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GAMIFYING "WHOLE-PERSON EDUCATION": THE DEVELOPMENT OF A MOBILE APPLICATION WITH AUGMENTED REALITY

Abstract. Whole-person education is what many educational institutions aim for, especially in these times of rapid technological innovations. Silliman University, one of the oldest universities in the Philippines, offers whole-person education to achieve total human development. This study is an innovative technology integration in the classroom of the course "whole-person education". Specifically, this paper describes the development of a mobile game application that integrates augmented reality. Applying the gamification theory, a learning trail about the 5Cs of Silliman Education - Classroom, Church, Culture, Court, and the Community, was integrated. The learning trail consists of three learning paths, and each path consists of ten checkpoints. Three qualifying questions were embedded to determine the player's learning path. Each checkpoint is augmented using QR codes. Players need to complete the game in the shortest possible time. The educational game mobile application was developed using Appery.io, a rapid development, integration, and deployment platform. The mobile application runs on the Android operating system as part of the first release. A survey was conducted among 244 players of the game application. A 4-point scale questionnaire is integrated into the game app, asking the players about their level of agreement with the statements representing their game evaluation. The result shows that the game application was evaluated positively by the respondents, with a mean of 3.69. Expressly, the players agreed ($\underline{x}$ = 3.69) that they learned a lot about the AR trail. The students also agreed ($\underline{x}$ = 3.35) to the statement, "I would like my teachers to integrate apps like this in my classes." The result implies that augmented reality and gamification as teaching strategies in the classroom are perceived positively and accepted by the students. The educational game promotes the understanding of whole-person education especially in a developing country where digital divide is a pressing issue.

Keywords: augmented reality in education; gamification; mobile learning application; whole-person education.

1. INTRODUCTION

Among the effective pedagogies and classroom activities to improve student engagement in the classroom is the application of gamification – a process of incorporating games in teaching delivery, content, assessment, and feedbacking. Why gamification? Gamification keeps students engaged and motivated for otherwise tedious activities [1]. According to Hanus and Fox (2014, as cited in [1]), gamification can use social competition to encourage collaboration and motivation to foster learning. Gamification of education can enhance levels of students' engagement, similar to what games can do to improve their particular skills and optimize their learning [2].

As stated by Hakulinen and Auvinen (2014, as cited in [2]), many researchers have looked into the influence of gamification in an educational context, stimulated by the effects that game elements can produce, getting favorable results such as the increase of engagement, user retention, knowledge, and cooperation. Gamification makes learning fun and interactive, allowing learners to see real-world applications and real-time feedback, enhancing the learning experience [3]. The results of the study by Murillo-Zamorano et al. [4] point out that gamification favors the development of skills demanded by the current work in the context of active learning. Significant differences exist between the results of the group that attended the gamified active learning setup and those who attended the non-gamified one. These skills are the ability to work in groups, the ability to listen to others' opinions, self-learning ability, the ability to apply knowledge in practice, analytical ability, and the ability to synthesize information. In this way, gamification represents an educational tool capable of satisfying the interests of the digital society.

The problem statement. Disruptive innovations and technological revolution where machines and robots are almost replacing humans, coupled with globalization and internationalization of education, make whole-person education a pressing need. Consequently, there is a growing demand for integrating learning technologies such as gamification, mobile technology, and augmented reality in a holistic and integral approach. The United Board for Christian Higher Education (UBCHEA), a nongovernmental organization, defines "whole person education as the intellectual, spiritual, and ethical development of individuals" (United Board for Christian Higher Education in Asia, 2017). Several higher education institutions integrated whole-person education in teaching, research, and community extension. However, whole-person education must be institutional, holistic, and responsive to today's high demands of disruptive innovation [5]. Moreover, technology integration in developing countries like the Philippines is always challenging. Slow Internet connectivity, unskilled teachers, limited budget, and other digital gaps are increasing in many Philippines schools.

Analysis of recent studies and publications. Gamification is moving from a simple novelty to a valid pedagogical approach that can deliver powerful learning experiences in any form of education. Game developers realize that many gaming attributes, like challenges, rewards, and collaboration, also have relevance in the classroom. Games become integrated into learning [6]. The increased focus on student engagement and the possibilities provided by digital learning make gamification a powerful tool for educators. Gamification is on the cutting edge of innovation in the ever-changing education system. While it is a powerful tool for new ways of teaching, it is costly and ineffective when misused [7].

Gamification refers to using game design elements in contexts other than games to increase user engagement with a system (Kapp, 2013, as cited in [8]). According to Dichev and Dicheva (2017, as cited in [8]), this strategy has been used in learning contexts to improve learners' motivation, participation, collaboration, and self-guided learning. The goal is to generate levels of involvement equal to what games can usually produce (Fardo, 2014, as cited in [2]). Nick Pelling first used gamification in 2002 to refer to using game elements in non-game situations (Domingues et al., 2013, as cited in [1]). These game elements should only be those that play a significant role in the gameplay, such as rewards, difficulty levels, scoring points, time limits, resource limits, clear objectives, and a narrative that contextualizes those objectives. However, using game elements does not imply using games (Deterding et al., 2011, as cited in [1]). Gamification as a concept has been broadened and defined by others as well. Deterding et al. (2011, as cited in [9]) defined it as the process of using game thinking and game mechanics to solve problems. Lee and Hammer (2011, as cited in [9]) refer to it as using game mechanics, dynamics, and frameworks to promote desired behaviors. Gamification is an emerging trend in higher education. Much room is available to create innovative, flexible, powerful, easy-to-use gamification platforms [10]. Goshevski et al. [10] reviewed popular

educational gamification platforms, namely ClassCraft, Kahoot, Seppo, and Youtopia. With the advancement of mobile technology, many gamified applications can run on various mobile technology platforms.

Mobile app development in schools is proliferating. Like gamification, mobile learning applications significantly impact students' academic achievement and attitudes towards learning [11]. While it is true that students use mobile technology for social media purposes [12], mobile apps are also used in schools for various purposes. For example, mobile apps are used to promote library services [12], as a class record for teachers [13], and for several academic and administrative purposes. Nevertheless, a mobile app is most notably used as learning media for innovation in specific classes, from the hard sciences to general education courses. For example, courses like computer programming [14], ethics on the use of social media [15], and many more. Consequently, many mobile apps utilize artificial intelligence, specifically augmented reality (AR).

In a systematic review [16], AR's top four advantages in schools include increasing motivation, facilitating interaction, catching the interest of students with disabilities or special educational needs, and the low cost of implementing this technology in the classroom. Gartner.com defines AR as "the real-time use of information in text, graphics, audio and other virtual enhancements integrated with real-world objects." AR provides "a digitally enhanced real-world view with added layers of 2D video or 3D animated content" [17]. These visualizations are illustrated in the form of QR codes. Several studies have used QR codes to display augmented reality content [18] [19]. Quick Response (QR) code is a form of 2D bar code and was developed by Denso-Wave, a Japanese automatic data capture equipment company (Denso, 2009), as cited in [20]. A QR code can hold 7089 numeric characters, 2953 binary bytes, 1817 Kanji characters, or a mixture. It stores information in both vertical and horizontal directions. A QR code can be read from any direction at 360° through position detection patterns at the three corners. A QR code is a piece of long multilingual text, a linked URL, an automated SMS message, a business card, or just about any information that can be embedded into the two-dimensional barcode. Data can be easily encrypted to provide confidentiality of information in the code. Coupled with moderately equipped mobile devices, QR codes can connect the users to the information quickly and efficiently [20]. Studies show that QR codes provide significant benefits in education. Some common use of QR integration in schools includes library information, student activity submission, collaborative learning, and resource sharing [20].

All the three technological innovations when combined and developed as one – gamification, mobile technology, and augmented reality – disrupt teaching and learning and bring education to a new level of content and experiences. For example, in a gamified mobile augmented reality trails of integrity and ethics app, the app has "helped students to become more active and engaged in their learning of abstract conceptual knowledge about AIE, and that their perspectives on AIE have changed as they have begun to link ethical dilemmas on the TIEs with their everyday realities" [21]. In another study, a gamified mobile app with augmented reality was developed about responsible use of social media [15]. It was concluded that the gamified mobile app evidences a "new and innovative way of learning responsive to the demand of 21st-century learning".

The research goal. The research aims to integrate an innovative teaching tool for the course "whole-person education" in the classroom. Specifically, the research is aimed at gamifying the teaching of a course called "Whole-Person Education," using mobile and augmented reality applications. This article describes the development process of coming up with the learning trail game. Likewise, this paper describes the development of the mobile game application and the use of QR codes to visualize the augmented reality content. Further, the article presents the effectiveness level of the newly developed gamified mobile app with

augmented reality. The research goal is to make the course "Whole Person Education" innovative and entertaining for the students to learn while having fun. It is also hoped that this research could be replicated by any other schools who are wanted to integrate technology in the classroom. It is also hoped that this paper will contribute significantly to the educational technology community, especially in developing countries constantly challenged by digital gaps.

2. METHODS

The study employed a software development method emphasizing the integration of a learning trail, questions-and-answer format, game flowchart, and an easy-to-use programming tool.

2.1. Learning Trail

The game mechanics of the developed educational mobile app is anchored on the mechanism used in the study on the gamified responsible use of social media [15]. It is in the form of a learning trail. Learning trails support personalized and collaborative learning where learners follow prearranged trails and form personal trails through interaction [22]. Players have to follow a particular learning journey. There are three learning journeys provided, easy, moderate, and hard. The learning journey of a player will be determined based on the qualifying questions. The learning journey has 13 stop-overs. The stop-over is the place where players need to scan a QR code for them to view and respond to the question. Each question is equivalent to 1 point. The total time in completing the trail is measured.

2.2. The Questions

Questioning for game-based learning is a critical phase in any educational game development. The manner and framing of questions must be carefully anchored on relevant learning theories. Gamifying the questions should emphasize the role of languages in learning, such as in the dialog between learners and between learners and the content providers [23]. In this study, the questions depict the 5C's of Silliman Education – the classroom, the Church, the Cultural Center, the (athletic) Court, and the Community. There are two primary sources for formulating the questions: the university website and the book by D. S. Hibbard titled "The First Quarter: A Brief History of Silliman Institute During the First Twenty-Five Years of its Existence" [24]. Some questions were contributed by teachers handling WPE classes at Silliman University. See table 1 for a sample question.

Table 1.

Sample Question

Question: What tenets bind the SU WPE?	
CHOICES	**EXPLANATION**
A. Silliman Spirit	In the dormitories, students belong to a family, a part of the larger Silliman community. Corollary to this sense of community is the "Silliman Spirit" – an atmosphere of personal closeness, warmth, friendship, and concern.
B. Via, Veritas, Vita	Campus life revolves around the motto Via, Veritas, Vita (the Way, the Truth, the Life). Silliman's mission is to develop the whole person within the Christian context and in a sound environment. Students are expected to put their education to work in service to those in need.

C. Faith, instruction, research, extension	Silliman's goal of building competence, character, and faith anchored on the Gospel of Christ aims to develop the whole person. It believes that success and fulfillment are achieved when one views oneself concerning the larger community. Silliman, therefore, envisions genuine quality Christian education as a result of an interaction of experiences from at least five venues: the classroom, the Church, the cultural center, the (athletic) court, and the community.
D. Competence, character, and faith (Correct Answer)	"Whole person education" is what Silliman offers. It is the holistic development of competence, character, and faith, transforming one into a person for others. The approach to learning is encapsulated in its tri-logical ministry of teaching, healing, and preaching, providing opportunities for deep reflection toward an appreciation of self about the larger community.

2.3. The Game Flow

The game flow is considered the heart of any educational game. A game flow should ensure effectiveness in keeping the game both educational and engaging by combining game flow and learning objectives in educational games [25]. To play the WPE game, students must download and install the WPE app (the link to download the app can be found in the SOUL Virtual Office for Students). Currently, the app will only work on Android devices. Once successfully installed, students must log in with their username and password. For first-time users, students need to create an account by clicking the Sign-up button on the login page. They can then use the desired username and password to log in. Upon successful login, students will be asked if they agree with the application's privacy statement. If no, they will be brought back to the login page; if yes, a video explaining the Five Cs of Silliman University will be displayed.

After watching the video, students will now enter a page where they will scan the QR code for Qualifier questions 1, 2, and 3. Qualifier questions need to be in sequence for the QR code to work. When a student selects a wrong answer, a feedback message will be displayed on the screen regarding the answer. Students can only proceed to the next question if they answer the current question correctly. Unlimited attempts were given for each item. The process is the same with all questions, including the questions from the Learning path. Once all the qualifier questions are answered, the student's Learning Path will be displayed on the screen. The learning path will determine which set of questions will be answered by the student. A learning path is based on the student's total score from the qualifier question. Learning Path 1 is offered if the score is less than or equal to 1, Learning Path 2 if the score is equal to 2, and Learning Path 3 if the score is 3.

There are ten questions in each unique Learning path. Students need to answer all the questions assigned in the Learning path. Each question can be answered using a QR code, and it can be answered randomly. Students can only scan the QR code according to the assigned Learning Path. An error will be displayed if the student tries to scan the QR codes that are not part of his/her learning path. Students can track which items from the ten questions have already been answered using the app's display. Once all ten questions are answered, the user student will be directed to answer the final question. The final question is common to all Learning paths.

Immediately after submitting the answer to the final question, the total score will be displayed. There are 11 items in total, including the final question. An answer is considered correct if the right answer is selected during the first attempt at that question. After the result, students will be directed to a survey. There are 13 statements in the survey which can be answered on a scale of 1-4, 1 being "strongly disagree" and 4 "strongly agree". After submitting the survey, the student can choose to go back and play the game again or terminate the program. The game flow is shown in figure 1.

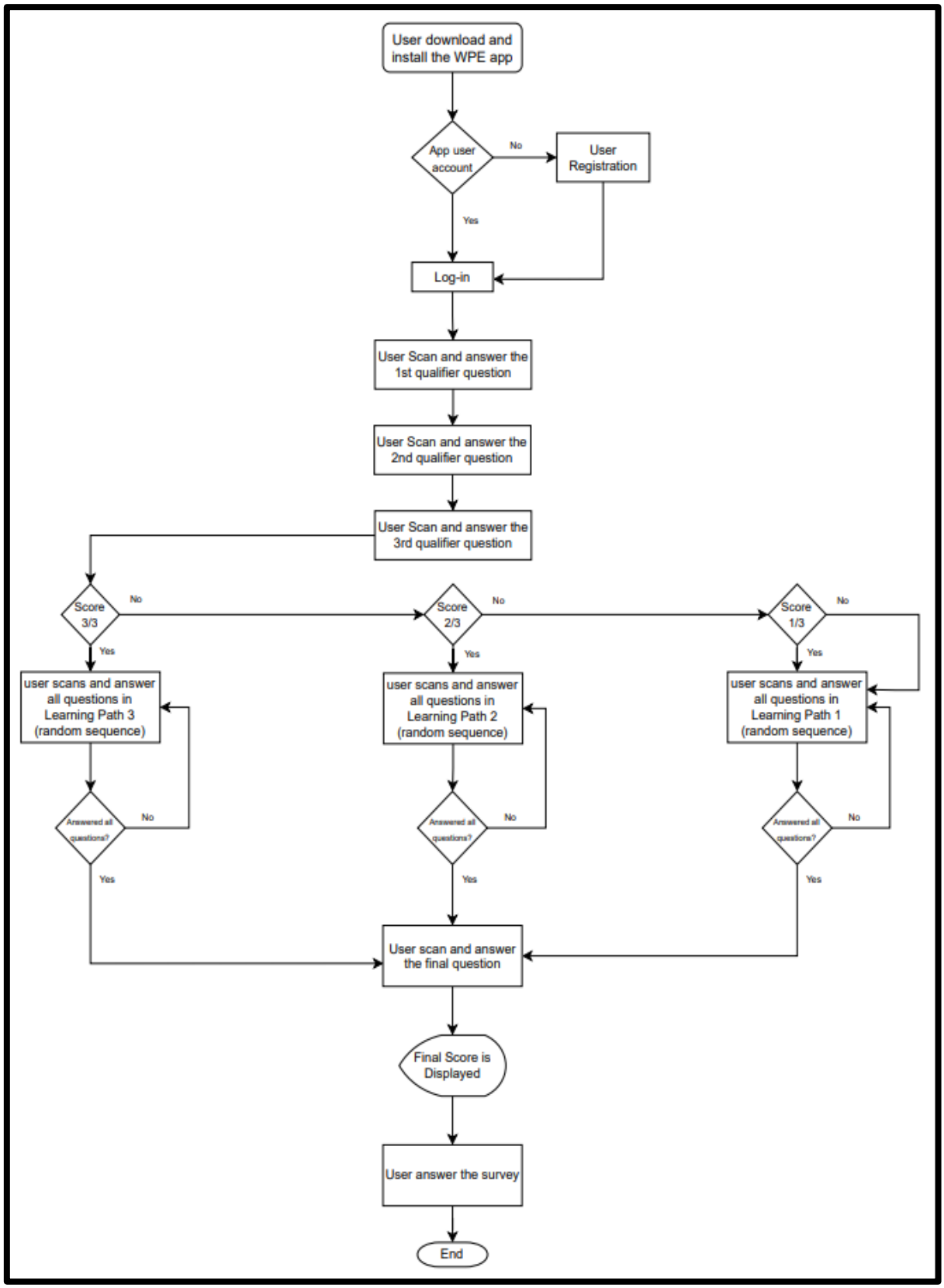

Figure 1. The game flowchart

2.4. The Mobile Programming Tools

The application was developed using Appery.io. Appery.io is a popular platform for rapid development, integration, and deployment. It is "a multi-purpose platform for low-code app development" (Exadel, Inc.). As posted on its website, Appery.io "is a cloud platform that makes it fast and straightforward to build hybrid and mobile web apps connected to APIs. " The platform runs directly in the browser through their visual app builder. Further, Appery.io runs with a complete backend such as databases, server code, secure proxy, API express, and push notifications.

The WPE mobile web application runs directly in the browser via Appery's visual app builder on the Android operating system. Specifically, the WPE game application can run on any Smartphone with the Android 11 operating system. The installer can be downloaded at https://tinyurl.com/SU-WPE-download.

2.5. The Use of QR Code

To be true to its purpose as a mobile and an augmented reality application, QR codes were used to serve as portals to the varying question within in the game. It is through this code that players will gain access and interact with the content of the program. An Appery plugin was used and configured to enable camera access to the mobile device as well as reading the QR code. This particular plugin uses a jQuery script which is fully customizable based on the intended outcome, in this case it is reading a set of QR codes. Users need to have a mobile device with a working camera for the application to work. First, the users need to scan and answer the first three (3) QR codes which are labeled as qualifiers. The scanning of the qualifiers is sequential, meaning users should scan the codes in order, or the code will not work. Depending on their score in the first 3 qualifying questions, they will be directed to their appropriate paths; Easy, Moderate, and Difficult. Each path contains 10 QR codes with one question per code. This time, the scanning of code is in free mode, meaning users can freely choose where to start or what QR code to scan within the path. A tracker in the application will enable the user to know which QR codes have been scanned already and which ones are not. Once all codes have been scanned, the users need to scan the final QR code for the final question. After which, the result will then be displayed.

3. THE RESULTS AND DISCUSSION

3.1. The User-Interface

The app's user interface was designed to be easy, effective, convenient, and comfortable from the users' perspective [26] [27]. For first-time user of WPE game app, players must create an account using the Sign-up button, as shown in figure 2, and fill out the necessary data. Players will be asked if they agree to the confidentiality assurance and participant consent statements (Figure 3). If not, players will be directed to the login page.

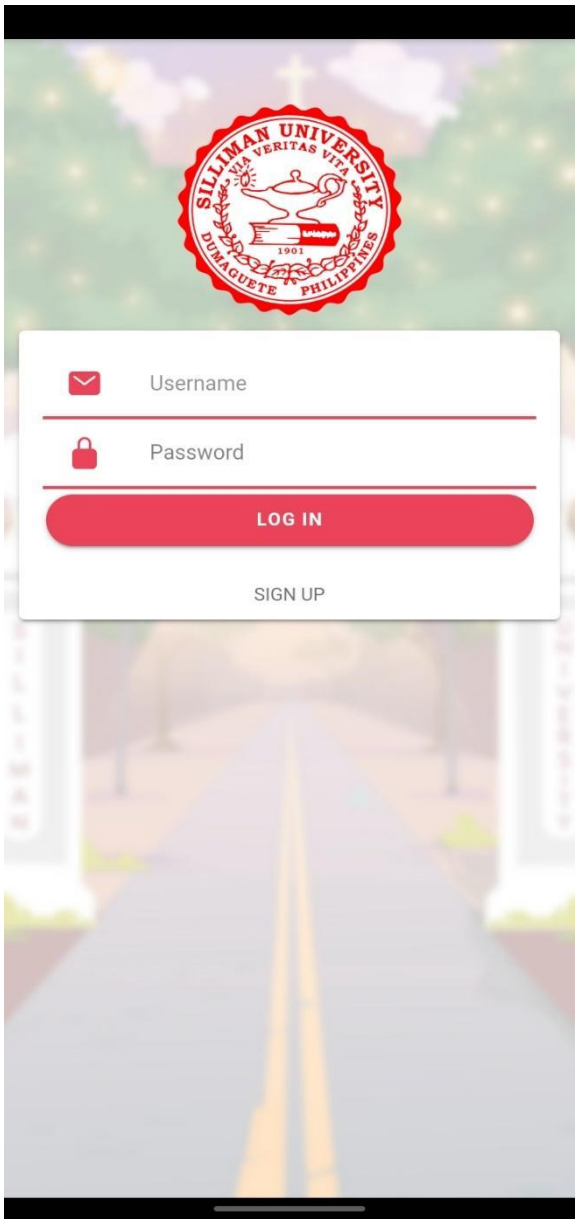

Figure 2. Login page

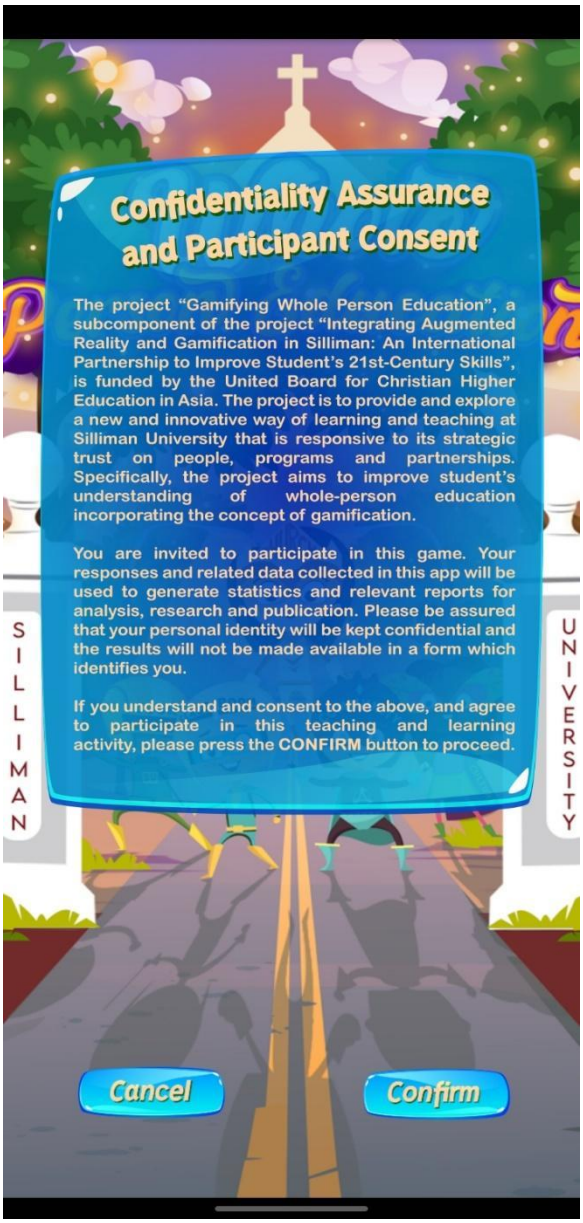

Figure 3. Confidentiality and Assurance page

Players can either select to continue with the game using the "Play" button or read more information about the game using the "I" button, shown in Figure 4. When players are ready, they need to press the red button to open the device's camera to start scanning QR codes, as shown in Figure 5.

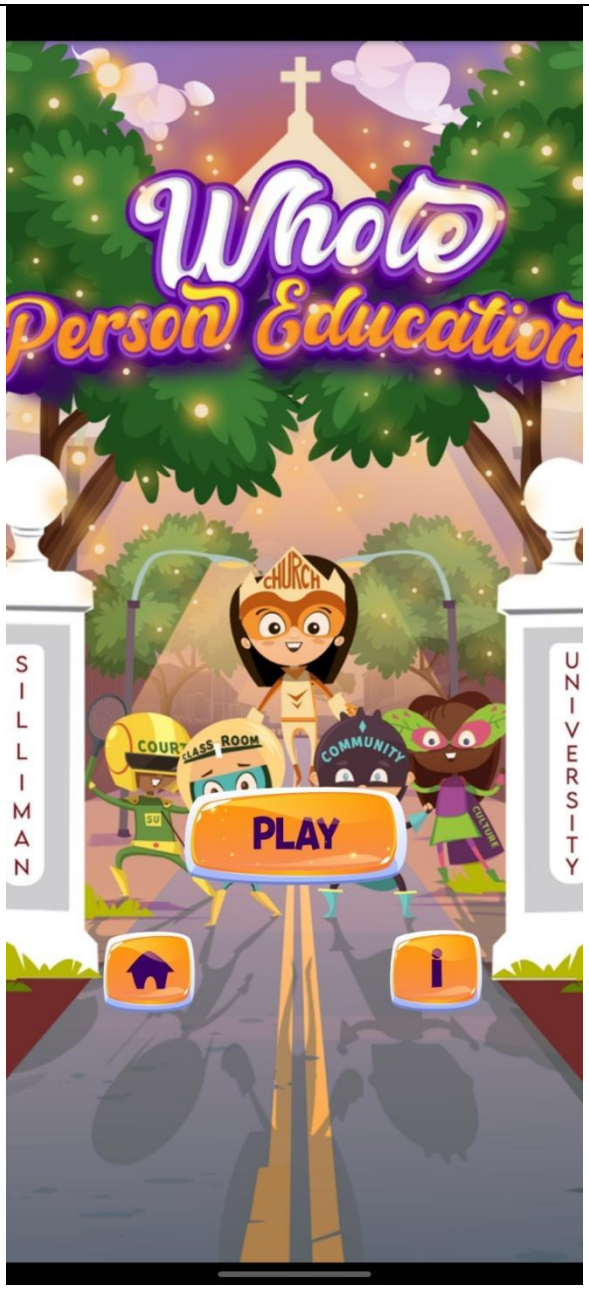

Figure 4. Homepage

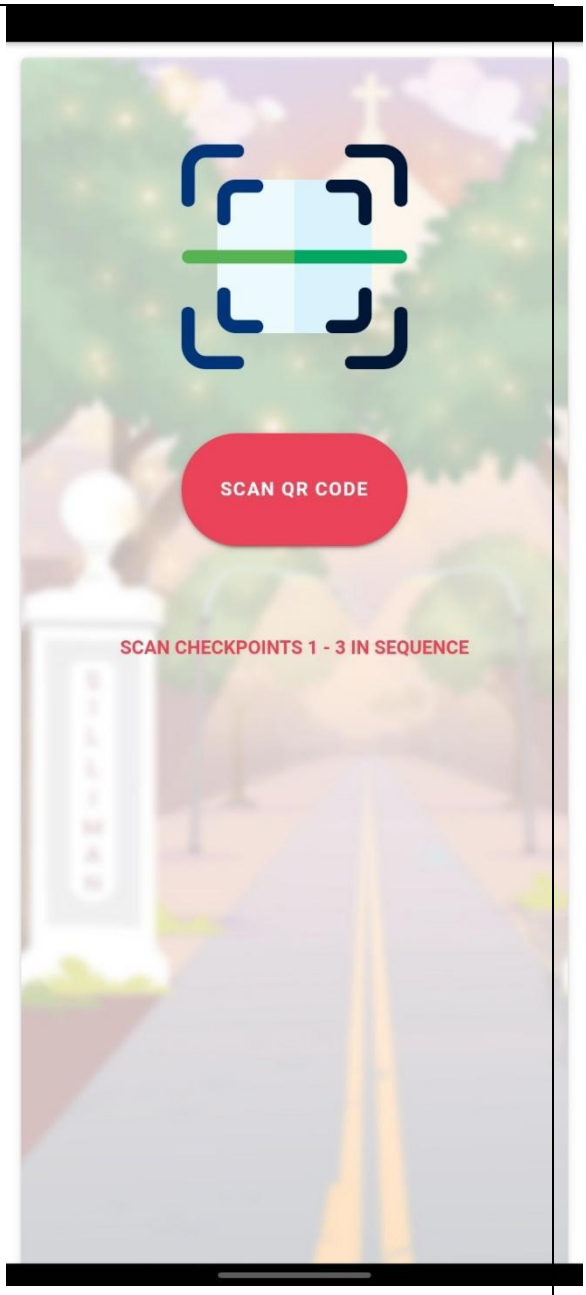

Figure 5. Scanning Page

The game has three qualifier questions, see sample at Figure 6. A feedback explanation will be displayed if a player selects the wrong answer. Players must click the OK button and try again. If the answer is correct, an explanation about the answer will be displayed along with the state of the answer. The next button will also appear on the lower right side so that users can move to the next question. Once all qualifying questions are answered, the total score will be displayed along with the corresponding learning path number.

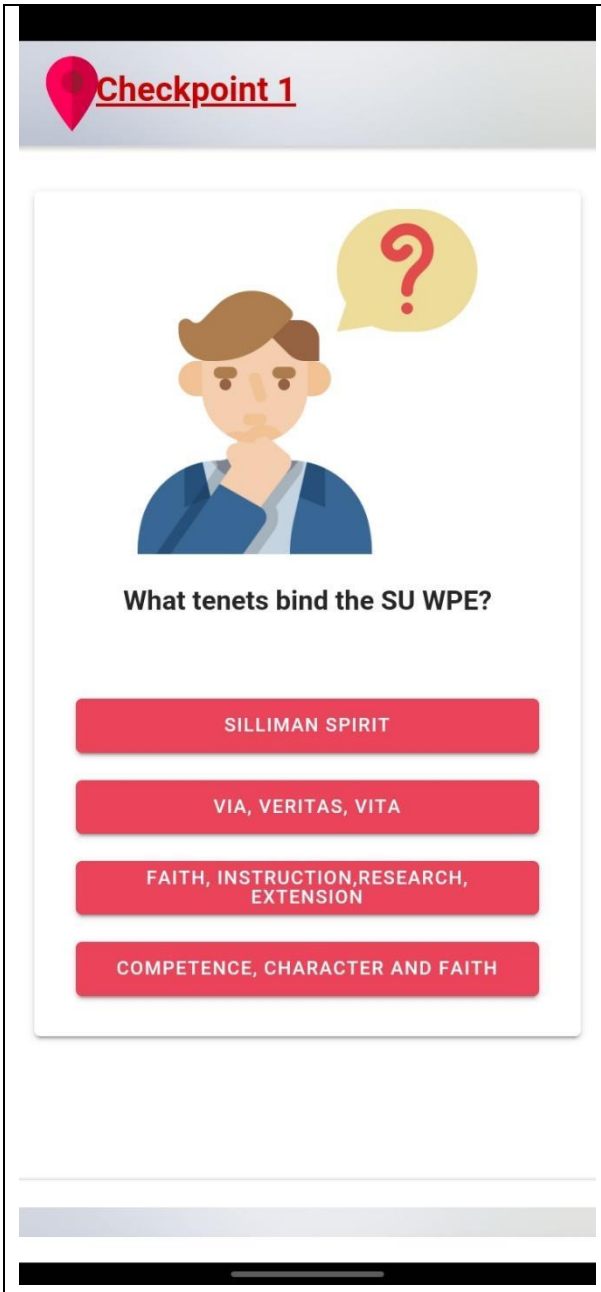

Figure 6. Qualifying Questions

Figure 7. Summary of Completed Checkpoints

There are ten questions in the learning path. Since players can choose to scan the QR codes randomly, a module is designed to track which questions were already answered, see screenshot in Figure 7. This page shows that all the questions in this learning path were already answered. Players can now move to the final question. After the final questions are answered, the total score will be displayed. The correct answer is counted when users select the right answer on the first attempt.

3.2. Game Evaluation

Game evaluation is “essential to systematically evaluate such games to obtain sound evidence on their impact” [28]. In this study, a 4-point scale questionnaire asks the players' level of agreement with the statements representing their overall learning, attitude, and

experience towards the game. The scale is represented with emoticons where players can tap and slide according to their agreement level. A happy face represents "strongly agree," and a sad face for "strongly disagree," see Figure 8. A total of 244 players are senior high to college students of Silliman University. The game was tested on October 13-15, 2021.

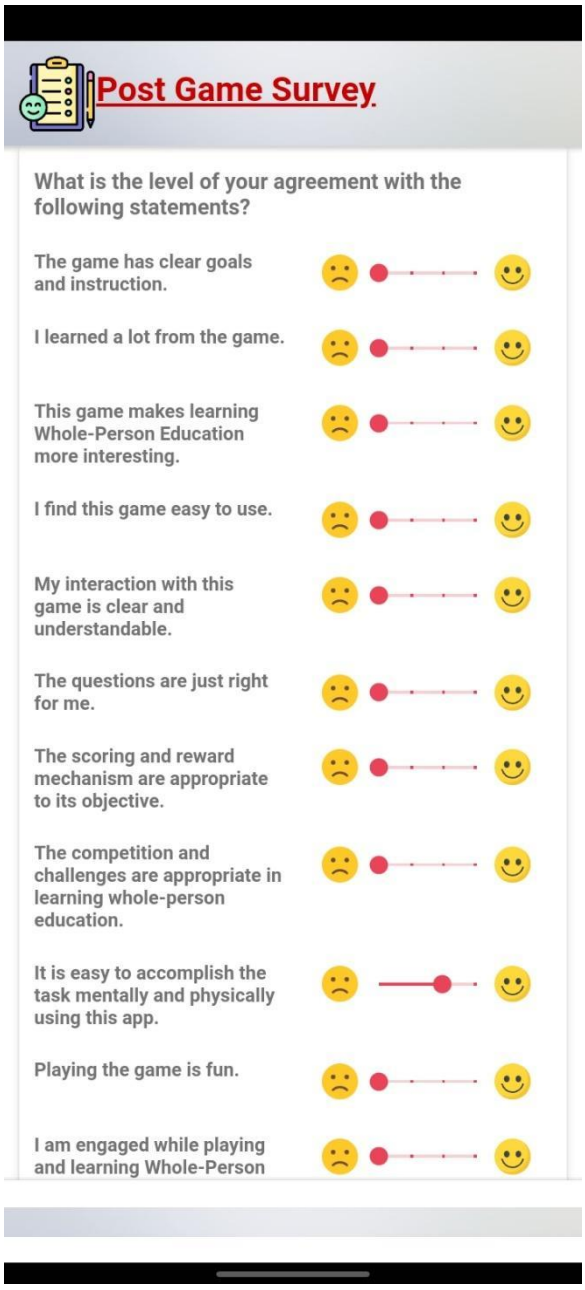

Figure 8. Post-Game Evaluation Survey

As shown in Table 2, the overall mean is 3.38, described as strongly agree. Specifically, the players agreed ($\underline{x}$ = 3.69) that they learned a lot about the AR trail. It implies that through the game, students acquired high knowledge about the 5Cs of Silliman Education. The result also shows that players strongly agreed that playing the game is fun, with a mean of 3.50. Likewise, the players rated the statement, "This game makes learning Whole-Person Education more interesting" ($\underline{x}$ = 3.47) and "I am engaged while playing and learning Whole-Person Education" ($\underline{x}$ = 3.41) "strongly agree." The result validates that gamification makes learning

fun, interactive, and engaging [29]. Most importantly, the data shows that the game application is educational and serves its purpose as a teaching strategy. In terms of the game aspects, the players strongly agreed that the mobile app has clear goals and instructions ($\underline{x}$ = 3.48), the competition and challenges are appropriate in learning whole-person education ($\underline{x}$ = 3.46), and the scoring and reward mechanism are appropriate to its objective ($\underline{x}$ = 3.39). These results denote that the WPE game app comprises highly acceptable gamification features such as challenge, reward, competition, and user engagement [3]. Moreover, in terms of accomplishing the task mentally and physically, the players rated the app "strongly agree" with a mean of 3.34. It is also supported by the rating of the player's interaction with the game, which is clear and understandable ($\underline{x}$ = 3.33), and appropriateness of the questions ($\underline{x}$ = 3.02). In the same manner, the statement "I find this game easy to use" is rated "agree" with a mean of 3.20. These results show that the WPE game is user-friendly. Moreover, there is also a demand from the students urging other teachers to integrate game apps in their classes.

Table 2.

Evaluation Result

Evaluation Statement	Mean	Level of Agreement
I learned a lot from the game.	3.69	Strongly Agree
Playing the game is fun.	3.50	Strongly Agree
The game has clear goals and instructions.	3.48	Strongly Agree
This game makes learning Whole-Person Education more interesting.	3.47	Strongly Agree
The competition and challenges are appropriate in learning whole-person education.	3.46	Strongly Agree
I am engaged while playing and learning Whole-Person Education.	3.41	Strongly Agree
The scoring and reward mechanisms are appropriate to their objective.	3.39	Strongly Agree
I would like my teachers to integrate game apps like this in my classes.	3.35	Strongly Agree
It is easy to accomplish the task mentally and physically using this app.	3.34	Strongly Agree
My interaction with this game is clear and understandable.	3.33	Strongly Agree
My Internet connection is stable.	3.29	Strongly Agree
I find this game easy to use.	3.20	Agree
The questions are just right for me.	3.02	Agree
Overall Mean	3.38	Strongly Agree

4. CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

Gamification is an effective way to teach and learn holistically. It increases student engagement in the classroom, especially on the subject matter. The SU-WPE mobile app is a gamification tool for teachers and students. It is an effective educational game to learn about Whole-Person education. Augmented reality through QR codes and learning trails are among the many interactive strategies that translate educational content into a game. The study is among the many confirmations that gamification in learning makes learning fun and interactive. Gamifying teaching delivery enhances the learning experience [3].

The development of the gamified "Whole Person Education" is innovative in the context of developing countries where the digital divide is a pressing issue. It is innovative, considering that the course is new in the university. Likewise, it is innovative considering the course "Whole Person Education" is an ongoing institutional advocacy in many institutions, especially in many Christian schools in Asia.

It is recommended that a multiplatform should be developed. The game application should run with other popular mobile operating systems such as iOS and Windows. Additional learning journeys and questions should be added to the databank. Audio and sound effects are also suggested to cater to the auditory kind of learners.

A more thorough analysis of the game's impact is also recommended for further studies. Impact evaluation should highlight the relevance of questions if it offers social constructivism, proximal development, and complex learning among the student-players [23]. An impact study is also recommended to measure the structure, navigational learning, knowledge acquisition, cognitive aspects, and trail visualization [22]. Measuring the accuracy of the process used in combining game flow and learning objectives is also suggested. It is worth noting to study if the game flow does not lead to the Shavian reversal effect [25]. An in-depth analysis is also suggested to measure the effectiveness and appropriateness of QR codes as an augmentation tool in an educational learning trail game [18] [19].

There is also a need to conduct further research on student engagement, achievement, and other educational data mining and analytics surrounding knowledge, attitude, and experiences in gamification. Likewise, an in-depth study should focus on the reward, cognitive, emotional, behavioral, and other variables [17]. Moreover, other gamification strategies should be explored for mobile learning in the classroom [30].

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ГЕЙМІФІКАЦІЯ «ФОРМУВАННЯ ЦІЛІСНОЇ ОСОБИСТОСТІ»: РОЗРОБКА МОБІЛЬНОГО ДОДАТКУ З ДОПОВНЕНОЮ РЕАЛЬНІСТЮ

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Анотація. Формування цілісної особистості є основною метою багатьох освітніх закладів, особливо в сучасний період швидкого розповсюдження інноваційних технологій. Університет Сілліман, один із найстаріших університетів на Філіппінах, пропонує шляхи формування цілісної особистості, які можуть бути враховані для загальнолюдського розвитку. Представлене дослідження є інноваційною технологією, інтегрованою в навчальний курс «Формування цілісної особистості». У статті описана розробка ігрового мобільного додатка, який інтегрує доповнену реальність. інтеграція навчального маршруту 5Cs університету Сілліман відбулась із застосуванням теорії гейміфікації: класна кімната, церква, культура, заняття спортом, спільнота. Освітній маршрут складається з трьох освітніх траєкторій, кожна з яких містить десять контрольних точок. З метою визначення індивідуальної освітньої траєкторії задається три відповідних питання. Кожна контрольна точка доповнена QR-кодами. Учасникам необхідно пройти гру за найкоротший час. Мобільний додаток для навчання було розроблено на платформі Appery.io, він може бути встановлений на операційній системі Android першого випуску. Під час дослідження було проведено опитування, яке охопило 244 учасників-гравців. Крім цього, інтегрована 4-бальна анкета надавала учасникам можливість оцінити ігрову розробку. Результат дослідження демонструє, що респонденти позитивно оцінили ігровий додаток із середнім балом 3,69, вони також погодилися (x^{-} = 3,69), що отримали розширені знання щодо доповненої реальності. Студенти також погодилися (x^{-} = 3,35) із твердженням: «Я хотів би, щоб мої вчителі інтегрували такі додатки на моїх заняттях». Результат дослідження означає, що доповнена реальність і гейміфікація як освітні стратегії в навчанні сприймаються учнями позитивно. Навчальна гра сприяє формуванню цілісної особистості, особливо в країнах, що розвиваються, де цифрова нерівність є гострою проблемою.

Ключові слова: доповнена реальність в освіті; гейміфікація; мобільний навчальний додаток; формування цілісної особистості.