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Teaching mathematics in the modern world using Quipper

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Abstract

This study determined the effect of using Quipper on teaching Mathematics in the Modern World on the performance of first-year Bachelor of Science in Hospitality Management (BSHM) students at Dr. Ruby Lanting Casaul Educational Foundation Inc., Tabaco City, during the first semester midterm of the academic year 2024-2025. Using a quasi-experimental pre-post-test design, two groups—control and experimental—were assessed on skills including sets, functions, relations, operations, logical reasoning, validity of arguments, and statistical calculations.

Results showed that both groups exhibited low mastery during the pre-test. However, after the intervention, the experimental group using Quipper demonstrated significantly higher performance than the control group. The experimental group achieved near full mastery with a mean score of 17.97, while the control group showed only mastery with a mean of 15.09. Statistical analysis revealed a significant difference in post-test results, affirming the positive impact of Quipper on student performance.

Among the skills tested in the experimental group, the learning outcome that was least mastered was determining valid conclusions based on given assumptions and analyzing how logic applies in various mathematical and real-world contexts, which was described as mastery. The researcher enhanced the materials posted for the least mastered learning outcome to enhance the Mathematical skills of the BSHM students of Dr. Ruby Lanting Casaul Educational Foundation Inc.

Keywords: Quipper; Mathematics in the Modern World; Quasi-experimental method; Academic performance; BSHM students

1. Introduction

Modern teaching and learning environments have incorporated technology into learning, emphasizing enhancing the Mathematics teaching-learning process. Technology has been identified as a key enabler in improving students' interest and understanding of Mathematical ideas. Among them, it seeks to transform classical training in mathematics and meet modern students' needs and expectations within the modern educational process conditions to individualized learning, several materials including interactive ones, and other opportunities. They can now also search for informative materials and be involved in an activity that sharpens the brain's part responsible for recalling information.

Mathematics has long been regarded as the foundation of scientific and technological progress. However, most students consider Mathematics as one of the most challenging subjects taken in college. What students do not know is that Mathematics plays a vital role and has numerous real-life applications, making the knowledge of Mathematics concepts of great importance for them to easily cope with this fast-evolving world. This is why teachers have long sought more effective and innovative methods for teaching the subject.

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Interestingly, Mathematics in the Modern World was a compulsory subject in college and trained students to solve quantitative problems and manage them in various areas of their lives. This course added real-world uses to standard mathematical exercises to develop students' abilities to decide logically about real-world situations using mathematics. The course gave students essential knowledge in logic sets functions and statistics so they could make accurate predictions and good decisions both at home and at work. Mathematics in the Modern World as a general education course helped students understand why people need math skills in their professional and personal areas of interest. It was regarded as a vital part of a wholesome college education.

With the rise in the use of technology, especially by educational institutions to enhance learning outcomes, the understanding of the role of innovative tools like Quipper became important. Although this research was relevant to educators, administrators, and policymakers interested in enhancing mathematics instruction and improving student performance in a technology-based environment, it was the focus of this thesis. Therefore, this study aimed to teach Mathematics in the Modern World through Quipper to contribute to the overall conversation about technology integration in teaching. It expanded on the idea of effective teaching practices and provided specific recommendations to educators. This research reinforced the continuous development of effective mathematics education suitable for 21st-century learners.

1.1. Statement of the Problem

This study determined the effects of teaching Mathematics in the Modern World using Quipper. Specifically, it answered the following questions:

- What is the level of the control and experimental groups in the pre-test along;
    - analyzing sets, functions, relations, and operations;
    - evaluating logic in mathematical statements by applying inductive and deductive reasoning;
    - determining the validity of arguments involving logical statements and quantifiers;
    - determining valid conclusions based on given assumptions and analyzing how logic applies in various mathematical and real-world contexts; and calculating the range, mean, median, and mode for a given data set?
- What is the performance level of the control and experimental groups in the post-test?
- Is there a significant difference in the performance of the control and experimental groups in the pre and post-test?
- What learning outcomes need to be improved by the experimental group in the post-test?
- What enhancement to the materials may be proposed to address the least mastered skills?

1.2. Assumption of the study

The researcher was guided by the following assumptions:

- The performance level of the control and experimental groups in the pre-test along with analyzing sets, functions, relations, and operations; evaluating logic in mathematical statements by applying inductive and deductive reasoning; determining the validity of arguments involving logical statements and quantifiers; determining valid conclusions based on given assumptions and analyze how logic applies in various mathematical and real-world contexts; and calculating the range, mean, median, and mode for a given data set was almost the same.
- The performance level of the control and experimental groups in the post-test differs.
- There were least mastered learning outcomes identified after using Quipper.
- Materials were enhanced to address the least mastered skills of the students.

Hypothesis

There is no significant difference between the pre-test and post-test results of the control and experimental groups.

1.3. Scope and Delimitation

This study focused on the effectiveness of Quipper as a platform for teaching Mathematics in the Modern World. The researcher concentrated on the midterm assessment during the academic year 2024–2025, and the subjects of the study were first-year Bachelor of Science in Hospitality Management (BSHM) students of Dr. Ruby Lanting Casaul Educational Foundation, Inc. Other topics in Mathematics in the Modern World were not included. Likewise, students from other programs were not part of the study

2. Material and methods

2.1. Research Method

This study utilized the experimental research method, particularly quasi-experimental research, since the researcher aimed to establish the effects of Quipper in teaching Mathematics in the Modern World. In a quasi-experimental design, the researcher selected an existing group of participants that had not been randomly assigned to the experimental and control groups. The principle behind the experimental design was relatively simple and involved assigning subjects to two groups: an experimental group and a control group. The method was a useful way of ensuring that an experiment had a strong level of validity. The researcher utilized the pre-test and post-test design. To determine the level of performance in Mathematics in the Modern World, the pre-test and post-tests were administered to both the control and experimental groups.

2.2. Subjects of the Study

The subjects of this study were sixty-six (66) first-year Bachelor of Science in Hospitality Management (BSHM) students enrolled in the Mathematics in the Modern World course during the 1st semester of the Academic Year 2024-2025 at Dr. Ruby Lanting Casaul Education Foundation Inc. The researcher selected students from two blocks of the BSHM program: BSHM 1A and BSHM 1B. Both blocks were composed of 39 students, but only 33 students from each of these two blocks were chosen and carefully studied as subjects of the study. The basis for selection was their grade in Mathematics in the Modern World for the preliminary. The researcher ensured that each group had an equal number of students with above-average, average, and below-average performance.

2.3. Research Instrument

The researcher utilized multiple-choice pre- and post-tests with 20 items that matched the topics in Mathematics in the Modern World to create an efficient student assessment method. This decision was informed by several considerations. The test was designed to be completed within a reasonable time frame, ensuring students could answer thoughtfully without feeling rushed, which helped maintain engagement and reduce fatigue, as noted by Nitko (2004). Twenty (20) well-designed items provided reliable measures of student performance, as the quality of items was more important than their quantity. This approach was also practical given resource constraints, making test administration and analysis more feasible, as discussed by Gronlund (2003).

2.4. Validation of the Research Instrument

The validation of the research instrument was an essential part of the research process. An instrument used for measuring any purpose needed to be validated to ensure its alignment for its users. This process substantiated the quality of the instrument and guaranteed that it measured what it was intended to measure. The pre- and post-tests, together with the table of specifications, were validated by three (3) instructors teaching Mathematics in the Modern World: one validator from Bicol University Tabaco, one from San Jose Community College, and one from Dr. Ruby Lanting Casaul Educational Foundation Inc. The validators also assessed the materials using a checklist with scaled responses before the researcher posted them on the Quipper platform. A five-point Likert scale was adopted, with 5 representing excellent and 1 representing very poor.

2.5. Dry Run of the Research Instrument

The dry-run of the trial group was conducted with BSBA Financial Management students at Dr. Ruby Lanting Casaul Educational Foundation Inc. A table of specifications (TOS), was created to identify each item's proper placement and weight. The test originally consisted of 20 items.

3. Results and discussion

3.1. The Performance Level of the Control and Experimental Groups in the Pre-test

Even as it was well-known that in the teaching and learning process, many challenges were realized when students experienced challenges in the learning outcomes. This indicated a real need for strategies that would enable students to explore the nature of mathematics and better understand its realities. The use of technology in the classroom had a significant impact on students and overall learning in class.

3.1.1. *The Performance Level of the Control Group in the Pre-test*

Table 1a The performance level of the Control group in the Pre-Test

Learning Outcomes	**N**	**No. of items**	**Total Score**	**Mean**	**PL %**	**Description**
Analyzing sets, functions, relations, and operations	33	5	83	2.52	50	Low Mastery
Evaluating logic in mathematical statements by applying inductive and deductive reasoning.		3	42	1.27	42	Low Mastery
Determining the validity of arguments involving logical statements and quantifiers.		3	46	1.39	46	Low Mastery
Determining valid conclusions based on given assumptions and analyze how logic applies in various mathematical and real-world contexts		3	39	1.18	39	Low Mastery
Calculating the range, mean, median, and mode for a given data set		6	59	1.79	30	Low Mastery
Overall	33	20	269	8.15	41	Low Mastery

Using a 20-item researcher-made pre-test in Mathematics in the Modern World, the results obtained were analyzed to determine the performance level of the subjects in the control group on the learning outcomes.

The students in the control group obtained a total score of 83 on the 5-item test analyzing sets, functions, relations, and operations. The mean score of the students in this was 2.52. Their corresponding performance was 50, which is described as low mastery. The results show that the students had little knowledge or were close to the near mastery level on the learning outcome tested. Three items were provided for determining the validity of arguments involving logical statements and quantifiers. The students in this group got a total score of 46. Their computed mean score was 1.39, and their performance level was 46, which is described as low mastery. This should mean that they have little or no competency in the area being tested. Along with evaluating the logic in mathematical statements by applying inductive and deductive reasoning, the students in this group obtained a total score of 42 on a 3-item test. Their computed mean score was 5.33 and their performance level was 42, which means low mastery, indicating little prior knowledge of the learning outcome tested. Nevertheless, determining valid conclusions based on given assumptions and analyze how logic applies in various mathematical and real-world contexts; on a 3-item test, students achieved 39 points. Their computed mean score was 1.18, and their performance level was 39, which means low mastery. This indicated that the students in this group also had little or no knowledge of the learning outcome test. Lastly, the students got a total score of 59 on a 6-item test allocated to calculating the range, mean, median, and mode for a given data set. Here, they obtained a computed mean score of 1.79 and a performance level of 30, described as low mastery. This showed that the students in this group were unfamiliar with the learning outcome being tested. This was further supported by their reactions during the conduct of the pre-test, as they expressed confusion and mentioned that they were not familiar with some mathematical terminologies. The researcher discovered that the students struggled in learning mathematics due to poor foundations in basic mathematics. The results of the pre-test of the control group implied that before the actual implementation of the study, the students had little or not enough knowledge of the topic tested. This confirmed that the students still faced difficulties with the learning outcomes, indicating a low level of skills and topic mastery. This may have been due to misconceptions and the fact that the required skills had not yet been developed, thus affecting their mastery of the learning outcomes. This aligned with the study of Saad (2017), which found that most students disliked mathematics, as observed in the classroom, where teachers faced the hard reality that mathematics was considered difficult for most of them.

3.1.2. *The Performance Level of the Experimental Group in the Pre-test*

The tool used to determine the performance level of the experimental group on learning outcomes was the same researcher-made pre-test that was used in the control group. This test was administered to measure the prior knowledge of the experimental group before the delivery of instructions using Quipper. Table 1.b shows the performance of the experimental group in the pre-test. This included the number of items, total number of students, total scores obtained by the students, computed mean score, and the descriptive equivalent of the performance level.

Table 1b The Performance Level of the Experimental Group in the Pre-Test

Learning Outcomes	N	No. of items	Total Score	Mean	PL %	Description
Analyzing sets, functions, relations, and operations	33	5	82	2.48	50	Low Mastery
Evaluating logic in mathematical statements by applying inductive and deductive reasoning.		3	37	1.12	37	Low Mastery
Determining the validity of arguments involving logical statements and quantifiers.		3	40	1.21	40	Low Mastery
Determining valid conclusions based on given assumptions and analyzing how logic applies in various mathematical and real-world contexts		3	45	1.36	45	Low Mastery
Calculating the range, mean, median, and mode for a given data set		6	67	2.03	34	Low Mastery
Overall	33	20	271	8.21	41	Low Mastery

The students in the experimental group obtained a total score of 82 on the 5-item test, with a mean score of 2.48 and a performance level of 50. This performance is given the Low Mastery category signifying that although there was some level of understanding of the concepts, the group cannot be said to master the application of these concepts. The second best performance or score was on determining valid conclusions based on given assumptions and analyzing how logic applies in various mathematical and real-world contexts. The students obtained a total score of 45 on the 3-item test, with a mean score of 1.36 and a performance level of 45. It refers to the Low Mastery, and that makes it complex to analyze data received and make logical conclusions. In the topic of determining the validity of arguments involving logical statements and quantifiers, the students achieved a total score of 40 on the 3-item test, with a mean score of 1.21 and a performance level of 40. As seen with this performance, Logical Arguments remain a challenge to validate and is still considered under the Low Mastery. Likewise, while evaluating logic in mathematical statements by applying inductive and deductive reasoning, the students showed a total score of 37 on 3 items with a mean score of 1.12 and a performance level of 37. This has been found to have scored in the Low Mastery level and as such proved that these students had quite a lot of difficulties in inducting and deducing figures and in analyzing and drawing logical conclusions. The lowest was listed on the calculation of the range, mean, median, and mode of a given set of data. The students in the experimental group obtained a total score of 67 on the 6-item test, with a mean score of 2.03 and a performance level of 34, categorized as Low Mastery. This indicates that the group encountered difficulties in using conceptual knowledge and computations in statistics appropriately. Therefore, the students in the experimental group obtained a total of 271 on the 20-item test, a mean score of 8.21, and an overall performance level of 41 which all are under Low Mastery. These results depict the considerable weaknesses of the participants in all the studied learning outcomes, indicating the importance of an individualized instructional approach to improve their math skills. The researcher observed that the students from this group also struggled in learning mathematics due to a weak foundation in mathematics. Overall results of the pre-test on the experimental group imply that the students had low performance levels on the topics. The reason may be that the skills needed before learning these topics have not yet been developed. Understanding Mathematics becomes difficult for students if the teaching method is abstract without any materials or integration of technology used for the students to explore and better understand the concepts.

3.2. The Performance Level of the Control and Experimental Groups in the Post-test

The control group used the traditional approach while Quipper was employed in delivering the lessons in the experimental group as it taught analyzing sets, functions, relations, and operations, the ability to evaluate logic in mathematical statements through inductive and deductive reasoning, establishing the ability to determine the validity of arguments including those involving logical statements and quantifiers, determining valid conclusions based on given assumptions, evaluating how logic applies to mathematics and real life, and calculating the range, mean, median and mode. After 6 weeks of implementation, a researcher-made post-test was administered to determine if there were significant improvements in the performance of the two groups using different approaches. The post-test consisted of learning outcomes parallel to that of the pre-test.

3.1.3. *The Performance Level of the Control Group in the Post-test*

The traditional approach of teaching was applied by the researcher in the delivery of the lesson in the control group, wherein the teaching method focused on the teacher as the main source of information in the classroom.

Table 2a The performance level of the Control group in the Post-Test

Learning Outcomes	N	No. of items	Total Score	Mean	PL %	Description
Analyzing sets, functions, relations, and operations	33	5	126	3.82	76	Mastery
Evaluating logic in mathematical statements by applying inductive and deductive reasoning.		3	87	2.64	88	Near Full Mastery
Determining the validity of arguments involving logical statements and quantifiers.		3	79	2.39	80	Mastery
Determining valid conclusions based on given assumptions and analyzing how logic applies in various mathematical and real-world contexts		3	66	2	67	Near Mastery
Calculating the range, mean, median, and mode for a given data set		6	140	4.24	71	Near Mastery
Overall	33	20	498	15.09	75	Mastery

It embraces the idea of a method centered on the teacher involving face-to-face interaction, mainly from teacher to student. Here, the teacher-researcher used the common ways of teaching such as a whiteboard and talk, and a little use of printed materials. Table 2. a shows the performance level of the control group in the post-test.

The 3-item test is allocated to evaluating the logic in mathematical statements by applying inductive and deductive reasoning. Here, the students in the control group got a total score of 88, a computed mean score of 2.64, and a performance level of 88, which is described as near full mastery, significantly higher than their performance level in the pre-test for the said topic. The students in this group got a total score of 79 on the 3 items allocated to determining the validity of arguments involving logical statements and quantifiers. A computed mean score of 2.39 was obtained by the students and a performance level of 80, which is described as mastery. This indicates that the students in this group surpassed their performance in the pre-test for the same topic from low mastery to mastery of the topic. On the 20-item post-test, 5 items were allocated along analyzing sets, functions, and operations. Here, a total of 126 points were obtained by the students, with a computed mean score of 3.82 and a performance level of 76, which means mastery. These results indicated that there was an increase in the performance level of the students from 59 in the pre-test, which is described as near mastery to 76 which is described as mastery. This means that the students in this group have reached the mastery level of the topic. On the 6 items along with calculating the range, mean, median, and mode for a given data set, the students in the control group got a total score of 140, with a computed mean score of 4.24 and performance level of 71, which is described as near mastery. The traditional teaching approach helped students to master particular learning outcomes. Three items were allocated to determining valid conclusions based on given assumptions and analyzing how logic applies in various mathematical and real-world contexts. Here, the students in the control group got a total score of 66, with a computed mean score of 2 and a performance level of 67, which means near mastery. The results showed that the students in this group performed better in the post-test than in the pre-test for this topic. The researcher was able to help the students build their foundation in basic mathematics and for that, the students' performance improved. Overall, the students in the control group got a computed mean of 15.09, with a performance level of 75, which means mastery. The results imply that somehow the traditional approach to teaching had a positive effect on the learning of the students in the control group as shown in the significant increase in the performance level of the students. However, this was not enough to help the students reach the level of mastery that they should have for a certain topic. As the researcher experienced during the regular lessons, the use of the whiteboard, marker, and traditional teaching approach helped improve the performance of the learners in the control group. But still, it was not enough to near full mastery of the overall skills and topics. Teachers have to know time changes a lot when it comes to teaching especially in Mathematics, hence the need to embrace change. It also makes it extremely difficult for some of the strategies that were applied to be used today, especially coming into the generation of learners where students are so much involved with technological gadgets and other trends. There is indeed a need to carry out learning processes and methods that would enhance the students' mathematical skills.

3.1.4. *Performance of the Experimental Group in the Post-test*

Table 2b The performance level of the Experimental group in the Post-Test

Learning Outcomes	N	No. of items	Total Score	Mean	PL %	Description
Analyzing sets, functions, relations, and operations	33	5	156	4.73	95	Full Mastery
Evaluating logic in mathematical statements by applying inductive and deductive reasoning.		3	95	2.88	96	Full Mastery
Determining the validity of arguments involving logical statements and quantifiers.		3	93	2.82	94	Full Mastery
Determining valid conclusions based on given assumptions and analyzing how logic applies in various mathematical and real-world contexts		3	78	2.36	79	Mastery
Calculating the range, mean, median, and mode for a given data set		6	171	5.18	86	Near Full Mastery
Overall	33	20	593	17.97	90	Near Full Mastery

Unlike the control Group, the students in the experimental group were taught the integration of Quipper in the classroom instructions. The researcher ensured that the students in this group were given access to the platform during the entire experiment implementation. E-Modules and activities were regularly incorporated into the lesson, which allowed the students to explore and prove concepts. The teacher-researcher guided them through the Quipper classroom, which has been an invaluable feature of Quipper technology in the delivery of the lesson. Table 2.b shows the performance level of the experimental group in the post-test.

Three of the 20-item post-test items were allocated to evaluating the logic by applying inductive and deductive reasoning, the students in this group obtained a total of 95 points on this topic. Here the students got a computed mean score of 2.88 and a performance level of 96, which means full mastery. The results show a significantly higher performance level of this group in the post-test than the pre-test, indicating that the students can perform better even under the Quipper teaching approach. Along with analyzing the sets, functions, relations, and operations, the students in the experimental group got a total score of 156, with a computed mean score of 4.73, their performance level was 95, which is described as full mastery. This result is significantly higher than their performance level in the pre-test for the said topic. This means that for this topic, the Quipper teaching approach helped the students reach the level of learning outcomes from 50 on the pre-test to 95 on the post-test. From low mastery to full mastery after the 6-week duration of the experiment. On the 3 items along with determining the validity of arguments involving logical statements and quantifiers, the students in the experimental group got a total score of 93. Their computed mean score was 2.82 and their performance level was 94, which is described as full mastery. This demonstrates that the students in this group have progressed in their performance of this topic from showing low levels of mastery to full mastery. As what was observed by the researcher during the experimentation phase the students who were exposed to Quipper were able to accurately and efficiently identify the validity of arguments and explore the Quipper, which led to a clearer understanding of the concept compared with those in the control group. Six items were allocated to the learning outcomes of calculating the range, mean, median, and mode for a given data set. Here, the students in this group obtained a total score of 171. Their computed mean score was 5.18, and their performance level was 86, which was described as near full mastery. Some of their performances improved greatly as revealed in the performance chart, where the performance level improved from 34 to nearly 86; the students have mastered this topic after going through Quipper. Lastly, the students got a total score of 79 on the 3 items allocated in determining valid conclusions based on given assumptions and analyzing how logic applies in various mathematical and real-world contexts. A computed mean score of 2.36 was obtained by the students, and a performance level of 79. Which is described as mastery. Although the result showed that there was a significant increase in the performance level on this topic, it was still not enough to obtain nearly full mastery of the lesson. That is what the researcher was trying to address, as to what enhancement materials may be proposed to address the skills of the students who have the least mastered. Overall, the students in the experimental group got a computed mean of 17.97, with a performance level of 90, which means nearly full mastery. This shows that the students mastered all the learning outcomes tested and the lowest learning outcomes got a lower performance rate were determining valid conclusions based on given assumptions and analyzing how logic applies in various mathematical and real-world contexts. The researcher explored the Quipper LMS platform by uploading

learning files, activities, quizzes, assignments, and tests, and guided the students in the experimental group to ensure a smooth flow and avoid problems. The researcher easily monitors the students' performance by simply checking his cell phone where the Quipper application was installed. This means that the use of Quipper as a classroom had an impact on the improvement of the performance of the students. The results of the post-test in the experimental group imply that there is a great improvement in the performance level of the students. This also shows that the students in this group exhibited higher performance levels than those in the control group. This shows that when Quipper is used as a classroom instruction, it helps develop mathematical thinking among students. The lessons and activities using Quipper prepared by the teacher-researcher on the Quipper platform truly helped increase the performance level of the students. This is because the software allows teachers and students to work through the concepts together through exploring and visualizing. Quipper is an accessible and user-friendly social learning platform that offers a variety of features that allow students to interact and collaborate with teachers and peers and access teacher-provided courses. The teacher can assign the assignment, set the due date, and keep track of the student's progress. Some teachers have used Quipper to integrate technology into the teaching and learning process in the classroom. Because online platforms facilitate interactions between teachers and students even when they are not in the same room, they promote inquiry-based and independent learning. Students in today's generation are tech savvy and with the help of the Quipper platform, the students don't need to write down all the modules in their notebooks and it gives them an option, lot of time to study the topic and e-modules since everything was already provided in the materials posted in the Quipper platform. By reminding the students always to check their Quipper account, they can easily monitor, download the module, study, and submit their output since the Quipper was already installed in their cellphones or any gadget available and by that, they can easily access the classroom. It is the perfect combination if the instructor and students are both good when it comes to technology and application, because even using the cellphone the teacher can send instructions and activities easily, and the students can effortlessly access the given activities and modules. The results were supported by the findings of Kim Sipin (2023)[6] stressed the implications of using technology in enhancing Technology readiness and independent learning of Students. The findings reveal the fact that Quipper increases students' motivation and effective learning as it provides the required study materials for learning and flexible ways of studying and these findings support the Septinawati et.al (2020)[7] study titled Quipper School Makes Teachers More Creative where authors have observed that use of technologies helps the teachers to be more creative and helps them in improving the learning experiences of students. Also, the study establishes the application of Quipper in enhancing students' independence in learning by offering a chance to revise the content at their own pace enhancing comprehension of what has been taught. It is with this discussion in mind that reaffirms the fact that technology works more as an enabler that improves education results. Students are then able to gather much information through Quipper and at the same time interact with that information in a way they may not easily do by physical means. The tuning of the learning process to the needs of a learner increases efficiency and helps to understand that everyone can set his or her own pace in learning. Furthermore, the use of such technologies as more of an interactive approach also creates hallways for peer collaboration hence developing a culture of community of learners. This way, relying on technology so heavily also sharpens the skills essential to working and learning in today's world. In general, applying technology in the learning process is not only a value-added but also a key to enabling the competencies required in the future society.

3.3. Test of Significance on the Difference in the Performance of the Control and Experimental Group in the Pre-test and Post-test

The result of the test difference was used to determine the difference between the control and the experimental groups in the pre-test and post-test mean scores. As to the common observations made with both groups, both groups have enhanced their performances after 6-week experimentation. The control group was taught the traditional way by the researcher, while Quipper was incorporated into the teaching and learning processes in the experimental group.

3.1.5. *Test of Difference on the Significance in the Performance of the Control*

And Experimental Groups in the Pre-test. In this section, the researcher wanted to assess the validity of the difference in performances of the control and the experimental group in the pre-test of this particular study. The pre-test is informative because it provides the basis for comparing the results of the experiment to the level of performance of the subjects before any further injections of treatments are made. The assessment established a reference point that allowed the evaluation of students' progress while identifying their specific weak mathematical concepts. The evaluation process served as a baseline that helped the researcher design effective instructional improvements for areas where students had learning gaps. From Table 3.a, we get the test of difference on the results of the pre-test on the overall performance of the control and experimental groups.

Table 3a Test of Significance on the Difference in the Performance of the Control and Experimental Groups in the Pre-test

Group	Mean	Mean Difference	Variance	t-value		Remark
				Computed	Critical	
Control	8.15	0.06	24.11	-0.047	±1.671	Not Significant
Experimental	8.21		30.47			

Table 3.a shows the significance on the difference in the performance during the pre-test between the control and experimental groups. The calculated mean score of the control group is 8.15, and for the experimental group, 8.21 respectively leading to a mean difference of 0.06. The variance of 24.11 for the Control group and 30.47 for the experimental group pointed out a significant variation and the importance of within-group performances. Regarding the variability, the t-value of -0.047 implies no statistically significant difference in the mean of the groups. With this, we can say that there is no significant difference in the performance in the pre-test between the control and experimental groups. This means that before the experiment, the level of the control and experimental groups of student's knowledge of the concepts and learning outcomes did not differ much.

3.1.6. *Test Difference on the Significance in the Performance of the Control*

And Experimental Groups in the Post-test. In this section, the researcher assessed the validity of the difference in performances of the control and the experimental group in the post-test of this particular study. The post-test was informative because it provides the basis for comparing the results of the experiment to the level of performance of the subjects after injections of treatments are made. From Table 3.b, we get the test of difference on the results of the post-test on the overall performance of the control and experimental groups.

Table 3b Test of Significance on the Difference in the Performance of the Control and Experimental Group in the Post-test

Group	Mean	Mean Difference	Variance	t-value		Remark
				Computed	Critical	
Control	15.09	2.88	20.70	-2.779	±1.671	Significant
Experimental	17.97		14.75			

The data compared a control group with an experimental group, showing that the score obtained by the experimental group, equal to 17.97, is significantly higher than the score of the control group, which equals 15.09 with a mean difference of 2.88, thus indicating a positive effect of the treatment imposed to the experimental group. Based on the data, the t-computed value is -2.779, which is greater than the t-critical value at 0.05 level of significance, with degrees of freedom of 64. With this, the null hypothesis is rejected. This means that there is a significant difference between the performance of the control and experimental group in the post-test which underlines the success of the intervention. This implies that there is a positive effect on the integration of Quipper in the classroom instruction in the experimental group compared with the traditional method of teaching done in the control group. In the control group, the researcher only discussed the lesson the usual way by using a marker and board, and sometimes with the use of other visual materials found in the school. Whereas in the experimental group, the students were exposed to the Quipper software. They were able to explore, manipulate, and discover concepts via the Quipper platform. They were able to use Quipper also anytime and anywhere without disturbing teachers. Likewise, interaction with peers was also evident as the students were allowed to guide one another and reach a shared understanding. This was supported by the researcher's observation during the experimentation phase where the student's knowledge of the mathematical concepts was deepened and their mathematical skills enhanced. Their interest was also captured because of the Quipper interface's numerous features.

3.4. The Learning Outcome to be Improved

The researcher identified what learning outcome to improve in teaching Mathematics in the Modern World using Quipper. This is the skill where the students got the lowest mean score and corresponding performance level. Table 4 shows what topic is to be improved by the experimental group.

Table 4 Learning Outcome to be Improved

Learning Outcome	Number of Items	Mean	PL	Description
Determining valid conclusions based on given assumptions and analyzing how logic applies in various mathematical and real-world contexts	3	2.36	79	Mastery

After the intervention, the researcher found out that among the skills tested, the learning outcome to be improved by the students was determining valid conclusions based on given assumptions and analyzing how logic applies in various mathematical and real-world contexts. Here, the students obtained a mean score of 2.36 with a corresponding performance level of 79 percent, which is described as mastery. This skill was what the students struggled to near full mastery and this is the only topic that did not reach 80 in performance level. The researcher observed that during the implementation of this topic, some students arrived late to school and accessed Quipper late, as they were engaged in activities for other subjects and due to some emergency power interruption.

3.5. Enhanced Materials to Address the Learning Outcomes

Teaching mathematical concepts to college students presents significant challenges, primarily due to the prerequisite skills many students have yet to master and their existing misconceptions about related learning outcomes. Additionally, since "Mathematics in the Modern World" was categorized as a General Education Course (GEC) rather than a major subject within the Bachelor of Science in Hospitality Management (BSHM) program, students may not prioritize it in their studies. The researcher has observed that some students don't have an interest in reading materials when it is plain, further complicating their ability to engage with more advanced mathematical concepts. This highlights the need for targeted instructional strategies that address these gaps in understanding and build a stronger foundation for mathematical learning.

3.1.7. *Enhanced material on determining valid conclusions based on given assumptions and analyzing how logic applies in various mathematical and real-world contexts*

The material focused on improving the ability to determining valid conclusions based on given assumptions and analyzing the application of logic in various mathematical and real-world contexts. The students achieved a performance level of 79 percent, which was described as mastery, but it was the only learning outcome that did not reach an 80 percent performance level. The output and materials made by the researcher were uploaded to the Quipper LMS. It was carefully organized to enhance clarity and engagement, incorporating a video link and a simple yet visually appealing design to effectively capture students' attention and enrich their learning experience. The researcher also enhanced the learning experience by adding more examples and activities, which provided students with additional opportunities to practice and reinforce their understanding. Tables, diagrams, and figures were included to further support comprehension to provide clearer illustrations of key concepts. Although they struggled with fully mastering this skill, the structured and engaging approach to the material, combined with the extra practice opportunities and visual aids, contributed to their overall learning progress and comprehension.

4. Conclusion

The overall performance level of the control group in the pre-test along; with analyzing sets, functions, relations, and operations; evaluating logic in mathematical statements by applying inductive and deductive reasoning; determine the validity of arguments involving logical statements and quantifiers; determining valid conclusions based on given assumptions and analyzing how logic applies in various mathematical and real-world contexts; and calculating the range, mean, median, and mode for a given data set is considered low mastery. Likewise, the same overall performance level in the pre-test along the abovementioned learning outcomes was observed in the experimental group. The overall performance level of the control group in the post-test along with analyzing sets, functions, relations, and operations; evaluating logic in mathematical statements by applying inductive and deductive reasoning; determining the validity of arguments involving logical statements and quantifiers; determining valid conclusions based on given assumptions and analyzing how logic applies in various mathematical and real-world contexts; and calculating the range, mean, median, and mode for a given data set is considered mastery. On the other hand, the overall performance level of the experimental group in the post-test along the abovementioned learning outcomes was described as near full mastery. There is a significant difference in the performance of the control and experimental groups in the post-test. Among the skills tested in the experimental group, the learning outcome that was least mastered was determining valid conclusions based on given assumptions and analyzing how logic applies in various mathematical and real-world contexts, which

was described as mastery. The researcher enhanced the materials posted for the least mastered learning outcome to enhance the Mathematical skills of the BSHM students of Dr. Ruby Lanting Casaul Educational Foundation Inc.

Compliance with ethical standards

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Disclosure of conflict of interest

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Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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