GAMIFICATION OF STATISTICS AND PROBABILITY EDUCATION: A MOBILE COURSEWARE APPROACH

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ABSTRACT

Aim/Purpose	The study examined how the developed mobile courseware can be used as instructional material to improve senior high school statistics and probability learning, particularly during distance learning caused by the COVID-19 pandemic. The study also aims to assess the gamified mobile courseware's engagement, functionality, aesthetics, and information quality using the Mobile App Rating Scale (MARS) and a researcher-made Gamified Mobile Courseware Assessment Tool (GMCET).
Background	The need to investigate the effectiveness of incorporating game-based elements into mathematics courses through innovative instructional materials inspired the study. The COVID-19 pandemic has made distance learning a necessity, and gamified mobile courseware is a potential solution to improve learning outcomes and engagement in mathematics courses.
Methodology	The study employed a descriptive-evaluative method with quantitative and qualitative data to achieve its objectives. Five IT practitioners assessed the developed courseware using the MARS regarding engagement, functionality, aesthetics, and information. A researcher-made GMCET was also used to evaluate the app's content quality, learning objectives, content presentation, learning assessment, and usability. Five math experts and 12 math teachers rated the app using the GMCET. The study used weighted mean to analyze the quantitative data and content analysis for the qualitative data.
Contribution	The study provides insights into the strengths and weaknesses of gamified mobile courseware from the perspective of IT practitioners, math experts, and math teachers. The study's findings can inform improvements in future iterations of courseware, and the study provides a valuable guide for practitioners looking to develop gamified mobile courseware for mathematics courses.
Findings	The quantitative results based on the weighted mean indicate that the IT practitioners had a moderately positive perception of the developed courseware

	across all categories. At the same time, the math teachers and math experts showed highly positive perceptions of the gamified mobile courseware in Statistics and Probability, rating it highly across all categories. The qualitative data analysis through content analysis highlights the need for improving the user interface, usability, user experience design, user control, flexibility in interaction, data quality, reliability, and user privacy of the developed app.
Recommendations for Practitioners	Practitioners can use the study's findings to improve the design of gamified mobile courseware for mathematics courses and other content areas. The study recommends that practitioners focus on improving the user interface, usability, user experience design, user control, flexibility in interaction, data quality, reliability, and user privacy of gamified mobile courseware.
Recommendations for Researchers	Future research can build on this study's findings by exploring the use of gamified mobile courseware in other mathematical courses and other subject areas. Further research can also examine how gamified mobile courseware can improve learning outcomes for students with different learning needs.
Impact on Society	The study's findings could improve the effectiveness of gamified mobile courseware in enhancing student learning outcomes in mathematics courses. This can lead to better student performance, improved engagement, and increased interest in mathematics courses, positively impacting society.
Future Research	Future research can explore using gamified mobile courseware in other mathematics courses and other subject areas. Additionally, future studies can examine how gamified mobile courseware can improve learning outcomes for students with different learning needs. Further research can also investigate the impact of gamified mobile courseware on student motivation, interest, and performance in mathematics courses.
Keywords	game-based learning, gamification, mobile courseware, statistics and probability

INTRODUCTION

Instructional materials play a crucial role in supporting student learning and can significantly increase academic achievement. They are designed to complement learning content and can take various forms. They allow at-risk learners to cope with learning activities, transform abstract ideas into concrete or understandable concepts, encourage discovery learning, facilitate the teacher's job of delivering instruction, and keep students' attention during class (Ojating & Ojating, 2022). Instructional materials facilitate learning by enabling students to investigate new information independently. Therefore, teachers need to select instructional materials with care and carefully select materials that aid students' learning. According to Bukoye (2019), the high rate of students' failure in external exams was associated with the teachers' failure to recognize the importance derived from the use of instructional materials and their misuse. In the 21st century, using technology as a teaching tool in the classroom is crucial for both students and teachers due to the rapid advancement of technology and increased access to education. Hence, educators must provide an educational program that adequately supports learners' development and goals by utilizing Information and Communications Technology (ICT) to keep up with a technologically driven society.

Despite the government's efforts and various groups' initiatives for development, the quality of education in the Philippines still needs improvement (Duterte, 2023). Furthermore, incorporating game-like elements into mobile courseware presents a promising way to get students interested and motivated in math. It has been discovered that game-based learning effectively enhances student performance and attitudes toward learning (Wang et al., 2022). Additionally, mobile learning has become a

popular way for students to access educational content flexibly and efficiently. Thus, integrating game-based elements into mathematics mobile courseware presents an opportunity to make learning more engaging and effective. Several studies have explored the integration of game-based elements into mathematics mobile courseware. Vankus (2021) emphasized that integrating game-based elements into mathematics mobile courseware can enhance students' learning experiences, particularly by improving their affective domain, which includes aspects like attitude, motivation, and confidence. He also highlighted the potential of such game-based learning to foster engagement, collaboration, and communication, facilitating a more interactive and practical learning environment. Similarly, Hui and Mahmud (2023) highlighted that integrating game-based elements into mathematics mobile courseware positively impacts students' affective domain, including attitude, motivation, and confidence, and supports the learning process by creating an engaging environment. However, the researchers also noted teachers' challenges in creating personalized gamification tools to cater to students' varying mathematical knowledge.

Meanwhile, gamification is another strategy that has gained popularity in distance learning, especially during the COVID-19 pandemic, as it offers an engaging and motivating learning experience. Gamification involves using game-based elements, such as points, badges, leaderboards, and challenges, to incentivize students to participate actively and complete tasks. Gamification also provides opportunities for students to collaborate and build a sense of community in a remote learning environment, potentially addressing the challenges of engagement and motivation in distance learning.

Several studies have investigated the effectiveness of gamification in distance learning. For example, Martinez-Maldonado et al. (2020) found that gamification increased students' motivation, engagement, and satisfaction in online courses. The study emphasized the importance of aligning gamified activities with learning goals and providing feedback and rewards. Similarly, Nieto-Escamez and Roldan-Tapia (2021) suggested that gamification strategies, such as quizzes, simulations, and competitive elements, can enhance students' motivation, engagement, and learning outcomes. However, the researchers also highlighted that the success of these strategies can vary, and some students may not engage as expected due to factors like the pandemic situation or the design of the gamified environment.

Based on the readings and notes by the researcher, Klinjuy and Iaosanurak (2021), Arunsirot (2020), and Smiderle et al. (2020) determined the impact of gamification on students' knowledge, attitudes, learning outcomes, engagement, and behavior through game elements like points, leaderboards, badges, levels, rankings, challenges, feedback, and work tasks using quantitative experimental designs. Meanwhile, Kumnuanta (2021) developed a Gamification-Enhanced Divergent Thinking Application (GEDTA) using eight core drives: social influence, relatedness, scarcity, unpredictability, curiosity, and loss and avoidance. Molano (2022), on the other hand, developed a gamification-based instructional package in General Mathematics and determined its level of acceptability. Tondello and Nacke (2020) developed a personalized gamification, tested it, and conducted a pilot study to get participant feedback on how they customized their experience. However, it is worth noting that these studies only focused on determining the impact of the gamification approach on students' knowledge, attitudes, learning outcomes, engagement, and behavior. While a few studies focused on evaluation, it was only for the level of acceptability. Also, the qualitative assessment focused only on getting user feedback. They did not provide quantitative evaluations of content quality, learning objectives, content presentation, lesson assessments, or usability. Furthermore, there is a lack of research focusing on monitoring mechanisms to track students' progress and performance. As a result, there is a need for future studies to incorporate these essential elements into the evaluation of mobile courseware to provide a more comprehensive understanding of its effectiveness in enhancing student learning outcomes.

To investigate whether integrating game-based elements into Statistics and Probability mobile courseware could be used as instructional material for distance learning, this study aimed to provide actionable insights and recommendations for educators and developers to design more effective and engaging learning tools.

Specifically, the study focuses on the following research questions:

1. How can mobile courseware be developed incorporating game-based elements for the Statistics and Probability course?
2. What is the perception of I.T. practitioners, Statistics and Probability teachers, and Mathematics experts on the developed gamified mobile courseware?
3. What improvements can be made to the developed app based on the validators' input?

By gaining a more comprehensive understanding of the benefits and limitations of integrating game elements into mathematics mobile courseware, it is hoped that the study will help educators create more engaging learning environments, thereby improving student performance and motivation.

MATERIALS AND METHODS

The study adopted a descriptive-evaluative research method to achieve its objectives, combining both descriptive and evaluative approaches to investigate a phenomenon. Creswell and Creswell (2018) described this research design as an approach where the researcher first provides a detailed description of the phenomenon using qualitative or quantitative data and then evaluates the significance of the findings. In this study, the phenomenon under investigation was integrating game-based elements in statistics and probability mobile courseware, particularly in the context of synchronous and asynchronous classes in the Philippines during the onset of the COVID-19 pandemic.

Three groups of respondents were involved in the study to evaluate the gamified mobile courseware. The first group was made up of teachers who were teaching the Statistics and Probability course. The second group consisted of mathematics experts who evaluated the gamified mobile courseware regarding content quality, learning objectives, content presentation, learning assessments, and usability. The third group consisted of I.T. professionals who assessed the gamified mobile courseware regarding engagement, functionality, aesthetics, and information.

The researcher used an expert purposive sampling technique to select the validators. According to Creswell and Creswell (2018), expert purposive sampling involves selecting participants based on their unique or special knowledge of the research question. It is beneficial for research topics that require a high level of expertise or specialized knowledge. The mathematics teachers who handle Statistics and Probability in senior high school were the judgmental evaluators, while the mathematics experts had at least finished their Master's degree related to their baccalaureate degree and had at least ten years of teaching experience. The I.T. practitioners who graduated with a degree in B.S. in Computer Science, or B.S. in Information Technology, were employed (corporate or academic) or freelanced.

To obtain feedback from the respondents, the researcher sent an intent letter via email to the target respondents. Five of ten I.T. professionals, five of ten math experts, and twelve of twenty teachers teaching Statistics and Probability responded. The Mobile App Rating Scale (MARS) (Appendix A) was distributed to the I.T. professionals to evaluate the gamified mobile courseware. The Cronbach alpha for the MARS, adapted from Stoyanov et al.'s (2015) study, was reported to be 0.90. The MARS's content validity index and K-coefficient were 0.89 and 0.868, respectively. The MARS coefficient of reliability was 0.877.

On the other hand, the researcher disseminated the Gamified Mobile Courseware Evaluation Tool (GMCET) to math teachers and math experts (Appendix B). It was a researcher-made questionnaire and was subjected to content and reliability analyses. The content validity index of the GMCET was 0.91, and the K-coefficient was 0.907. The internal consistency of the GMCET was 0.982. Both the MARS and the GMCET had a feedback section.

To ensure the accuracy and reliability of the responses, the researcher personally handed and collected the research instruments because of the need to demonstrate the developed app.

RESULTS

DESIGN AND DEVELOPMENT OF THE GAMIFIED MOBILE COURSEWARE

The Statistics and Probability gamified mobile courseware is a mobile application designed for Android smartphones and tablets with Android 6.0 (Marshmallow) or higher operating systems. This app provides an online feature that allows teachers to monitor their students' progress and communicate with them. Additionally, it enables students to take various assessments. The app's offline feature allows students to access and learn all course materials without using mobile data, particularly for those who don't have unlimited Wi-Fi. Both teachers and students can benefit from the gamified mobile courseware. Teachers can use the app to monitor student progress and communicate with their students. Figure 1 displays some of the teacher functionalities of the app.

Figure 1. Teacher functionalities of the gamified mobile courseware

On the other hand, the gamified mobile courseware was developed primarily for students. Figure 2 exhibits the learner-functionalities of the gamified mobile courseware.
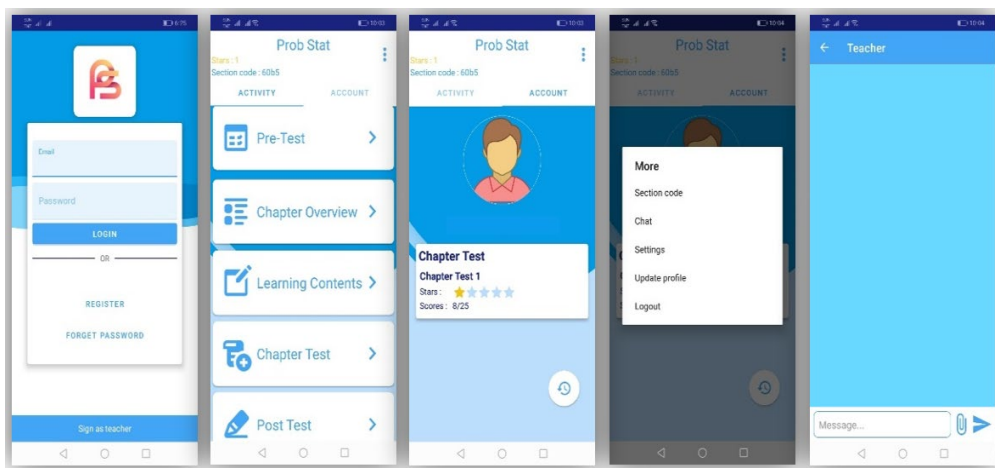
Figure 2. Student functionalities of the gamified mobile courseware

The gamified mobile courseware has been meticulously designed, focusing on DepEd's Curriculum Guide in Statistics and Probability version 2013, ensuring comprehensive coverage of critical concepts. The courseware includes the following core topics: Random Variables and Probability Distribution, Normal Distribution, Sampling, and Sampling Distributions, Estimation of Parameters, Tests

of Hypothesis, and Correlation and Regression Analyses. Figure 3 shows some of the contents of gamified mobile courseware.
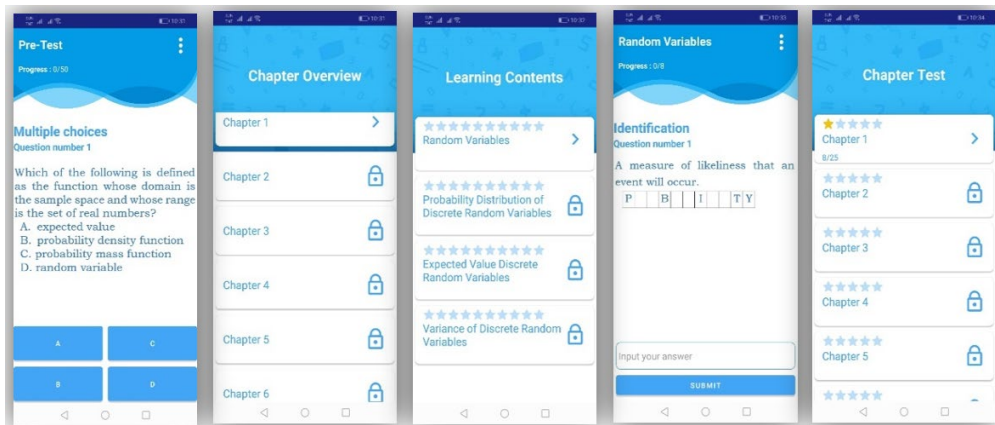

Figure 3. Some of the contents of the gamified mobile courseware

The gamified mobile courseware for Statistics and Probability was developed using Bybee and Landes's (1990) 5E Instructional Model, which consists of five phases: Engagement, Exploration, Explanation, Elaboration, and Evaluation. To achieve engagement, the Pre-test and Learning Preparation were included. Exploration was facilitated through Chapter Overview, while the explanation phase utilized Learning Contents. Learning Links and Learning Assessments were provided for the elaboration phase, and the evaluation phase involved Chapter Tests and Post-test assessments.

The development of the gamified mobile courseware was grounded on various theories and models, including the Self-Paced Curriculum Learning Model, Mastery-Based Learning Theory, Game-Based Learning Theory, and Mobile Learning Theory. Incorporating game elements such as "conflict" enabled learners to battle against themselves to unlock the Chapter Test and subsequent lessons. To do this, they had to complete the required number of "stars" in each lesson chapter. Additionally, the app prompts the learner with instructions if they attempt to leave an assessment or move to the next lesson/chapter that is locked, as illustrated in Figure 4.
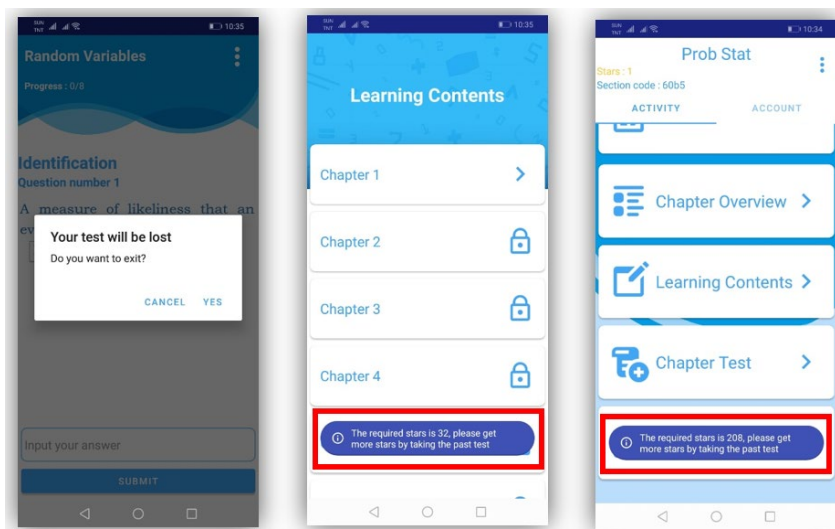

Figure 4. Some notification systems of the gamified mobile courseware

The developed mobile courseware includes a reward system that allows learners to unlock the next lesson or chapter after completing a required number of stars. To proceed to the next task, the learner must acquire at least four stars, equivalent to an 80 percent mastery level. Similar to popular games like "Candy Crush Saga," learners can repeat assessments where they did not get the required number of stars. Furthermore, learners earn hints based on the number of stars they earn upon completing a chapter test, which they can use during the posttest.

EVALUATION OF THE DEVELOPED GAMIFIED MOBILE COURSEWARE

The summary evaluation of the gamified mobile courseware in Statistics and Probability by IT practitioners is presented in Table 1. The table presents four categories: engagement, functionality, aesthetics, and information, along with their corresponding categorical means and standard deviations.

Table 1. Summary of IT practitioners' evaluation of the gamified mobile courseware

Category	Categorical Mean	SD	Verbal Interpretation
Engagement	4.28	0.617	To a great extent
Functionality	3.60	0.919	To a moderate extent
Aesthetics	3.92	0.888	To a moderate extent
Information	3.93	0.813	To a moderate extent
Grand Mean	3.93		To a moderate extent

Legend: 1.00 to 1.79 – Not at all; 1.80 to 2.59 – To a small extent; 2.60 to 3.39 – To some extent; 3.40 to 4.19 – To a moderate extent; 4.20 to 5.00 – To a great extent

Based on the categorical means, the IT practitioners found the gamified mobile courseware engaging "to a great extent," as evidenced by a categorical mean of 4.28. This suggests that the courseware successfully captured the interest and attention of IT practitioners, which is an essential aspect of effective learning.

Regarding functionality, the IT practitioners rated the courseware "to a moderate extent," with a categorical mean of 3.60 and a standard deviation of 0.919. This suggests that while the courseware had some useful functions, there is room for improvement in functionality to support the course's learning objectives better.

The IT practitioners also rated the aesthetic aspect of the courseware "to a moderate extent," with a categorical mean of 3.92 and a standard deviation of 0.888. This suggests that the courseware was visually appealing but could benefit from further improvements in its design and presentation.

Similarly, the IT practitioners rated the information provided by the courseware "to a moderate extent," with a categorical mean of 3.93 and a standard deviation of 0.813. This suggests that while the courseware provided helpful information, it could be improved to support the course's learning objectives better.

Finally, the grand mean of the evaluation is 3.93, which indicates that overall, the IT professionals rated the gamified mobile courseware "to a moderate extent." This suggests that while the courseware had some positive aspects, there is room for improvement in functionality, aesthetics, and information to better support the course's learning objectives.

Table 2 summarizes math teachers' and experts' evaluation of the developed app in Statistics and Probability. The table demonstrates that math teachers and experts favorably evaluated the gamified mobile app in all five evaluation categories. The categorical mean (CM) scores for all five categories are above 4.5, indicating that the gamified mobile courseware delivers quality content and achieves its learning objectives. The two categories with the highest mean scores are the Learning Objectives and

Content Presentation categories, with CM scores of 4.88, indicating that both groups found the courseware effective in achieving its objectives and presenting content engagingly and effectively.

Table 2. Summary of math teachers and math experts' evaluation

Category	Math Teachers			Math Experts		
	CM	SD	V. I.	CM	SD	V. I.
Content Quality	4.85	0.323	To a great extent	4.85	0.249	To a great extent
Learning Objectives	4.88	0.198	To a great extent	4.90	0.244	To a great extent
Content Presentation	4.88	0.256	To a great extent	4.82	0.286	To a great extent
Learning Assessments	4.74	0.679	To a great extent	4.92	0.186	To a great extent
Usability	4.58	0.763	To a great extent	4.92	0.186	To a great extent
Grand Mean	4.79		To a great extent	4.88		To a great extent

Legend: C. M. – Categorical Mean; V. I. – Verbal Interpretation; 1.00 to 1.79 – Not at all; 1.80 to 2.59 – To a small extent; 2.60 to 3.39 – To some extent; 3.40 to 4.19 – To a moderate extent; 4.20 to 5.00 – To a great extent

The Usability category received the lowest CM score of 4.58 from math teachers and 4.92 from math experts, indicating that some improvements could be made in this area. However, this score is still very positive, with a verbal interpretation of "To a great extent." The SD values for all five categories are relatively low, ranging from 0.186 to 0.763, indicating that the evaluation scores are consistent among both evaluators.

Specifically, the table shows that the gamified mobile courseware received high ratings for Content Quality, Learning Objectives, and Engagement, with scores ranging from 4.2 to 4.6 out of 5. These results suggest that the courseware provides well-structured and comprehensive content, effectively delivers its intended learning outcomes, and keeps learners engaged throughout the learning process. In addition, the table indicates that the courseware received a high score for Learning Assessments, with a rating of 4.5 out of 5. This suggests that the courseware provides effective and meaningful assessments that accurately measure learners' understanding and mastery of the content.

However, the Usability category received a slightly lower score of 3.8 out of 5, indicating room for improvement. This suggests that the evaluators may have encountered challenges or difficulties in using the courseware, such as difficulty navigating the interface or accessing certain features.

Overall, the gamified mobile app delivers quality content, achieves its learning objectives, presents content engagingly and effectively, and provides effective learning assessments. The Usability category received slightly lower scores, suggesting improvements could be made to enhance the user experience. However, the favorable evaluations from the other categories indicate that the gamified mobile app in Statistics and Probability has the potential to be a valuable tool for learners seeking to improve their skills and knowledge in this subject area.

EVALUATORS' FEEDBACK ON THE DEVELOPED GAMIFIED MOBILE COURSEWARE

During the first test of the gamified mobile courseware on the MARS's feedback section, depicted in Table 3, the IT evaluators identified several issues. The table identifies three main categories: Engagement, Functionality, and Information, highlighting the themes that emerged under each category.

Table 3. IT practitioners' feedback on the gamified mobile courseware

Category	Emerged themes
Engagement	• improving the user interface design, usability, user experience design, and user control of the app • improving the flexibility in interaction and communication, and collaboration with the app
Functionality	• reducing user frustration • improving data quality, reliability, and user privacy of the app • ensuring data quality and user authenticity • preventing unexpected errors and fraud • reducing user frustration
Information	• improving data privacy, user experience, and data security, preventing data loss

Under *Engagement*, the main themes that emerged include improving the user interface design, usability, user experience design, user control of the app, and flexibility in interaction, communication, and collaboration with the app. This suggests that IT professionals consider the user experience a crucial aspect of mobile courseware and suggest improvements to enhance user engagement and interaction with the app.

Functionality was the second category, and the themes that emerged under it included reducing user frustration, improving data quality, reliability, and user privacy of the app, ensuring data quality and user authenticity, preventing unexpected errors and fraud, and reducing user frustration. These themes suggest that IT professionals value the functional aspects of mobile courseware and that it should be reliable, secure, and free from errors to ensure users have a positive experience.

The final category was *Information*, and the themes that emerged under it include improving data privacy, user experience, data security, and preventing data loss. This suggests that IT professionals consider the security and privacy of user data to be of great importance and suggest that measures be put in place to ensure that user data is protected.

IT practitioners had no feedback on the aesthetic aspect of the gamified mobile app in Statistics and Probability because aesthetics is subjective and can vary depending on personal preferences. Additionally, IT professionals may be more concerned with the technical aspects of the courseware, such as its functionality, usability, and security, than with its visual design. Moreover, the gamified mobile courseware may have already been designed with a visually appealing interface, which did not draw any significant feedback from the IT professionals.

The researcher also solicited comments and suggestions for improving the developed gamified mobile courseware in the feedback section of the GMCET from the math teachers and math experts. The feedback of math teachers and math experts on the gamified mobile courseware for Statistics and Probability is summarized in Table 4.

Table 4 summarizes feedback from math teachers and experts on the gamified mobile app in Statistics and Probability. The feedback has been divided into four categories: Content Quality, Content Presentation, Learning Assessment, and Usability.

Table 4. Math teachers' and math experts' feedback on the gamified mobile courseware

Category	Emerged themes
Content Quality	• clarity and ease of understanding • adequacy, inclusivity, and accessibility of the learning contents
Content Presentation	• the need for 21st-century learning materials • personalization, customization, inclusivity, and accessibility of the content
Learning Assessment	• independence and reliance of the learners • performance tracking and monitoring of the app • gamification of the app
Usability	• quality of the learning content • relevant and convenient • gamified and engaging • flexible and accessible • communication and feedback • technical issues and improvements

In the *Content Quality* category, the emerging themes are clarity and ease of understanding, adequacy, inclusivity, and accessibility of the learning content. This suggests that math teachers and experts emphasize the importance of having content that is easy to comprehend and accessible to students of all levels, backgrounds, and abilities.

In the *Content Presentation* category, the emerging theme is the need for 21st-century learning materials, personalization, customization, inclusivity, and accessibility of the content. This indicates that math teachers and experts value modern and innovative learning materials tailored to individual learners, designed to be inclusive and accessible.

In the *Learning Assessment* category, the emerging themes are independence and reliance of the learners, performance tracking and monitoring of the app, and gamification. This suggests that math teachers and experts value the ability of learners to work independently and rely on the courseware to track their progress. Additionally, incorporating gamification elements effectively motivated learners and made learning more engaging.

Finally, in the *Usability* category, the emerging themes are the quality of the learning content, relevance, convenience, gamification and engagement, flexibility and accessibility, communication and feedback, and technical issues and improvements. This category covers a broad range of themes, indicating that math teachers and experts are concerned with many aspects of the usability of the courseware, including its quality, relevance, and convenience, as well as its engagement and accessibility. They also emphasize the need for effective communication and feedback mechanisms and addressing technical issues and improvements to enhance the overall user experience.

There could be several reasons math teachers and experts did not provide feedback on the "learning objectives" category of the developed gamified mobile courseware in statistics and probability. One reason could be that the learning objectives of the courseware were well-defined and clear, and thus, there was no need for expert feedback or suggestions. Another reason could be that the experts were

already familiar with the learning objectives of statistics and probability courses and did not see the need to comment on them. It is also possible that the experts may have provided feedback on the learning objectives of the courseware. However, it was not included in the evaluation report or the presented data. Alternatively, the experts may have provided feedback on other aspects of the courseware, which were deemed more important or relevant to the learning objectives.

DISCUSSION

The courseware had some positive aspects, but improving its functionality, aesthetics, and information is crucial to align with the course's learning objectives. The result also implies that designers and developers of gamified mobile courseware should pay more attention to designing game mechanics that align with the course's learning objectives, creating visually appealing interfaces, and providing adequate information to support learners' comprehension and mastery of the course content. According to Wang et al. (2022), using courseware in mathematics education has positively affected students' learning outcomes, particularly in enhancing their problem-solving skills and understanding of mathematical concepts. However, their study also revealed that their courseware's functionality, aesthetics, and information did not always align with the course's learning objectives, hindering its effectiveness in promoting effective mathematics education.

Therefore, it is essential to continuously evaluate and enhance the courseware to promote effective mathematics education. By doing so, it can be ensured that the courseware aligns with the course's learning objectives and enhances students' learning outcomes. However, while gamification can improve learners' engagement, further research is needed to prove its impact on students' learning, according to Boudadi and Gutierrez-Colon (2020). They emphasized that researchers need to delve further into the effects of gamification on learning because there is no common language among them.

Furthermore, the favorable ratings for Content Quality, Learning Objectives, Engagement, and Learning Assessments suggest that the courseware successfully provides comprehensive content, achieves learning objectives, and engages learners effectively. However, the lower rating in the Usability category suggests room for improvement in the user experience. This could involve changing the courseware's interface, navigation, or features to make it more intuitive and user-friendly.

The evaluation results indicate that the gamified mobile app in Statistics and Probability effectively provides comprehensive content, achieves learning objectives, and engages learners effectively. However, improvements can be made in the Usability category to enhance the user experience by improving the courseware's interface, navigation, or features. By addressing these areas for improvement, developers can create more effective and engaging mobile courseware, enhancing learners' understanding and skills in Statistics and Probability.

CONCLUSIONS

The study, focusing on the gamification of Statistics and Probability through a mobile courseware approach, has yielded promising results. The positive feedback and evaluations from I.T. practitioners, math teachers, and math experts across various categories, such as content quality, engagement, and learning assessments, affirm that the developed gamified mobile app can be an effective instructional material for distance learning, particularly during asynchronous learning modalities.

The app's success in delivering quality content, achieving learning objectives, and engaging learners is evident from the high ratings in these categories. However, the lower rating in the usability category indicates room for improvement in the user experience to enhance the app's usability.

While the study was limited to a specific sample size and subject area, the implications of the findings are far-reaching. The effectiveness of gamified mobile courseware in enhancing distance learn-

ing, particularly in asynchronous learning modalities, is apparent. This study can inform the development of instructional materials that use gamification strategies to improve learner engagement and motivation in various subject areas beyond Statistics and Probability.

Moreover, the study underscores the importance of usability and user experience design in developing instructional materials for distance learning. Future studies should consider expanding the sample size and including other stakeholders such as students and instructional designers. They should also explore the potential benefits of incorporating gamification in online learning environments across different subject areas.

In conclusion, the gamifican of Statistics and Probability through a mobile courseware approach has demonstrated the potential to enhance the effectiveness of distance learning. The insights gained can guide future efforts in designing and implementing gamified instructional materials.

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APPENDIX A. MOBILE APP RATING SCALE

Part I. Respondents' profile

Name: _____ Sex: ◯Male ◯Female

(Optional)

Highest Educational Attainment: _____

Years of Experience: _____

Part II. Software evaluation of the developed gamified mobile courseware in statistics and probability

Direction: Please evaluate the gamified mobile courseware in Statistics and Probability on the extent of how the elements (engagement, functionality, aesthetics, and information) were developed by encircling the number that corresponds to your answer for each item.

Specifically, please encircle:

5 – if the elements of the gamified mobile courseware have been developed to a great extent,
4 – if the elements of the gamified mobile courseware have been developed to a moderate extent,
3 – if the elements of the gamified mobile courseware have been developed to some extent,
2 – if the elements of the gamified mobile courseware have been developed to a small extent, and
1 – if the elements of the gamified mobile courseware have been not all developed.

Engagement Criteria	To a great extent	To a moderate extent	To some extent	To a small extent	Not at all
The developed gamified mobile courseware is interesting to use.	5	4	3	2	1
The developed gamified mobile courseware uses any strategies to increase engagement by presenting the Statistics and Probability contents interestingly.	5	4	3	2	1
The developed gamified mobile courseware's content (visual information, language, design) is appropriate for the target audience.	5	4	3	2	1
The developed gamified mobile courseware addresses the user's academic needs.	5	4	3	2	1
The developed gamified mobile courseware provides incentivization programs such as badges, stars, and hints, that encourage user-engagement	5	4	3	2	1

Functionality Criteria	To a great extent	To a moderate extent	To some extent	To a small extent	Not at all
The developed gamified mobile courseware works accurately/fast to do app features (functions) and components (buttons/menus).	5	4	3	2	1
The developed gamified mobile courseware is easy to be learned and to be used.	5	4	3	2	1
The developed gamified mobile courseware's menu labels/icons, and instructions are clear.	5	4	3	2	1
The movement between screens of the developed mobile courseware is logical, accurate, appropriate, and uninterrupted.	5	4	3	2	1
The interactions such as taps, swipes, pinches, and scrolls of the developed gamified mobile courseware are consistent and intuitive in all components/screens.	5	4	3	2	1
The developed gamified mobile courseware works consistently with all its target user(s).	5	4	3	2	1
The developed gamified mobile courseware responds quickly and smoothly.	5	4	3	2	1
The developed gamified mobile courseware is easy to use and responds to interaction as expected.	5	4	3	2	1
Aesthetics Criteria	To a great extent	To a moderate extent	To some extent	To a small extent	Not at all
The developed gamified mobile courseware has a high level of visual appeal such as seamless graphics that is consistent and professionally designed.	5	4	3	2	1
The developed gamified mobile courseware provides variations of the same basic color that creates a powerful visual impression to the user.	5	4	3	2	1
The developed gamified mobile courseware uses familiar screens that can be seen in many mobile apps.	5	4	3	2	1
The developed gamified mobile courseware only asks for a bare minimum of information from the user.	5	4	3	2	1
The developed gamified mobile courseware uses words or phrases that are appropriate to the target user.	5	4	3	2	1
Information Criteria	To a great extent	To a moderate extent	To some extent	To a small extent	Not at all
The visual explanation of concepts of the developed gamified mobile courseware through charts, graphs, images, videos, etc. is clear, logical, and correct.	5	4	3	2	1
The developed gamified mobile courseware contains what is described in the operations manual.	5	4	3	2	1
The extent of coverage of the developed gamified mobile courseware is comprehensive and concise.	5	4	3	2	1

Please provide your comments/feedback on the developed gamified mobile courseware for further improvement(s).

_____
_____
_____

APPENDIX B. GAMIFIED MOBILE COURSEWARE EVALUATION TOOL

Part I. Respondents' profile

Name: _____ Sex: ◯ Male ◯ Female
　　　　　　　　(Optional)

Highest Educational Attainment: _____

Years of Teaching Experience: _____

Part II. Evaluation of the gamified mobile courseware in statistics and probability

Direction: Please evaluate the gamified mobile courseware in Statistics and Probability on the extent of how the elements (content quality, learning objectives, content presentation, learning assessments, and usability) were developed by encircling the number that corresponds to your answer for each item.

Specifically, please encircle:

5 – if the elements of the gamified mobile courseware have been developed to a great extent,
4 – if the elements of the gamified mobile courseware have been developed to a moderate extent,
3 – if the elements of the gamified mobile courseware have been developed to some extent,
2 – if the elements of the gamified mobile courseware have been developed to a small extent, and
1 – if the elements of the gamified mobile courseware have been not all developed.

CONTENT QUALITY

Criteria	To a great extent	To a moderate extent	To some extent	To a small extent	Not at all
The contents of the gamified mobile courseware are aligned with DepEd's content standards for Statistics and Probability.	5	4	3	2	1
The gamified mobile courseware has adequate facts/details to support the concepts being presented.	5	4	3	2	1
The developed gamified mobile courseware provides enough examples and illustrations to emphasize and elaborate on the concepts.	5	4	3	2	1
The concepts presented in the gamified mobile courseware are suited to the learner(s).	5	4	3	2	1
There are no conceptual and/or computational errors found in the gamified mobile courseware.	5	4	3	2	1
The contents of the gamified mobile courseware stimulate and promote higher-order thinking skills.	5	4	3	2	1

The contents of the gamified mobile courseware support the educational philosophy, goals, and objectives of the Department of Education.	5	4	3	2	1
The contents of the gamified mobile courseware meet high standards of quality in factual content for Statistics and Probability.	5	4	3	2	1
The contents of the gamified mobile courseware are diverse concerning the level of difficulty and reader appeal.	5	4	3	2	1
The contents of the gamified mobile courseware are appropriate for the age, emotional, social development, and ability of the learners.	5	4	3	2	1
The contents of the gamified mobile courseware have cultural, literary, or social value.	5	4	3	2	1
The contents of the gamified mobile courseware help develop the learners to be good at decision-making.	5	4	3	2	1

LEARNING OBJECTIVES

Criteria	To a great extent	To a moderate extent	To some extent	To a small extent	Not at all
The learning objectives of the gamified mobile courseware are based on DepEd's curriculum guide.	5	4	3	2	1
The learning objectives of the gamified mobile courseware are presented clearly and explicitly.	5	4	3	2	1
The learning objectives of the gamified mobile courseware included active verbs from the Revised Bloom's Taxonomy.	5	4	3	2	1
The learning objectives of the gamified mobile courseware are relevant to the content and learning activities.	5	4	3	2	1
The learning objectives of the gamified mobile courseware are ordered properly.	5	4	3	2	1
The learning objectives of the gamified mobile courseware set what is expected from the learner before the start of each lesson.	5	4	3	2	1
The learning objectives of the gamified mobile courseware focus on the learner, not on the teacher.	5	4	3	2	1
The learning objectives of the gamified mobile courseware are sequentially appropriate.	5	4	3	2	1
The learning objectives of the gamified mobile courseware are attainable within a reasonable time.	5	4	3	2	1
The learning objectives of the gamified mobile courseware set expectations that are within the student's level of cognitive, social, language, and/or moral development.	5	4	3	2	1
The learning objectives of the gamified mobile courseware highlight what mathematical skills/competencies are expected of the learner.	5	4	3	2	1

CONTENT PRESENTATION

Criteria	To a great extent	To a moderate extent	To some extent	To a small extent	Not at all
The topics and ideas contained in the gamified mobile courseware are logically organized from easy to difficult.	5	4	3	2	1
The contents of the gamified mobile courseware are presented based on the learner's needs and interests.	5	4	3	2	1
The language used in the gamified mobile courseware is suited to the learner's level of comprehension.	5	4	3	2	1
The language used in the gamified mobile courseware provided a clearer understanding of the basic concepts and principles of the Statistics and Probability course.	5	4	3	2	1
The concepts presented in the gamified mobile courseware are clear and simple.	5	4	3	2	1
Activities are presented in the gamified mobile courseware for each topic to enrich the learner's conceptual and/or procedural knowledge.	5	4	3	2	1
An overview of what is to be learned is presented in the gamified mobile courseware.	5	4	3	2	1
The concepts of the gamified mobile courseware are presented in a creative and meaningful manner.	5	4	3	2	1
The gamified mobile courseware provided a recall of pre-requisite skill(s) needed for each topic presented.	5	4	3	2	1
The learning contents presented in the gamified mobile courseware are sensitive to gender orientation and viewpoints of indigenous people.	5	4	3	2	1
The contents presented in the gamified mobile courseware support/promote the learner's self-esteem and self-respect for the self-esteem of others.	5	4	3	2	1
The learning contents presented in the gamified mobile courseware are relevant to the learner's needs and interests.	5	4	3	2	1

LEARNING ASSESSMENTS

Criteria	To a great extent	To a moderate extent	To some extent	To a small extent	Not at all
Sufficient activities are provided in the gamified mobile courseware to apply the knowledge and skills gained in each topic.	5	4	3	2	1
The learning activities are provided in the gamified mobile courseware with suitable and acceptable vocabulary that would ensure a better understanding of the concepts and skills to be performed by the learner.	5	4	3	2	1
The learning assessments of the gamified mobile courseware are congruent with the learning objectives and concepts presented.	5	4	3	2	1
The learning activities provided in the gamified mobile courseware assessed the acquisition of necessary skills in Statistics and Probability.	5	4	3	2	1
The directions provided in the gamified mobile courseware for each learning assessment are presented and understandable.	5	4	3	2	1

The learning assessments in each topic of the gamified mobile courseware are presented in a simple to complex manner.	5	4	3	2	1
The learning assessments of the gamified mobile courseware have a very clear purpose as to what is to be evaluated among the learners.	5	4	3	2	1
The learning assessments of the gamified mobile courseware provide timely feedback regarding the learner's progress.	5	4	3	2	1
Formative and summative assessments are provided in the gamified mobile courseware.	5	4	3	2	1
The learning assessments of the gamified mobile courseware are relatable to the learner's experiences in real-world contexts.	5	4	3	2	1
The learning assessments of the gamified mobile courseware can easily be scored.	5	4	3	2	1
A reward system is provided after each learning assessment of the gamified mobile courseware.	5	4	3	2	1

USABILITY

Criteria	To a great extent	To a moderate extent	To some extent	To a small extent	Not at all
The gamified mobile courseware can be used easily and independently by the learner.	5	4	3	2	1
The design allows the user to navigate freely the developed gamified mobile courseware.	5	4	3	2	1
The user can control the rate and sequence of the presentation of the gamified mobile courseware.	5	4	3	2	1
The developed gamified mobile courseware is user-friendly and age-appropriate.	5	4	3	2	1
The developed gamified mobile courseware used the concept of games to gain attention and maintain the motivation of the user.	5	4	3	2	1
The developed gamified mobile courseware is free of technical problems.	5	4	3	2	1
The user can always know where they are in the gamified mobile courseware and how are they progressing.	5	4	3	2	1
The gamified mobile courseware allows the user to leave whenever they desired but can easily return to where they stopped in the course.	5	4	3	2	1
Fonts (style, color, and saturation) of the gamified mobile courseware are easy to read for both on-screen and printed versions.	5	4	3	2	1
The developed gamified mobile courseware offers tools (hints, guides, etc.) that support learning.	5	4	3	2	1
The gamified mobile courseware is enjoyable and interesting to use.	5	4	3	2	1
The gamified mobile courseware provides the user with frequent and different learning activities that increase learning success.	5	4	3	2	1

Please provide your comments/feedback on the developed gamified mobile courseware for further improvements.

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AUTHOR

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