GAMIFICATION: ITS EFFECT ON THE ACADEMIC ACHIEVEMENT AND ATTITUDE IN MATHEMATICS

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ABSTRACT

This quasi-experimental research examined the effectiveness on the use of gamification as compared to the use of interactive discussion in the academic achievement of the students and their attitude towards mathematics. A total of 80 Grade 8 students in Nabunturan National Comprehensive High School, Schools Division of Davao de Oro, were utilized as subjects in the study – 40 students in the control group: 40 students in the experimental group. The pre-existing sectioning of the students at the start of the school year was not altered and the general sections were considered. Researcher-made test questionnaire in mathematics was utilized to measure the academic achievement of the students while an adapted instrument was utilized in quantifying the students' attitude towards mathematics. Validity and reliability measures were conducted to ensure that the instruments measure the objectives set forth in the study. Descriptive results showed that the onset attitude of the students towards mathematics was moderate for both control and experimental groups. The competency level of the students in the pretest was low for both control and experimental groups. Subsequently, after the intervention, the competency level of the students in the control group remained low while that of the experimental group showed improvement from low to moderate implying that their academic achievement improved from unsatisfactory to satisfactory. In terms of the attitude towards mathematics, the findings revealed that the experimental group's demonstration of positive attitude towards mathematics is significantly higher than the control group ($p<0.05$). On the other hand, the students in the experimental group showed significantly higher posttest scores as compared to the control group, implying that the use of gamification is more effective in improving the academic achievement of the students in mathematics. Findings indicative on the use of gamification in teaching mathematics and further explore its effectiveness on the other units of the subject.

Keyword: *Mathematics, Gamification, interactive discussion, quasi-experimental, Department of Education, Davao de Oro, Philippines*

1. INTRODUCTION

1.1 Background of the Study

Gamification is an emerging trend in the field of mathematics education. This approach not only cultivates a pleasant and engaging learning environment but also garners positive feedback from students. Recent study of Jutin and [1] showed that gamification support the students' learning such that it improves the students' engagement in the subject. On the contrary, despite the widely acknowledged and esteemed significance of mathematics, the persistent issue of subpar academic achievement among students continues to be a matter of concern within educational institutions in both developed and developing nations [2]. A study conducted in secondary schools in Fiji revealed that the deficiency in the required competencies in mathematics primarily contributes to poor academic achievement [3]. Moreover, research revealed that the students exhibited a pessimistic disposition towards the

subject of mathematics. Wakhata, et al. [4] found that in Uganda, majority of the secondary students being surveyed demonstrated negative attitude towards mathematics.

Meanwhile, the 2019 TIMSS results revealed that the Philippines scored lowest in Mathematics among all 58 participating countries. Locally, in Davao Region, a study revealed that there was a notable poor academic achievement among the students in the public schools for subjects that were taught in English such as Mathematics, and related Sciences. Evidently, results indicated that students were performing at a very low level [5]. Specifically, in the research locale, Nabunturan National Comprehensive High School, the achievement level of the Grade 8 students was 42.29% for the School Year (SY) 2022-2023.

With the presented scenario, the researcher deemed it imperative to look for instructional modifications that would not only enhance the achievement of the students but would also influence the way they perceive the subject. The conduct of the study was essential in support of the Department of Education's drive to close the learning gap in Mathematics even before the pandemic. The findings of the study may serve as basis for crafting instructional innovations that can aim for the improvement of the students' academic achievement and attitude towards Mathematics.

1.2 Review of Related Literature

Gamification is the application of game-like strategies, models, dynamics, mechanics, and elements in non-game contexts. Its purpose is to convey a message or content, or to modify behavior, through a playful experience that encourages motivation, engagement, and enjoyment [6]. The integration of gamification into the educational setting is a relatively recent development, despite the longstanding playful nature of video games [7]. Gamification has arisen as a pedagogical strategy that involves incorporating game components into instructional contexts that are not typically intended for play. Studies on pedagogical methods and student motivation indicate that creating a pleasant, comfortable, secure, and engaging setting is an effective way to foster lifelong learning and attain positive outcomes in educational institutions [8]. Despite students perceiving studying as tedious gamification has the ability to boost the learning process. According to the authors, gamification provides the opportunity to create and recreate experiences, which can lead to changes in behaviour while giving a sense of autonomy and authority [9].

On the other hand, exam scores are assessed based on established standards, which function as indicators of students' academic achievement. Grades constitute an integral component of the educational process that is inevitable. Effectively assessing pupils' performance across several subject areas is of utmost importance in this particular scenario. Although there are differing opinions on student ranking, the existing literature provides sufficient evidence to support the notion that students' grades should accurately reflect their academic performance [10]. In the same stance, the outcomes of summative tests serve as a concrete measure for evaluating academic achievement. Assessment findings were utilized as a dependable data source in educational research. The assessment outcomes evaluate the extent to which the learners have achieved proficiency in the competencies that were instructed [11]. The global pandemic had a substantial impact on students' academic performance in the field of Mathematics. Research has demonstrated that the global school systems are experiencing significant disruptions because to the urgent nature of the Covid-19 pandemic. Around 1.6 billion students, or 94 percent of the world's student population, were affected by educational institution closures in over 190 countries. The suddenness of the problem took teachers and administrators off guard, forcing them to build emergency remote-learning systems. Consequently, the occurrence of learning deficits was observed [12].

Meanwhile, attitude pertains to individuals' perceptions and responses towards their surroundings and is seen as a significant factor in the context of learning and various conditions. According to Cai, et al. [13], the presence of a negative attitude can significantly disrupt the classroom environment. According to Wijaya, et al. [14], attitude is a multifaceted and distinctive notion that encompasses several features and spans across numerous domains. Additionally, attitudes towards mathematics should not be viewed as a broad and uniform characteristic, but rather as a composition of distinct and specialized components, encompassing a multidimensional understanding of attitude. The dimensions in our situation include the perception of mathematical incompetence, enjoyment of mathematics, perception of utility, and mathematical self-concept [15]. Further, different types of emotional responses, both negative and positive, impact the learning environment and tasks of students when they encounter exams and academic assignments. Students who exhibit unpleasant affective responses may experience worry, ennui, and distress, leading them to avoid engaging in academic pursuits, display lethargy in the educational setting,

and potentially even withdraw altogether. According to the research conducted experiencing unfavorable affective reactions, such as stress, might lead to a decline in motivation for learning and a tendency to avoid academic tasks [16]. Anxiety is a common condition that manifests in every individual. Anxiety is recognized as a hindering element in the process of learning, as it can impede a person's cognitive performance by affecting their ability to concentrate, recall information, comprehend concepts, and solve issues. This has been documented in the context of concentration, in relation to memory, and in terms of understanding concepts and problem-solving [17][18]. To sum up, students' diverse encounters with mathematics shape their attitudes towards the subject. Their psychological state is influenced by their cumulative experiences with a subject, which in turn shapes their attitude, either positively or negatively [19]. According to Mullis, et al. [20], students who had a favorable outlook on mathematics showed a greater inclination to engage in mathematics courses and devoted more time to studying the subject compared to students with a pessimistic perspective. On the other hand, students who have a pessimistic outlook on mathematics view it as a superfluous subject and experience fear when it comes to engaging in related courses.

1.3 Theoretical Framework

Foundation theories were used in the study of Egri, et al. [21] in their investigation on the effect of gamification to the achievement of the students in mathematics. Based on the cited theories, the human mind might be conceptualized as a black box. Consequently, by means of conditioning and reinforcement, students can be compelled to acquire knowledge. The theory was supported in the findings of Jamil, et al. [22] that students who received treatment using gamified methodology attained superior scores compared to students who received non-gamified methodology. This finding further supports the notion that students exhibited favorable motivation towards engaging in gamified activities within the classroom setting. Based on the research findings, it was recommended that the curriculum be modified to incorporate gamified activities in order to impact students' academic performance.

1.4 Statement of the Problem

The main purpose of the study was to determine the effect of gamification in the students' academic achievements and their attitudes towards Mathematics. Moreover, it sought to determine the significant difference in the mean pretest and posttest score of the control group; significant difference in the mean pretest and posttest score of the experimental group; significant difference in the posttest scores of the control and experimental groups; significant difference in the attitude of the students towards mathematics before and after the intervention in the control group; significant difference in the attitude of the students towards mathematics before and after the intervention in the experimental group; and the significant difference in the attitude towards mathematics of the control and experimental groups after the intervention.

1.5 Scope and Delimitation of the Study

The study was confined to a sample of Grade 8 public school students in Nabunturan National High Comprehensive High School for School Year 2024-2025. The control and experimental groups were from the same grade level. The study was delimited to the scores of the students in their pre-test and posttests administered. The items of the test were made based on the DepEd's Most Essential Learning Competencies (MELCs) in Grade 8 Mathematics for quarter 1 about Rational Algebraic Expressions. Moreover, this was delimited to the topics on illustrating rational algebraic expressions, simplifying rational algebraic expressions and operation on rational algebraic expressions. Furthermore, this was delimited to the students' responses in the survey instrument for their self-reported attitude towards learning mathematics.

1.6 Significance of the Study

The findings can provide new insights into the factors that had significantly influenced the academic achievement and attitude towards learning mathematics of the students in public secondary schools. Specifically, the students would benefit greatly from the outcomes of this study because they would experience teaching strategies that may suit to their preference. Further, the findings may help them to adopt strategies that would enhance their academic achievement. Subsequently, the findings of the study would provide a mechanism for teachers to reflect on their practices. They would be able to improve on their instructional practices and would further develop their digital literacy as well so they can fully assist the needs of their learners. In addition, the school administrators may utilize the findings to create programs and activities that support students' instructional needs. On a bigger scope, the

findings would serve as bases for crafting intensified programs and policies that could assist the achievement problem in the field. This may also serve as a starting point for an evaluation of existing systems, particularly in terms of providing instructional support to promote achievement and positive attitude towards learning. Finally, future researchers. Future researchers who would want to confirm the conclusions of this study may find this study useful.

2. METHODS

2.1 Research Design

The study utilized the quantitative design, specifically the matching-only pretest-posttest control group quasi-experimental design. According to McGregor [23] quantitative research involves using a pre-established research plan that is based on logical reasoning. This plan organizes, standardizes, and codifies the research into clear principles, formal methods, and methodologies. The purpose of this was to allow others to easily follow the same linear plan and replicate the study. Similar to true experimental studies, the quasi-experimental design aimed to determine the cause-and-effect relationship between an independent and dependent variable. However, in this design, the groups were assigned using non-random criteria [24]. Specifically, the experimental and control groups are tried to be matched based on a specific variable [25]. In the context of this study, the variable to be matched was their academic standing before the start of the introduction of the intervention for the experimental group. The purpose of the quasi-experimental design method was to determine the amount of change between the experimental and the control group [25].

2.1 Research Locale

The study was conducted in Nabunturan National Comprehensive High School, Nabunturan West District, Division of Davao de Oro. As a brief geographic background, Republic Act No. 2039 established the Municipality of Nabunturan on July 23, 1957. The municipality of Compostela previously had Nabunturan as one of its barangays. The municipality is classified as first-class and served as the capital of the Province of Davao de Oro, previously known as Compostela Valley Province. Significantly, the respondents were coming from Nabunturan National Comprehensive High School, formerly known as Compostela High School, a public high school in Nabunturan, Davao De Oro. It was official established under Republic Act No. 5551. The school is located in Poblacion, Nabunturan, Davao de Oro.

2.2 Subjects of the Study

This research utilized two sections of Grade 8 of the Nabunturan National Comprehensive High School. The students in these sections were not randomly selected since there was a pre-existing section grouping. Hence, the use of quasi-experimental strategy. To address credibility and validity issues, the two groups were drawn out from the general sections and were given pretests to establish that they were at par with each other before the introduction of the intervention. There were 40 students in the experimental group and 40 students in the control group.

2.2 Research Instruments

This study utilized a researcher-made test in Mathematics to measure the students' achievement. A panel of experts validated the research instruments to determine their appropriateness in the context of this study.

Test Questionnaire in Mathematics (TQM). The researcher designed a 40-item multiple-choice test questionnaire in Mathematics to measure the academic achievement of the students in this subject. These items were made based on the DepEd's Most Essential Learning Competencies (MELCs) in Grade 8 Mathematics for quarter 1. The assessment comprised of 10 items focused on illustrating rational algebraic expressions, 10 items on simplifying them, and 20 items on performing operations involving rational algebraic expressions. Additionally, a table of specification (TOS) was made to specify the competencies of each item of the test. The percentage scores of the respondents were determined to measure the academic achievement. This percentage scores were derived by dividing the raw scores by the highest possible score multiplied by 100. To determine the level of students' academic achievement, the following parameters, descriptive equivalents, and interpretations presented below were used as adapted from the work of Smith and Brown [26].

Attitude Towards Mathematics. The instrument was a 19-item survey with the following indicators: students' math self-concept; perceived usefulness of mathematics; interest for mathematics which was adapted from the work Marquina and Gallego [27]. The survey questionnaire included 7 items measuring students' math self-concept, 5 items assessing the perceived usefulness of mathematics, and 7 items evaluating their interest in mathematics. The respondents' attitude towards mathematics on each of the indicators were rated using a 5-point Likert scale ranging from 1 for ''strongly disagree" to 5 for ''strongly agree".

2.3 Validity and Reliability of Research Instruments

The questionnaires for the researcher-made questionnaire in mathematics and attitude towards mathematics an were subjected to content validation by both internal and external panel of experts. This was done to ensure that the contents of the questionnaires were within the scope intended for this study. This was followed by pilot-testing of the researcher-made instrument. The pilot test was administered to 30 students who were not part of the experimental process. The purpose of the pilot testing was to establish that the reliability and validity of the formulated tests to be administered for revision and improvement, if necessary.

2.4 Validity and Reliability of Research Instruments

The researcher-made questionnaire in mathematics was subjected to item analysis. The process included the determination of the discrimination index, difficulty index, overall average index, and evaluative remarks.

Table -1: Item Analyses of the Researcher-Made Questionnaire

Descriptive Rating	Discrimination Index (%)	Difficulty (%)	Overall (%)	Remarks
Very Good	60	60	27.5	Retained
Good	20	22.5	72.5	Retained
Fair	20	17.5		Retained

The table shows that there were items included in the researcher-made questionnaire which has a discrimination index of 0.6 or 60% and difficulty of 60%; described as very good. In addition, there were items with a discrimination index of 20%; described as good. Baustista & De Vera [28] posited those items with discrimination index of $0\% < D < 30\%$ with low and high difficulty; and $D \geq 30\%$ with low to high difficulty are retained.

2.5 Research Procedure

Permission to perform the study was sought by the researcher. After all protocols had been reviewed and observed, the researcher got an endorsement letter from the Dean of Graduate School. After which, the researcher sent the letter of approval for the study's conduct to the Office of the Schools Division Superintendent of Davao de Oro, along with the endorsement letter as an attachment. Upon approval, a copy permitting to conduct the study was furnished to the school principal of the research locale to gain access to possible respondents of the school.

The respondents' and their parents were given a general orientation wherein the researcher discussed the purpose of the research, the extent of the respondents' participation, mode of data collection, type of data that were gathered, and the mode of data processing and presentation. The ethical considerations were also discussed as well. Further, respondents were assured that all information were kept confidential. Subsequently, respondents' and their parents were requested to voluntarily sign forms, parental consent for the parents and assent form for the respondents.

The experimental group was exposed to different gamified activities relevant to the topic. These were a blended activities where the students were exposed to both online gamifications and teacher-innovated activities. The games were incorporated in the learning plan. The students were exposed in concept discussions and drill; however, the drills were not plainly board work, but this was gamified.

The researcher personally administered the research instrument both in pretests and post-tests. The administration of the test was in face-to-face modality. Since there were 40 items, a maximum of 60 minutes was allotted for the students to complete the test. Examination papers were personally checked by the researcher. Scores were collated using Microsoft Excel and were sent to the statistician of Assumption College of Nabunturan for processing. The respondents were assigned with numbers or codes instead of their real names. Meanwhile, the interpretations of the data results were made by the researcher.

2.6 Ethical Considerations

To gain the public's trust and support, researchers must uphold ethical norms in their work. The definition of participants is included in the research introduction, which also highlighted the importance of ethical considerations in the design, review, and conduct of this study when conducting research on educational quality [29]. The National Ethical Guidelines for Health and Health-Related Researches serves as the foundation for this study's ethical review.

To earn the trust and backing of the public, it is essential for researchers to adhere to ethical standards. The introduction of the research defines the participants and emphasizes the significance of ethical considerations in the study's design, review, and execution, particularly when investigating educational quality [29].

Social Values. Including participants in a study is justified by its potential social value. When the research hypotheses or questions addressed have the possibility to benefit a particular demographic, subgroup, or community, the study is considered socially valuable [30].

Informed Consent. In order to employ informed consent, a person must voluntarily decide to accept a particular treatment or experiment after going through an educational and deliberate process. They must also be aware of the nature of therapy, its potential repercussions, and its risks [31].

Vulnerability of the Research Participants. Gordon [32] cites the US Department of Health and Human Services (HHS) Policy for the Protection of Human Subjects, which emphasizes the need of safeguarding the welfare and rights of study participants who are at risk. The ability of the participants to make wise and defensible decisions was used to gauge their vulnerability. Vulnerable participants are individuals who may be more likely to be harmed or to incur higher costs, according to the Belmont Report [33].

Risk, Benefit and Safety. Emphasizing the significance of research necessitates acknowledging and predicting potential risks and implementing suitable measures to ensure the safety, well-being and ethical treatment of study participants. Implementation of mitigating measures against potential risks is intended to reduce the hazards and increase safety for those who may be discussing sensitive topics [34]

Data Privacy and Confidentiality. The practice of maintaining data privacy and confidentiality is implemented to safeguard the participants, build rapport and trust with them while maintaining the integrity of the study methods and ethical requirements. When it is not possible to remove identifiable information from the data, they are required to get consent before releasing such data. Therefore, the code requires acquiring more agreement when it is not possible to modify the data [35].

Justice. The ethical principle of justice raises inquiries regarding the allocation of the research's responsibilities and the distribution of its benefits [36] According to Al Halbusi, et. al. [37] one way of implementing justice is to inform the participants to explicitly communicate to them that they will not immediately reap any benefits from the research. On the other hand, justice also entails providing the participants with due recognition and respect as both knowers and providers of information.

Transparency. Research transparency provides collective understanding that researchers have a moral responsibility to enable the assessment of their knowledge claims based on evidence. This is achieved by making their evidence, analysis, and research design accessible to the public [38] On a similar note, Jacobs et al. [39] pointed out that researchers are required to disclose the evidence supporting their empirical findings.

Qualification of the Researcher. Competency in research is essential for carrying out ethical studies involving human subjects. Human ethical review committees (HRECs) must assess whether researchers possess the

necessary research skills and experience to conduct the proposed research. In other words, the research should be carried out or supervised by individuals or teams who have the appropriate qualifications and competence for the task [40].

Adequacy of facilities. The smooth conduct of research requires that the facilities are adequate for the safety and protection of the participants. This also entails the need to have an adequate resource and space to store data securely; ensuring that the participant's' private information are kept confidential [40].

Community Involvement. Collaborative engagement, cultural sensitivity with respect to communities are some of the venues for community involvement. Further, conduct of researches are more meaningful when the study outcomes may bring benefit to the community [41].

2.7 Statistical Treatment

For comprehensive interpretation and analysis of data, the following statistical tools in Statistical Package for Social Sciences (SPSS) were used: mean was used to determine the level of the students' achievement in pretest and posttest, both in the experimental and control groups. On the other hand, independent t-test. This was to determine the significance of the differences of the scores in the experimental and control groups. Finally, paired t-test was used to determine the significance of the differences of the scores in the pretest and posttest of the respondents within a group.

3. RESULTS

Table -2: Mean Pretest Score of the Control and Experimental Group

Group	Number of Students	Mean	Percentage Score	Descriptive Equivalent
Control (Section Dahlia)	40	10.30	25.75%	Low
Experimental (Section Lilac)	40	11.70	29.25%	Low

Table 3 shows the results of the pretests administered to the control and experimental groups. Results show that the control group had a mean score of 10.30, equivalent to a percentage score of 25.75% with a descriptive equivalent of low. On the other hand, the experimental group has a mean of 11.70 or 29.25%, also described as low.

Table -3: Mean Posttest Score of the Control and Experimental Group

Group	Number of Students	Mean	Percentage Score	Descriptive Equivalent
Control	40	13.80	34.50%	Low
Experimental	40	18.00	45.00%	Moderate

As shown in Table 3, the mean posttest score of the control group was 13.80, equivalent to a percentage score of 34.50%. with an equivalent of low. Meanwhile, the results showed that the experimental group has a mean posttest score of 18.00 or 45.00%; described as moderate.

Table-4: Significance of the Difference in the Mean Pretest and Posttest Score in the Control Group

Control Group	N	Mean	df	P-value	Interpretation
Pretest	40	10.30	78	<0.001	Significant
Posttest	40	13.80			

α = 5%

As presented in Table 4, the mean pretest score of the control group is 10.30 while their posttest is 13.80. Its p-value of less than 0.001; interpreted as significant.

Table-5: Significance of the Difference in the Mean Pretest and Posttest Score in the Experimental Group

Control Group	N	Mean	df	P-value	Interpretation
Pretest	40	11.70	78	<0.001	Significant
Posttest	40	18.00			

α = 5%

As presented in Table 5, the mean pretest score of the experimental group is 11.70 while their posttest is 18.00. Its p-value of less than 0.001; interpreted as significant.

Table-6: Significance of the Difference in the Mean Posttest Scores of the Control and Experimental Group

Group	N	Mean	df	P-value	Interpretation
Control (Section Dahlia)	40	13.80	78	0.000	Significant
Experimental (Section Lilac)	40	18.00			

As shown in Table 6, the mean posttest score of the control group is 13.80 and the experimental group is 8.00. The test for the significant difference shows that the p-value is 0.000; interpreted as significant.

Table-7: Attitude of Students towards Mathematics of the Control and Experimental Group before the Intervention

Group	N	Self-Concept	Utility	Interest	Overall Mean	Interpretation
Control (Section Dahlia)	40	3.00	3.52	3.19	3.23	Moderate
Experimental (Section Lilac)	40	2.86	3.80	3.36	3.34	Moderate

Table 7 shows that the attitude of the control group towards mathematics before the intervention is as follows: self-concept is 3.00; utility has a mean of 3.52; interest is 3.19; with an overall mean rating of 3.23. All mean values are interpreted as moderate. The attitude of the experimental group before the intervention reveals the following values: self-concept is 2.86; utility has a mean of 3.80; interest is 3.36; with an overall mean rating of 3.34. These mean ratings are interpreted as moderate.

Table-8: Attitude of Students towards Mathematics of the Control and Experimental Group after the Intervention

Group	N	Self-Concept	Utility	Interest	Overall Mean	Interpretation
Control (Section Dahlia)	40	3.88	3.89	4.03	3.93	High
Experimental (Section Lilac)	40	4.43	4.46	4.63	4.50	Very High

Table 8 shows the attitude towards mathematics of the students in the control and experimental group after the intervention. The data shows that the overall mean of the students' attitude towards mathematics in the control group after exposing them to the conventional teaching method is 3.93; interpreted as high. Meanwhile, the experimental group's attitude towards mathematics after exposing them to gamification shows a mean rating of 4.50; interpreted as very high.

Table-9: Significance of the Difference in the Attitude of the Students Towards Mathematics in the Control Group After the Intervention

Control Group	N	Mean	df	P-value	Interpretation
Before Intervention	40	3.23	78	<0.001	Significant
After Intervention	40	3.93			

As shown in the table, the attitude of the students towards mathematics in the control group before and after the intervention varies. Before the intervention, the mean attitude is 3.23 while after the intervention it has a mean rating of 3.93. The p-value of less than 0.001 is interpreted as significant.

Table-10: Significance of the Difference in the Attitude of the Students Towards Mathematics in the Experimental Group After the Intervention

Control Group	N	Mean	df	P-value	Interpretation
Before Intervention	40	3.34	78	<0.001	Significant
After Intervention	40	4.50			

It can be gleaned from Table 10, that the students' attitude towards mathematics before the intervention has a mean rating of 3.34. On the other hand, after the intervention, the mean rating is shown as 4.50. Further analysis revealed a p-value of less than 0.001 or a significant difference.

Table-11: Significance of the Difference in the Attitude of the Students Towards Mathematics in the Control and Experimental Group After the Intervention

Group	N	Mean	df	P-value	Interpretation
Control (Section Dahlia)	40	3.93	78	0.000	Significant
Experimental (Section Lilac)	40	4.50			

As presented in the Table 11, the students' attitude towards mathematics of the control group after the intervention has a mean rating of 3.93 while the experimental group has 4.50. The test for independent samples revealed a p-value of 0.000; interpreted as significant.

4. DISCUSSIONS AND CONCLUSION

4.1 Discussion

Mean Pretest Score of the Control and Experimental Group. The mean pretest scores of the control and experimental groups implied that they were of equal academic standing prior to the introduction of the intervention. The determination of the pretest as a gauge of the initial academic achievement of the students is supported in the assertion of Schwab, et al. [10] that the scores in the assessment represent their academic achievement. Further, Gulzar and Mahmood [11] pointed out that the outcomes in the tests are concrete measures of determining the competency of the students. As presented in the results of the pretest, the descriptive equivalents of the pretest scores in both groups are of equal level. The work of Sidiq et al. [42] further elaborated that the conduct of pretest in both control and experimental group is essential in establishing baseline data. Further, the authors emphasized its importance in the fair evaluation of the impact of the intervention.

Mean Posttest Score of the Control and Experimental Group. The mean posttest scores of the control implied that their academic achievement was unsatisfactory. On the other hand, the posttest score of the experimental group suggested that their academic achievement in mathematics was satisfactory. The use of gamification in the experimental group showed an advantage over the conventional interactive discussion in the control group as evident in the difference in the score increments. The descriptive equivalent in the posttest score of the control group remained to be low despite the intervention. On the contrary, the experimental group had shown a level increment

from low in the pretest to moderate in the posttest. The improvement on the competency level of the students as a result of introducing gamification in learning is in cognizance with that of Yıldırım and Sen [43]. According to the findings of the authors, gamifying mathematics provides a pleasant experience to the students resulting to positive learning outcomes. Further, Zumbach, et al. [44] revealed in their findings that gamification enhances the learning process with its influence to motivate the learners to compete to earn points and even content unlocking.

Analysis of the Mean Pretest and Posttest Score Difference in the Control Group. The data in Table 5 revealed that there is a significant difference in the mean pretest and posttest scores if the control group. This is evident in the p-value which is less than the threshold value of 0.05. This means that the increment in the posttest scores of the students in the control group is significantly different from their pretests scores. This suggests that the use of interactive discussion has successfully aided the achievement of the students in mathematics despite of the low descriptive equivalent. The finding was in cognizance with the work of Ayuwanti and Siswoyo [45] that conventional teaching methods allow teacher-student interaction which facilitates understanding of the concept. In addition, Lindsay and Evans [46] asserted that teacher-student interaction facilitates immediate feedbacking during mathematics class. The author further emphasized that this could aid in improving the academic achievement of the students.

Analysis of the Mean Pretest and Posttest Score Difference in the Experimental Group. The analysis for dependent samples on the pretest and posttest scores in the experimental group implied that the use of gamification in teaching mathematics was effective in improving their academic achievement. The improvement on the posttest scores of the students as a result of introducing gamification in learning is in cognizance with that of Yıldırım and Sen [43]. The improvement on the posttest scores of the students as a result of introducing gamification in learning was in cognizance with that of Yıldırım and Sen [43]. According to the findings of the authors, gamifying mathematics provides a pleasant experience to the students resulting to positive learning outcomes. Further, Zumbach, et al. (2020) revealed in their findings that gamification enhances the learning process with its influence to motivate the learners to compete to earn points and even content unlocking.

Analysis of the Mean Posttest Scores of the Control and Experimental Groups. Results of the analysis showed that the mean posttest scores of the experimental group were significantly higher than the control group. This finding implied that the use of gamification was more effective in raising the academic achievement of the students as compared to the conventional interactive discussion. The finding is in cognizance with the work of Bråting and Kilhamn [46] that gamification has contributed to the conceptual learning improvement of the students. Similarly, Partovi and Razavi [47] facilitate the achievement of solid knowledge foundation which is equivalent to the academic achievement of the students. Similarly, Deng, et al. [48] posited that the inclusion of gamification in mathematics classes facilitated the cognitive engagement of the students, leading to improved academic achievement. On the same stance, Moon and Ke [49] underscored in their findings that gamifying mathematics instruction provided greater efficacy in the teaching-learning process. Thus, the intervention improved the academic outcomes of the students.

Attitude of Students towards Mathematics of the Control and Experimental Group Before the Intervention. The mean description of the attitude of the students before the intervention showed that both the control and experimental groups were at par with each other. Both groups' attitude towards mathematics was described as moderate. This further implies that the students' demonstration of positive attitude towards mathematics was sometimes evident. The determination of the onset attitude towards mathematics was crucial in establishing the possible influence of the students' attitude with their achievement in mathematics. This is backed up with the findings of Cai, et al. [13] showed that attitude towards mathematics can either facilitate or hinder their achievement in the subject. Although Wijaya [14] posited that attitude towards the subject may not be the sole determinant of achievement. However, as argued in Jailani, et al. [50] that the students' attitude towards the subject may result to unease and fear in the subject itself.

Attitude of Students towards Mathematics of the Control and Experimental Group After the Intervention. The intervention given to the control group caused improvement on the students' attitude towards mathematics with a point increment, denoting the impact of the intervention. Meanwhile, the experimental group's attitude towards mathematics demonstrated apparent improvement. Consequently, the data revealed that the students' attitude towards mathematics after the implementation of the intervention revealed changes in their level of attitude. Specifically, the control group improved from moderate to high. This means that the students' demonstration of the

positive attitude towards mathematics is evident after the implementation of interactive discussion in their class. Up against the control group, the experimental group showed changes from moderate to very high. This denotes that the implementation of gamification had influenced the students' more positive attitude towards mathematics; from sometimes evident to very much evident. The two-level increment on the attitude towards mathematics of the students in the experimental group parallels to the work of Putz, et al. [9]. In addition, Bertram [51] observed that gamification provided venue for students to improve their attitude towards the subject; thereby reducing the anxiety in the subject. Moreover, the finding is in cognizance with Fuentes-Cabrera [52] stating that gamification motivates the learners which make them learn mathematics with positive attitude and relieve their perceived difficulties in the subject.

Analysis of the Difference in the Attitude the Students Towards Mathematics in the Control Group After the Intervention. The finding revealed that the improvement in the control group's attitude towards mathematics is significant. It can be implied that the use of interactive discussion was effective in improving the attitude of the students towards mathematics. According to Chen [16], positive response towards learning mathematics is essential in the reduction of stress and anxiety in the subject. This provides positive reinforcement for their learning. Further, the improvement on the attitude towards mathematics is an indicator that the intervention provided counteraction to the maladaptive response that usually occurs when encountering difficulties in mathematics [53] [54].

Analysis of the Difference in the Attitude the Students Towards Mathematics in the Experimental Group After the Intervention. The use of gamification in the experimental group was found to significantly improvement in their attitude towards mathematics. This means that the demonstration of positive attitude towards mathematics is very much evident. The probability value is less than 0.05 which means that the difference is statistically significant and did not happen by chance. It can be implied that gamification successfully improved how the students respond to the difficulties encountered in learning mathematics. The findings was a manifestation of what Prasetyo, et al. [55] pointed out that students shall be provided with venue where they can become positively inclined to learn the subject. In addition, teaching methodologies should lessen the students' reluctance to work on difficult math problems due to fear of committing failures.

Analysis of the Difference in the Attitude the Students Towards Mathematics in the Control and Experimental Group After the Intervention. The attitude of the students towards mathematics in both control and experimental groups showed significant differences when compared in the pre- and post-intervention. When compared between groups, the data showed that the attitude of the students towards mathematics in the experimental group showed significant improvement as compared to the control group. This implies that the use of gamification has caused significantly evident positive attitude towards mathematics as compared to the control group treated with interactive discussion. The finding is in corroboration with that of Charmaraman [17] that the manifestation of positive attitude towards mathematics could be facilitated by the students' learning experiences. This implies that the use of gamification facilitated the demonstration of positive attitude towards learning mathematics. On the same stance, Ahmed, et al. [53] showed that the use of gamification alleviates anxiety that can hinder their appreciation in the subject. Further, Swacha [56], stressed that the integration of gamification in classes showed more positive behavior such as being delighted in attending classes and being an active participant in learning.

4.2 Conclusion

The competency level of the students in Mathematics was low in both the control and experimental group before the intervention. The finding is conclusive that the students have unsatisfactory competence in mathematics before the implementation of the intervention in both groups. Subsequently, the onset attitude towards mathematics of the students in the experimental and control groups is indicative that their demonstration of positive attitude towards the subject were sometimes evident.

After the implementation of the intervention, notable changes on the attitude of the students towards mathematics were noted. The control group treated with the interactive discussion revealed high level of demonstration of the positive attitude towards mathematics. Meanwhile, the experimental group treated with gamification demonstrated very high level of positive attitude towards mathematics. There is a significant difference in the attitude towards mathematics of the students in the experimental and control group; hence, the first null hypothesis is rejected.

The competency level of the students as reflected in the posttest scores of the control and experimental group showed that only the experimental group has shown improvement from low to moderate level. There was a significant difference between the competency levels of the students experimental and control group when compared in their posttest scores. The experimental group showed a significantly higher competency level than the control group. Therefore, the second null hypothesis was rejected.

4.3 Recommendations

On the ground of the results, discussions and conclusions of this study, the following recommendations were made.

1. Considering the low to moderate level of competency of the students in mathematics, it is recommended that the teachers will employ strategies that can help the students become more engaged in the subject. Based on the findings, the use of gamification helps even if it is adopted from the web. With the intention to further improve the achievement of the learners, it is indicative that contextual gamification be explored.
2. Along with the school administrators and DepEd officials, there is a need to revisit the strategies used by the teachers in their actual instruction. Quarterly assessment on the strategies in the learning plan vis-à-vis the actual practices in this classroom. This may provide data-based interventions to assist the teachers in providing assistive instructional strategies that work to be utilized in the actual classes.
3. Future, researchers may utilize the findings to expound the research, applying the intervention to a bigger number of samples to validate the findings

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