively inspire students and positively impact their academic achievement. This research aimed to examine the effects of a gamified approach on boosting motivation and academic performance among students. The researcher evaluated the influence of low enthusiasm on students' academic achievement using various assessment tools, including examination results. Additionally, a questionnaire was administered to explore learners' needs, which revealed that students often rely on interactive resources and struggle to absorb large amounts of knowledge in traditional classroom settings. Therefore, they prefer learning through collaborative activities. According to the findings of the questionnaire analysis, when teaching methods are enjoyable and entertaining, students are more motivated because they are more engaged in the lesson, paying attention, and feeling more confident.

Elshemy (2017) further shows that hands-on games show a positive influence on academic outcomes and motivation. These studies found that gamified approaches elevate motivation and achievement, especially from learners who have very low enthusiasm levels, because they enable great learning experiences by making them joyful and interesting. Additionally, these types of games bring about collaborative environments for learning, critical thinking ability, and an enhanced understanding process.

According to Yusoph et al. (2021), the non-digital game-based learning approach positively impacted students' academic performance. Regarding students' perceptions of this approach, although some students disagreed with certain statements, the majority expressed favorable responses. This suggests that students have diverse learning styles; while some prefer game-based methods, others may not find them as effective or engaging.

Challenges in Hands-on Game-Based Learning

Some researchers and professionals argue that game-based learning may pose challenges or limitations that could hinder the effectiveness of instruction. In the view of Herrington, Oliver, and Reeves (2003), findings in "Engaging Learning Environments: Hands-On, Minds-On Pedagogies" explore the effects of hands-on activities on student engagement and learning outcomes. They discuss the integration of constructivist approaches, emphasizing the significance of hands-on experiences in fostering deeper understanding and critical thinking skills within collaborative learning environments. The study provides insights into effective strategies for incorporating hands-on games to enhance the learning experience in educational settings.

According to Hou (2023), gaps between theoretical insights and practical application in promoting game-based learning have been identified. These discrepancies may stem from the fact that, while numerous studies highlight the effectiveness of educational games, such games are complex systems made up of various elements and mechanisms. Determining which specific game features enhance learning or motivation—and which do not deliver the intended educational benefits—requires more precise investigation. Future research must focus on refining individual game mechanisms to better support learning outcomes.

Though there are a few who argue against game-based learning, emphasizing adverse effects that have been generated by this kind of approach, the work by Herrington, Oliver, and Reeves (2003) proves the fact that hands-on activities would ensure greater involvement and bring out positive results from learning.

METHODOLOGY

The researchers used a single-group quasi-experimental design to determine the effects of hands-on games in learning selected topics in geometry, particularly in Circles, on students' engagement and performance. Additionally, this study employed a single-group pretest-posttest design to collect the necessary data. Quantitative methods were used to examine the relationships between variables through statistical analysis. The pretest and posttest were administered to determine whether significant changes occurred following the implementation of the intervention.

This study was conducted at Mindanao State University – Integrated Laboratory School (MSU-ILS). The researchers chose MSU–ILS as the locale of the study due to easy access to the participants and the presence of the researchers, making it a convenient and conducive setting for the research. The participants of this study were one class of Grade 10. The participants were chosen based on the currently enrolled students in the class. Section Zephyrus, composed of fifty-two (52) students, was selected as the subject of this experiment. However, only forty (40) students were considered participants in the study, as some students were unable to complete both the pre-test and post-test, leading to incomplete data. Despite this, all 52 students were part of the learning process and experienced the same instructional activities.

To determine the effects of hands-on games in learning Circles on students' engagement and performance, the researchers used several instruments. The researchers employed a survey questionnaire to measure the students' engagement. These instruments include Likert scale items to gather quantitative data. To measure the level of students' engagement, the researchers adapted questionnaire from the Math and Science Engagement Scales created by Wang, Fredricks, Ye, and Hofkens (2016), which had strong psychometric properties. The

achievement test, which is researcher-made questionnaire, was utilized to measure the students' performance before and after the intervention. The test consists of 50 items composed of the topics on Circles. It was pilot-tested in March 2024 with a reliability value of 0.82 interpreted as "good" using Cronbach's alpha.

RESULT AND DISCUSSION

This section presents the data analyses of the pre-test, post-test, and the survey questionnaire. To have a clear presentation and better interpretation, the results from this study are presented and projected in tabular formats, graphical representations, and textual explanations.

Table I. Distribution of Participants' Level of Engagement Before the Intervention

No.	Statement	Mean	Standard Deviation	Descriptive Remarks	Rank
1	I go through the work for math class and make sure that it's right.	3.75	1.056	Engaged	4
2	I think about different ways to solve a problem.	3.75	0.899	Engaged	4
3	I try to connect what I am learning to things I have learned before.	3.8	1.091	Engaged	3
4	I try to understand my mistakes when I get something wrong.	3.93	0.971	Engaged	2
5	I have to do the work rather than be told the answer.	3.5	1.013	Engaged	9
6	I think that's hard when I am doing work for class.	3.63	0.979	Engaged	6
7	When work is hard, I study more.	3.38	1.17	Somewhat Engaged	13
8	I stay focused.	3.48	1.198	Engaged	10
9	I put effort into learning math.	3.6	1.057	Engaged	7
10	I keep trying even if something is hard.	3.5	1.261	Engaged	9
11	I complete my homework on time.	3.1	1.033	Somewhat Engaged	17
12	I talk about math outside of class.	3.03	1.33	Somewhat Engaged	18
13	I always participate in class.	3.23	1.368	Somewhat Engaged	15
14	I'm always paying attention to the class.	3.58	1.107	Engaged	8
15	If I don't understand, I don't give up right away.	3.38	1.17	Somewhat Engaged	13
16	I look forward to math class.	3.33	1.141	Somewhat Engaged	14
17	I enjoy learning new things about math.	3.38	1.213	Somewhat Engaged	13
18	I feel good when I am in math class.	3.33	0.917	Somewhat Engaged	14
19	I think that math class is not boring.	3.15	1.075	Somewhat	16

				Engaged	
20	I want to be in math class.	3.45	1.154	Engaged	11
21	I care about learning math.	3.73	1.012	Engaged	5
22	I often feel excited when I am in math class.	3.23	1.165	Somewhat Engaged	15
23	I get motivated when I learn new things about math.	3.73	1.086	Engaged	5
24	I build on others' ideas.	3.43	1.279	Engaged	12
25	I try to understand other people's ideas in math class.	3.58	1.152	Engaged	8
26	I try to work with others who can help me with math.	3.8	1.067	Engaged	3
27	I try to help others who are struggling in math.	3.33	1.163	Somewhat Engaged	14
28	I care about other people's ideas.	3.8	1.067	Engaged	3
29	When working with others, I share ideas.	3.48	1.198	Engaged	10
30	I love working with classmates.	4.03	1.209	Engaged	1
—	**Overall Mean**	**3.51**	—	**Engaged**	—

Scale: 4.20 - 5.00 — Highly Engaged 2.61 - 3.40 — Somewhat Engaged

3.41 - 4.20 — Engage 1.81 - 2.60 — Rarely Engaged

1.00 - 1.80 — Not Engaged

Table I shows the various aspects of the level of engagement before the intervention of Grade 10 students of MSU- ILS. Further, this seeks to determine answer question 1 of the statement of the problem, “What is the participants’ level of engagement before the intervention?

It can be seen that most of the statements were rated as "Engaged" with a total of 19 or 63.33% of the statements falling within this category, while 11 or 36.67% of the statements were rated as "Somewhat Engaged". The weighted mean overall is 3.51, which corresponds to "Engaged," meaning the students showed an average level of engagement in math before the intervention.

Certain strengths were noted, including "I try to help others who are struggling in math" (mean = 4.03), which was almost at the "Highly Engaged" level (4.21–5.00). This finding reflects the tendency of the participants to work together and assist each other in their learning process. On the other hand, statements such as "I do my homework on time" (mean = 3.10) and "I talk about math outside of class" (mean = 3.03) were rated as "Somewhat Engaged," indicating that students have difficulty sustaining effort and interest outside of the classroom.

These results serve as an ideal benchmark for evaluating the effectiveness of the proposed intervention. The moderate level baseline engagement level indicates that despite the degree of involvement shown by students before the intervention, there remains potential for growth in all aspects of engagement, behavioral, emotional, and cognitive. For instance, the lower profiles in task completion and participation outside the class indicate some areas where focused efforts with hands-on games could make a difference. This is by Oladayo and Diri (2024), where they have reported that geometric concepts can be learned and remembered very well when enhanced with hands-on activities; this develops an interactive approach to learning as a facilitative technique to improve engagement and academic performance in geometry.

This is an observation that concurs with a study by Vale and Barbosa (2023) exploring active learning approaches to effective teaching and learning mathematics. Their work revealed that involvement in hands-on activities and the use of manipulatives improve the engagement level and understanding of students in learning mathematics. The result was that deep comprehension and retention of interest by students in learning. Mathematics was possible through active learning approaches.

Table II. Distribution of Participants' Level of Engagement After the Intervention

	Statement	**Mean**	**Standard Deviation**	**Descriptive Remarks**	**Rank**
1	I go through the work for math class and make sure that it's right.	4.13	0.939	Engaged	4
2	I think about different ways to solve a problem.	3.80	0.911	Engaged	14
3	I try to connect what I am learning to things I have learned before.	4.05	0.959	Engaged	7
4	I try to understand my mistakes when I get something wrong.	4.28	0.905	Highly Engaged	1
5	I have to do the work rather than be told the answer.	3.50	0.934	Engaged	20
6	I think that's hard when I am doing work for class.	3.95	0.904	Engaged	11
7	When work is hard, I study more.	3.65	1.122	Engaged	18
8	I stay focused.	4.00	1.013	Engaged	9
9	I put effort into learning math.	3.98	0.974	Engaged	10
10	I keep trying even if something is hard.	4.08	0.971	Engaged	6
11	I complete my homework on time.	3.58	0.844	Engaged	19
12	I talk about math outside of class.	3.18	1.107	Somewhat Engaged	21
13	I always participate in class.	3.73	1.037	Engaged	16
14	I'm always paying attention to the class.	3.98	0.920	Engaged	10
15	If I don't understand, I don't give up right away.	3.90	0.982	Engaged	12
16	I look forward to math class.	3.80	1.018	Engaged	14
17	I enjoy learning new things about math.	3.80	0.966	Engaged	14
18	I feel good when I am in math class.	3.75	0.776	Engaged	15
19	I think that math class is not boring.	3.70	1.159	Engaged	17
20	I want to be in math class.	3.73	0.933	Engaged	16
21	I care about learning math.	3.95	0.904	Engaged	11
22	I often feel excited when I am in math class.	3.73	0.933	Engaged	16
23	I get motivated when I learn new things about math.	4.03	1.025	Engaged	8
24	I build on others' ideas	3.70	0.883	Engaged	17
25	I try to understand other people's ideas in math class.	4.10	0.955	Engaged	5

26	I try to work with others who can help me with math.	4.15	0.975	Engaged	3
27	I try to help others who are struggling in math.	3.58	1.174	Engaged	19
28	I care about other people's ideas.	3.85	1.075	Engaged	13
29	When working with others, I share ideas.	4.10	0.744	Engaged	5
30	I love working with classmates.	4.18	.95776	Engaged	2
		3.86		**Engaged**	

Scale: 4.20 - 5.00 — Highly Engaged 2.61 -3.40 — Somewhat Engaged

3.41 - 4.20 — Engage 1.81 - 2.60 — Rarely Engaged

1.00 - 1.80 — Not Engaged

The data presented in Table II are various aspects of the participants' level of engagement after the intervention, which aims to answer question 2 on the statement of the problem, "What is the participants' level of engagement after the intervention?".

It can be observed that most of the statements were rated "Engaged" (3.41–4.20), with a total of 28 out of 30, one statement was scored as "Somewhat Engaged" (2.61–3.40), and one statement was rated as "Highly Engaged" (4.21–5.00). An overall weighted mean of 3.86 corresponds to "Engaged," which means the level of engagement of the participants is significantly increased compared to the pre-intervention weighted mean of 3.51. This corresponds to an improvement of 0.35, and it means that the inclusion of hands-on games positively affected students' engagement in learning mathematics. The highest-rated statement indicates an improvement toward cognitive engagement, is "I try to understand my mistakes when I get something wrong" (mean = 4.28); students demonstrated that they were willing to assess and learn from errors. Similarly, statements such as "I love working with classmates" (mean = 4.18) and "I try to work with others who can help me in math" (mean = 4.15) indicate the influence of hands-on games in encouraging collaboration and peer interaction. However, the statement "I talk about math outside of class" (mean = 3.18) remained at "Somewhat Engage," indicating that engagement outside the classroom still needs attention.

These accord with Hetmanenko et al. (2024), who used interactive learning strategies to enhance interest and engagement among students in mathematics. According to the research, it shows that through interactive learning strategies, abstract ideas have been made accessible to understanding through experience, thus enhancing participation and motivation. In addition, Gutierrez Jr. and Doronio (2024) argued that the classroom environment will be positive, with interactive activities, which promote engagement among the students by having meaningful and fun learning experiences. This significant improvement in engagement levels observed in this study underscores the effectiveness of hands-on games in transforming the learning environment. Such strategies promote collaboration, critical thinking, and active participation to address challenges often associated with disengagement in mathematics education.

Table III. Distribution of Participants' Performance Before the Intervention

Participants	**Raw Scores**	**Transmuted Grade**	**Frequency**	**Percent**	**Mean Rating**	**Qualitative Rating**
	6	56	1	2.5	**17.05/ 66.5**	**FAILED**
	7	57	1	2.5		
	9	59	1	2.5		
	11	61	1	2.5		
	12	62	4	10		

	13	63	1	2.5		
	14	64	1	2.5		
	15	65	2	5		
	16	66	1	2.5		
	17	67	4	10		
	18	68	8	20		
	19	69	6	15		
	20	70	2	5		
	21	71	3	7.5		
	22	72	1	2.5		
	24	74	1	2.5		
	25	75	1	2.5		
	28	78	1	2.5		
	TOTAL		**40**	**100**		

Scale: 98 and above – Excellent 81 - 86 – Fair/Satisfactory

93 - 97 – Very Good 75 - 80 – Passing

87 - 92 – Good 74 and below – Failed

The data presented in Table III are various aspects of the pretest results, which aim to answer question 3 on the statement of the problem, “What is the participants’ level of performance before the intervention?”

As shown, only 2 participants (5.00%) passed the pre-test, while the majority, 38 participants (95.00%), failed. The average pre-test score was 17.05, corresponding to a grade equivalent of 66.5, which is considered a failing mark. This indicates that most participants performed poorly on the pre-test. The researchers believe that the poor performance during the pre-test could be associated with the reason that the majority of the students had not yet to formally learned the relevant concepts in geometry, as evaluated in the pretest. Since the students had not covered such topics in their mathematics coursework, they were short of prior knowledge and mastery, which made them lowered their scores. This indicates that their level of performance requires improvement.

This discovery is consistent with previous studies where students have difficulties with abstract mathematics concepts, especially if they are being taught using traditional methods. It has been learned that the combination of hands-on learning can solve this problem. Li et al. (2023) presented a study in which hands-on activities greatly improved the geometry solving skills of middle school students, especially those students with lower academic performance initially.

Table IV. Distribution of Participants’ Performance After the Intervention

Participants	**Raw Scores**	**Transmuted Grade**	**Frequency**	**Percent**	**Mean Rating**	**Qualitative Rating**
	25	75	2	5	**32.6/ 82.857**	**FAIR/ SATISFACTORY**
	27	77	3	7.5		
	28	78	2	5		
	29	79	2	5		
	30	80	3	7.5		

	31	81	2	5		
	32	82	4	10		
	33	83	8	20		
	34	84	3	7.5		
	36	86	4	10		
	37	87	1	2.5		
	38	88	4	10		
	39	89	1	2.5		
	41	91	1	2.5		
	TOTAL		**40**	**100**		

Scale: 98 and above – Excellent 81 - 86 – Fair/Satisfactory

93 - 97 – Very Good 75 - 80 – Passing

87 - 92 – Good 74 and below – Failed

The data presented in Table IV are various aspects of the post-test results, which aim to answer question 4 on the statement of the problem, "What is the participants' level of performance after the intervention?"

As shown, all 40 participants (100%) passed the post-test. The average post-test score was 32.6, corresponding to a grade equivalent of 82.86, which is described as fair/satisfactory. As demonstrated, the 16.357 increase shows there is an increase in performance from the post-test for the participants than the pre-test.

A marked performance improvement was observed to be a reflection of the enhancement brought about by the hands-on games in understanding and mastering the concepts of mathematics about Circles. This was also supported by the studies by Bui et al. (2022), which pointed out that experiential learning techniques, like hands-on games, improve arithmetic and geometry skills as students actively participate in learning activities. In addition, score increases show that hands-on games were interesting and participatory for students to engage in mathematical experiences, thus being able to use math actively to fill in knowledge gaps and be confident in problem-solving.

The fact that students were more interested and involved during the hands-on games when they blended with learning activities shows that the integration of the games facilitated room for problem-solving, exploration, and critical thinking. According to Elshemy (2021), game-based learning not only enhances the academic performance of the students but also enhances motivation among the students, especially when they initially did not have enough interest in the subject matter. Hands-on games transform the classroom into an interactive place where students persevere through more challenges and tend to achieve better outcomes by making learning enjoyable and meaningful.

Additionally, the study of Abdullah and Hassan (2022) also promotes hands-on learning because it strengthens deep conceptual understanding and critical thinking. The experiment done by this study showed that students who learned through their own hands can recall information long time and apply such information effectively while solving problems. These results support the current study, highlighting the significance of innovative strategies like hands-on games in promoting academic success.

In conclusion, the results of the post-test provide compelling evidence that the effective implementation of hands-on games in the learning process significantly enhances student performance, particularly in mathematical topics that may initially pose challenges for them.

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Table V. Significant Difference Between Participants' Level of Engagement Before and After the Intervention

	N	Mean Rank	Sum of Mean Ranks	Z - score	P - value	Interpretation
Level of Engagement Before the Intervention	40	15.00	435.00	**-4.705**	**0.000**	**Significant**
Level of Engagement After the Intervention	40	0.00	0.00			

Table V presents the results of the Wilcoxon Signed-Rank Test, which was used to examine significant differences in participants' levels of engagement before and after the intervention. The test yielded a calculated z-score of -4.705 and a p-value of 0.000, indicating a statistically significant difference at the 0.05 level.

This shows there is a significant difference between the participants' engagement levels before and after the introduction of hands-on games. The significant increase in engagement demonstrates that hands-on games positively impacted the participants' overall involvement, collaboration, and motivation.

This finding is supported by Ghanizadeh and Jahedizadeh (2022), who found that interactive teaching strategies significantly enhance cognitive, emotional, and behavioral engagement in the classroom. Their study emphasizes that student-centered approaches, such as hands-on activities, foster a sense of ownership in learning and create a more engaging educational experience.

The results indicate that using hands-on games allowed the learners to interactively and collectively explore concepts and, therefore, increase their level of engagement. Such teaching approaches are very effective in transforming abstract topics, like geometry, into relatable and interactive learning experiences, fostering interest and deeper understanding among learners.

Table VI shows the results of the Wilcoxon Signed-Rank Test comparing the pre-test and post-test performance of the participants. The calculated Z-score was -5.516, with a p-value of 0.000, which is statistically significant at the 0.05 level. This indicates a significant difference between the pre-test and post-test scores. Furthermore, the post-test scores were higher than the pre-test scores, demonstrating that the use of hands-on games substantially improved the participants' performance.

This outcome follows the research undertaken by Abisai (2018), which shows the advantages of hands-on games in making students perform effectively in mathematics. Abisai's study found that using game-based learning not only enhances academic achievement but also increases student engagement and motivation, particularly in subjects like mathematics, where students often struggle with abstract concepts. In particular, it is such direct activities as were used in this geometry experience that may aid in making previously difficult topics better felt and understandable, and, through this, improvement in understanding and performance.

Similar is the case of Sapin (2022), games involving action should be incorporated into mathematics teaching. According to Sapin, the games also provide an easy way of achieving the learning objectives as they offer participation and a pleasurable learning experience. His findings were also underpinned by how such action-based games can give student learners different attitudes toward mathematics, which they proclaim to be difficult. Hands-on games further enhance faster learning as well as retain long-term memory, as these enhance motivation and provide a more enjoyable learning nvironment.

Other than the above studies, Tessema and Azeb (2023) examined the impact of the realist experiential learning strategy on students' conceptual understanding and mode of solving problems while learning solid geomentry. According to the findings of the researchers, students who received hands-on activities outperformed the students who were taught using conventional methods through knowledge-based approaches both in conceptual understanding and problem-solving skills. This supports that practical, student-centered learning of geometric concepts serves to improve one's understanding of concepts and how an individual can manipulate them.

Elshemy (2019) also did a study that presented the role that educational games play in improving mathematical thought as well as critical thinking. His findings were that game-based learning of mathematics curricula enhances cooperation, critical thinking, and strengthens conceptual knowledge of students. Like in the current research, Elshemy's study also demonstrates that considerable changes happened in the academic performance of the students after students had to undergo hands-on games in the class sessions.

These related studies fortify the argument that the use of game-based learning in the classroom, especially in areas like mathematics, greatly contributes to increased student performance. The performance improvements brought about by this study follow a trend that earlier researchers confirmed pervasive effectiveness of interactive methods of learning in enhancing the understanding and mastery of complex subject matters.

CONCLUSION

This research sought to determine the impact of hands-on games on students' engagement and performance in learning the lesson about Circles. The results indicated that before the intervention, students had a moderate level of engagement, with the majority of responses falling under the category "Engaged," although some areas, like participation in discussions outside the classroom, were lower. In addition, the pre-test scores indicated that the majority of the students were struggling to understand geometric concepts on Circles, as revealed by their low performance scores, hence a call for other types of instructional methods to enhance understanding.

After the intervention, there was a marked increase in performance and engagement. Post survey responses indicated increased participation, collaboration, and learning interest in geometry, particularly in solving problems and discussing concepts. Furthermore, post-test scores indicated a significant performance improvement, as all participants had passing grades. Statistical analysis revealed a significant difference between the pre- and post-intervention levels of student engagement and performance, confirming the positive impact of experiential games on active learning. The results align with previous studies on experiential learning, further reiterating the use of interactive activities in simplifying abstract mathematical principles and making them more appealing.

The findings of this study underscore the need for incorporating hands-on games in geometry, since they ensure a more interactive and interesting learning environment with increased student involvement and conceptual knowledge. Educators and curriculum designers can think of introducing similar methods to lesson plans to enhance performance and participation in mathematics. Further research is warranted to examine the long-term consequences of hands-on games on retaining knowledge and mathematical skills. Furthermore, control group research can further reveal whether hands-on games or conventional lessons are more effective comparatively.

In summary, incorporating hands-on games in teaching the lesson about Circles was an efficient teaching method that greatly enhanced the level of engagement and performance of the students. Through active involvement, greater understanding, and pleasure in learning, hands-on games help achieve a more interactive and student-focused approach to the study of mathematics.

Table VI. Significant Difference Between Participants' Performance Before and After the Intervention

	N	**Mean Rank**	**Sum of Mean Ranks**	**Z - score**	**P - value**	**Interpretation**
Pre-test	40	20.50	820.00	**-5.516**	**0.000**	**Significant**
Post-test	40	0.00	0.00			

RECOMMENDATIONS

Based on the findings, curriculum developers should incorporate hands-on games into mathematics curricula, particularly in Geometry topics like Circles. Design student-centered learning plans that foster active engagement and deeper conceptual understanding. School Administrators should provide professional

development for teachers on game-based instruction and foster a culture of innovation by supporting research-driven teaching strategies. Teachers must utilize hands-on games regularly, especially for abstract Geometry lessons. Monitor student engagement and adapt strategies accordingly. Implement games such as *Circle Twister*, *Theorem Relay*, *Sight Word and Number*, *Take it or Leave it*, and *Circle Explorer*. Parents must support classroom learning by encouraging math games at home and nurturing a positive attitude toward mathematics. Students must participate actively in hands-on math activities to better understand concepts and develop collaborative problem-solving skills. Future Researchers must **s**tudy the long-term impact of game-based learning on retention and skills. Use control groups to compare instructional approaches and expand the research to broader contexts. Investigate how specific games influence critical thinking, collaboration, and real-world engagement, and explore the role of community and parental involvement in sustaining math interest.

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