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CHAPTER 1 PROJECT OVERVIEW

Research Context

Research entitled, "Bahay Kubo: An Augmented Reality production for Filipino Vegetables and Nutritional Sources," will consider how AR could be a new way of exposing seniors interested in Agriculture to new educational resources and increasing their knowledge of what is available in Agriculture through the Technical Vocational Livelihood (TVL- Agricultural curriculum). The outcomes of the research will demonstrate how AR can provide agriculture vocational students with an improved form of interactive education compared to earlier methods of teaching students about plants, nutrition, and cultivation techniques (Alhussein,2020).

The app digitizes Filipino indigenous vegetables featured in the Bahay Kubo folk song further incorporating augmented reality (AR) technology to creating a dynamic interaction with its 3D vegetable models. With their mobile devices, users can explore the physical characteristics, nutritional values (vitamins and minerals), average lifespan of the vegetables within 3D space which allows for enhanced understanding and retention and facilitates a greater level of engagement in learning about these crops (Tzima et al. 2020).

An augmented-reality (AR) based learning environment provides learners with an experience of interaction that engages their natural curiosity rather than simply providing passive information (Akcayir, 2020). The use of AR technology also allows users to experience the benefits of this platform whether they are in-school or working with educators who have the ability to use this app as well as those who may not have the opportunity to do so. In addition to its interactive capabilities, the app also provides users with a searchable database that contains a variety of plant-related information, which can be used for educational or other research purposes in the future. This type of technology promotes experiential learning and facilitates the preservation of traditional Filipino crop varieties by providing access to knowledge that was previously not easily accessible due to the lack of representation and inclusion of crops in most current agriculture curriculum offerings (Sarkar & Khanna, 2020).

Purpose and Description of the Study

This project will evaluate an augmented reality (AR) application about the Bahay Kubo and how it can be used as an educational tool for students enrolled in Agricultural Education (Grade 11 and 12). The intent of the application is to enhance student knowledge/engagement regarding Agricultural education through the use of AR technology to visualize, interact with, and identify the plants that are staples (nutritionally beneficial) to the Filipino people, including, but not limited to, the use of different varieties/cultivars for agricultural purposes. By conducting this project the researchers hope to: improve student engagement & retention of knowledge of Agricultural Education through AR Technology; increase the way in which students experience learning through AR Technology; Create a bridge between traditional teaching methods and current technology in Agriculture Education.

Assess how AR-based learning improves agricultural understanding, practical knowledge and student motivation in Technical Vocational Livelihood (TVL) Agriculture Programs. Using a mobile AR platform called Bahay Kubo, TVL Agriculture students can learn about and interact with multiple traditional Filipino plants through the application’s interactive and engaging user experience. Using image recognition technology, the application allows users to scan/identify plants in the real world or search through a searchable database to obtain the plant’s complete nutritional information, as well as learn about the vitamins, minerals.

Setting of the Study

Benigno V. Aldana National High School (BVANHS) located in Binalonan Pangasinan, provides accessible quality education to the youth residing in the area. The school was established to address the lack of a secondary education provider in the area and has since grown to play an integral role in the (area's) advancement of education. The mission of the BVANHS is to empower students by providing them with the value of education as well as the skills and knowledge necessary to continue on to the post-secondary level of education and into their future careers. BVANHS has continued to expand both their facilities and their curriculum offerings as evidence of their continued commitment to excellence and expanding access to equitable learning opportunities.

With a strong tradition of providing high-quality educational services to junior and senior high school students since it was established in 1987, Benigno V. Aldana National High School (BVANHS) is a government operated secondary school in the Philippines, and as such, it is governed by the Philippine Department of Education. BVANHS provides programs tailored to the interests and strengths of students based on the K-12 Basic Education Curriculum, with programs specifically for Academic Track, Technical-Vocational Livelihood (TVL), and other programs designed based on the needs of business/industry and the local community. BVANHS strives to prepare students for post-secondary education, future employment and business growth by developing students' creativity, critical thinking, trade skill development and provides the necessary support to develop students' creativity and critical thinking skills.

BVANHS is located in a lively and easy-to-get-to area of Binalonan where there are many opportunities for learning in a safe, nurturing environment. The school includes fully equipped classrooms, science labs, computer labs, libraries, technical vocational instructional areas, etc. These facilities provide students with an active, participatory learning environment that gives them opportunities to succeed as learners and develop personally. Facilities will continue to be improved and increased as part of BVANHS’s long-term development plan to provide a comprehensive educational experience.

Benigno V. Aldana National High School, as a public entity, is a school that believes in delivering accessible education with integrity, excellence, and service. The school attracts students from the areas surrounding Binalonan and is a key center for secondary education in the region. Our well-qualified teachers are very dedicated to supporting student learning. The focus of the faculty is on providing a learning environment that stimulates student interest and encourages them to develop their full potential. Additionally, Benigno emphasizes the significance of co-curricular, values-related, and community engagement activities through participation and outreach by students and the supporting partnerships with other local entities. These programs allow students to connect their studies to the real world while developing numerous skills, including leadership, collaboration, and a sense of social responsibility. In addition, thanks to the generous support from the Pangasinan Local Government and the Department of Education, Benigno continues to be an important contributor to the future of youth in Pangasinan by producing graduates who are academically capable, value-based, and ready to engage.

Conceptual Framework

Bahay Kubo: An Augmented Reality Application for Exploring and Discovering the Nutrition Varieties and Secrets of Filipino Vegetables (Bahay Kubo AR) aims to provide enhanced agricultural education for senior high school students pursuing the Technical Vocational- Livelihood (TVL) Agriculture strand. Combining Augmented Reality (AR) tools with traditional agricultural learning approaches gives teachers and learners access to new ways of teaching and learning. Students will be able to participate in a more interactive, engaging, and immersive way that matches their current learning environment.

The AR app allows users to examine 3D models of Filipino vegetables as depicted in Bahay Kubo, a traditional Filipino folk song about what farmers grew around their homes. The AR app gives students immediate access to information on the visual characteristics and nutritional content of the plants (vitamins & minerals), the average life span, the different types available to farmers, and their use for growing food. By allowing students to engage with these plants in the AR app visually, they will be able to gain a better understanding of the relationships among physical characteristics and nutritional content, while also developing interest in local crops and sustainable practices within agriculture through interactive learning.

An easy-to-use platform was developed specifically for the mobile device so that both teachers and students have easy ways to access their information. This site features an organized database which contains all data related to different types of plants, and it can be easily modified with new information about new plant varieties or additional types of data as applicable.

Objectives of the Study

This project intends to create an augmented reality (AR) application that will help people gain a greater comprehension and appreciation for Filipino indigenous vegetables found in the Bahay Kubo song, while also creating a fun educational resource that can be used by students on the TVL track in agriculture. The key goals of this project include developing an AR app that

can help promote interest in Indigenous Veggies of the Philippines, provide students opportunities to learn more about these crops, develop unique and engaging ways for students to learn about the crops, as well as create opportunities for interaction with Indigenous Vegetable Communities.

To identify the requirements necessary for the development of the AR application in terms of:

Plant Identification and Visualization

Nutritional Information and Lifespan Data

Interactive and Immersive Learning Features

To determine the design considerations for the development of the application with regard to:

User Interface;

Content and Featured;

Architecture Framework

To evaluate the level of acceptability of the developed system.

Scope and delimitation

The tradition of the Bahay Kubo continues to exist today. To further our understanding of this tradition, we have developed an application that allows for augmented reality (AR) views of the vegetable species associated with the Bahay Kubo. This application is mainly focused on students and educators who would like to learn more about the Bahay Kubo vegetables as

well as plant enthusiasts. Through the use of AR technology, the app allows users to view all information regarding nutritional content such as vitamins, minerals. about selected Bahay Kubo vegetables, and showcases all the various types of Bahay Kubo vegetable species and the life cycle of these plants in 3-D. In addition, the application will allow users to engage and learn more about the cultural significance of Bahay Kubo vegetables as well as establish healthier lifestyles.

This app will initially contain only the 14 vegetable varieties included in the Bahay Kubo song; however, as time goes on, more vegetables will be added to both the app and database. The app will work on any modern smartphone or tablet with AR capabilities; thus, there will be no need to download anything additional in order to make the app function on your device. All that you need to do in order to use the basic functions of the app is connect to the internet at least once for downloading updates and accessing additional resources, although connecting to the internet is not required when using the offline functions. While this app will strive to accurately recognize plants and present them as accurately as possible in both Augmented Reality and Natural Language, several environmental parameters may ultimately impact the quality of AR performance. These parameters include things such as lighting conditions, camera resolution and angles, among others. Further, although the app will have been extensively researched for each vegetable's nutritional information, there may be additional health benefits discovered or regional varieties that are not covered in this app at the time of its launch. This app has been developed to provide educational purposes only, and should not be used as a substitute for consulting with an accredited nutritionist or botanist regarding proper dietary choices or health benefits of various plants. Finally, the success of this app relies heavily on continual support through regular updates, user input and continued maintenance of the plant recognition software in order to improve recognition accuracy, expand the database and enhance the overall user experience.

Definition of terms

This section provides definitions for important terms related to the study "Bahay Kubo, An Augmented Reality Application for Clarity & Understanding of Essential Concepts.

Augmented Reality (AR): Technology that adds digital elements (images, sounds, 3D objects) to real life through devices such as smartphones or tablets.

Bahay Kubo: A traditional Filipino folk song that lists many native vegetables found around a small rural hut called a Bahay Kubo (National Commission for Culture and the Arts, 2021).

Technical-Vocational-Livelihood (TVL): A specialized curriculum track offered in the Philippine K to 12 system. It provides hands-on and skills-based training to prepare students for careers and entrepreneurship (Department of Education, 2020).

Agricultural Literacy: Knowledge about agricultural concepts, practices, and systems, including crop production, food and nutrition, and sustainable agriculture (National Agricultural Literacy Outcomes 2020).

Indigenous Vegetables: Locally grown plants that are native to the Philippines and commonly used in traditional Filipino dishes (Bureau of Agricultural Research,2022). The project's main purpose is to use these vegetables to improve cultural heritage and health awareness.

Plant Life Cycle (Lifespan) describes the length of time it takes from seed germination to plant maturity to harvest (Food and Agriculture Organization 2020). Data about the plant life cycle for each Bahay Kubo vegetable is provided in the application, allowing users to better understand the growth cycle for each vegetable.

Image Recognition provides AR and computer vision (Li and Li 2020). Through image recognition, users can scan and then retrieve information about real vegetables using a mobile device's camera.

User Interface (UI) refers to the design of digital interfaces and elements through which users interact with digital content (Kalbach 2020). The UI for the Bahay Kubo App was designed as a very user-friendly educational resource.

User Experience (UX) describes the complete experience a user has when using a digital product and how easy it is for the user to use the product.

Experiential Learning. A learning theory that emphasizes hands-on, interactive, and reflective experiences as a way to enhance knowledge acquisition (Kolb, A. (2021). The use of AR in this study is grounded in experiential learning principles.

Cultural Preservation. The act of maintaining and promoting traditional practices, knowledge, and identities. The Bahay Kubo app supports cultural preservation by digitizing and educating users about traditional Filipino vegetables and farming knowledge. UNESCO, (2020)

Mobile-Based Application. A software application designed to run on smartphones or tablets. In this study, the application is developed for mobile devices to ensure accessibility for students and educators (Alalwa, 2021).

Educational Technology. The combined use of digital tools and pedagogical strategies to improve teaching and learning processes (Bates, 2022). AR is an emerging form of educational technology examined in this research for its effectiveness in agricultural instruction.

Database. An organized collection of structured data that is stored and managed electronically (Navathe B. 2021). The application includes a database of vegetables, allowing users to retrieve nutritional and agricultural information efficiently.

Scanning Functionality. A feature that allows users to use their camera to scan and identify real-world objects, triggering the app to provide relevant digital content (Zaharia, T. 2020) This is a key component of the app's interactive learning.

Chapter 2

This chapter provides both foreign and local literature and studies related to the development of the Bahay Kubo project, Augmented Reality Application that investigates and educates about the different types of Filipino vegetables, what kind of vegetables exist, and their secrets. The Review provides an overview of a number of study findings that show that

Augmented Reality (AR) enhances learning through interactive lessons and greater student involvement. This chapter describes how the use of digital technology preserves our cultural heritage while providing plant-based education, making it possible for people to learn more about local plants and vegetables, and encourages communities to learn more about the nutritional values of their local vegetables. In addition, it highlights where there are gaps in existing research that the Bahay Kubo AR project is designed to fill, thereby strengthening the framework of the research and providing more support for the use of AR as an educational tool for promoting the culture and healthy lifestyles of Filipinos.

Foreign Literature

Research in international literature has demonstrated the potential for Augmented Reality (AR) to facilitate experience and engagement through experiential and interactive learning experiences for students. These studies show us that by integrating 3-dimensional representations into our learning, we are able to increase the understanding of concepts by giving students an opportunity to learn about the concepts in an immersive environment. This is especially beneficial for concepts that cannot be physically seen but require a conceptual understanding that is difficult to visualize (e.g., Molecule interactions, Human Anatomy & Physiology) Akçayır, 2020.

Based on Wu et al. (2020) review and meta-analysis of augmented reality (AR) in educational settings, they concluded that overall AR is effective when used in educational settings to improve knowledge, improve retention rates, and improve engagement with the learner.

The authors of this article offered specific evidence to support their claim regarding how well AR helps students learn about topics in science classrooms which require much visualization, such as plant structure and environmental change. Moreover, they state that due to this immersion of the student into the AR environment, as well as the spatial qualities inherent within AR equipment, students find it much easier to relate the information presented to their own personal experiences in this way; therefore, allowing for retention of this information over both the short and long term.

Billinghurst (2021) concentrated on the cognitive and motivational effects of AR in the self-directed learning frameworks. Their observations bring out the

fact that AR applications stimulate curiosity along with critical thinking which is essential for the study of, for instance, biodiversity, sustainable counterparty relations, and indigenous crops. This puts AR not only as the content deliverer but also as a medium of mastering higher order thinking skills.

Ibáñez, Portillo, Cabada, and Barrón (2020) investigated the effects of augmented reality (AR) on students' motivation and academic performance. Their study demonstrated that learners who used AR tools exhibited higher engagement levels and achieved better outcomes compared to peers relying on traditional instructional methods. The researchers highlighted that interactive digital environment, such as AR applications, foster active participation and promote deeper understanding of the subject matter. These findings are particularly relevant to the Bahay Kubo project, which leverages AR technology to make agricultural and nutritional education more engaging, practical, and meaningful for students.

Chang et al. (2020) created an AR application for botanical gardens and natural parks that allowed users to scan QR codes or image markers placed in close proximity to the plants to view rich multimedia content. The results showed that users experienced enhanced plant recognition accuracy and increased environmental awareness. This supports the potential of applying similar scanning and visualization techniques in the Bahay Kubo application for identifying native vegetables and enhancing student engagement.

Lee (2020) investigated the use of augmented reality (AR) for agricultural training in the context of vocational education. The study demonstrated that AR facilitated the acquisition of practical skills, such as pest management, planting techniques, and crop nutrition analysis methods. These findings are particularly valuable for developing AR applications aimed at enhancing vocational and technical education, especially in agriculture.

Nguyen et al. (2021) researched augmented reality (AR) applications for the dissemination of traditional knowledge in Southeast Asia. The study revealed that when AR platforms integrate folklore, cultural practices, and biodiversity, not only are learning outcomes improved, but cultural pride and environmentally friendly behaviors are also promoted. This aligns well with the objectives of the Bahay Kubo AR application, which aims to incorporate Filipino folk traditions and indigenous agricultural knowledge into contemporary learning environments.

Even though these foreign studies provide useful insights, they are not locally tailored for particular cultural and educational settings, for instance, the Philippines. This is an invaluable gap in the current body of research, a gap for which the Bahay Kubo application is in a distinct position to remedy, by incorporating native Filipino vegetables and cultural stories in an AR learning environment.

Local Literature

In the Philippines, the use of technology in education has become increasingly important, especially in promoting interactive learning and cultural awareness. According to Reyes (2021), Augmented Reality (AR) applications can enhance student engagement by allowing learners to explore lessons in a more visual and hands-on manner. This technology helps Filipino students develop a deeper understanding of their lessons, especially in subjects related to science, agriculture, and health.

Caingcoy (2023) emphasized that integrating culturally relevant materials into the learning process significantly improves student engagement and academic outcomes. His research found that when lessons reflect learners lived experiences and cultural identities, students become more motivated and develop a deeper understanding of the content. This perspective is highly applicable to the Bahay Kubo project, which incorporates Filipino cultural heritage particularly the traditional folk song familiar to many as a foundation for promoting meaningful and interactive learning experiences through Augmented Reality.

The Department of Education (DepEd), through DepEd Order No. 32, s. 2020, emphasized the importance of developing contextualized and localized educational materials to enhance curriculum relevance and learner engagement. This policy supports the integration of indigenous knowledge and local culture into formal education and aligns with the United Nations Sustainable Development Goals, particularly those related to quality education, food security, and nutritional awareness. The Bahay Kubo AR application, which integrates agricultural learning with Filipino cultural heritage, strongly aligns with this directive. By embedding traditional knowledge within an interactive digital platform, the project embodies DepEd’s vision of fostering meaningful, culturally grounded, and technologically enhanced learning experiences.

Mateo (2024) developed an Augmented Reality (AR) mobile application called Pinoy Fruits to assist high school students in learning about native Filipino fruits and their nutritional benefits. The study revealed that the application significantly improved student engagement and interest in agricultural subjects. Its interactive features such as 3D fruit models, nutritional fact displays, and built-in quizzes made the learning process both educational and enjoyable. Teachers who participated in the study also observed that AR technology helped students maintain longer attention spans compared to traditional teaching methods. These findings suggest that AR-based tools like Pinoy Fruits can promote a more dynamic, student-centered learning environment, aligning with the goals of the Bahay Kubo AR project to enhance agricultural education through interactive digital experiences.

Lopes et al. (2024) developed an Augmented Reality (AR) mobile system designed to help users identify aromatic and medicinal herbs through real-time visual recognition and 3D interactive features. Their study revealed that AR technology significantly enhances interactivity and accessibility, particularly for learners in rural or low-resource environments with limited access to traditional educational materials. The results demonstrated that AR can transform ordinary learning into an engaging and immersive experience, making scientific and cultural knowledge more inclusive. This insight aligns with the objectives of the Bahay Kubo AR project, which aims to deliver culturally rooted agricultural and nutritional education in an interactive and accessible format.

Sánchez-Obando and Duque-Méndez (2023) investigated augmented reality interventions in rural public schools and found that AR applications can effectively simulate laboratory experiments and visualize growth cycles of plants. Their study demonstrated improvements in both conceptual understanding and practical application among students who lacked access to conventional lab equipment and teaching resources. This evidence is directly relevant to the Bahay Kubo project, which aims to provide experiential learning opportunities for students in under-resourced areas by using AR to bring agricultural and nutritional concepts to life.

Further, the use of Augmented Reality in culturally rooted projects such as Bahay Kubo shows an increasing understanding that Filipino learners identities should be reflected in their education. Since Filipino students usually see Westernized materials as divorced from their realities, the embedding of AR with culturally familiar content puts a bridge between

abstract knowledge and the reality of life. The Bahay Kubo project is made possible through the integration of agricultural science with a beloved folk song, which changes passive cultural appreciation to active, experiential learning. This approach not only brings back cultural heritage but also develops pertinent skills in sustainable agriculture that is more and more relevant in the era of climate change and food insecurity.

Dela Cruz (2022) developed a region-specific augmented reality (AR) teaching tool called Ating Lupa, which focused on local agricultural practices in Northern Luzon. The findings revealed that students not only learned more effectively but also showed increased interest in agricultural studies. This is particularly relevant to the national initiative of revitalizing the country's agricultural sector through youth education. Building on this foundation, the Bahay Kubo AR project seeks to expose elementary and high school students to the significance of traditional crops, cultivation methods, and the broader concept of food sovereignty through an interactive and culturally meaningful medium.

Ramos (2023) Pedagogical implications of using augmented reality (AR) to bridge generational and cultural gaps have been highlighted in recent research. An examined AR's influence on intergenerational learning in the rural environment through a pilot project in which the elderly community members provided oral histories and traditional knowledge. This content was later incorporated in an AR storytelling application that is used by their local students. Apart from preservation of intangible cultural heritage, the project also united the community and promoted respect amongst different generations. Likewise, the Bahay Kubo AR application is capable of being a cultural connector which would spread the worthwhile indigenous information of the older generations to the younger knowledge seekers in an informal manner.

Bautista et al. (2022) present a convincing argument for using offline AR modules in areas like Mindanao, where limited infrastructure and poor internet connectivity make online solutions difficult to implement. Their study shows that mobile-based AR can operate effectively without continuous internet access, making it a practical and scalable way to reduce the digital divide. This approach is particularly important in the Philippine context, where gaps in educational resources between urban and rural areas remain a major challenge.

CHAPTER 3 TECHNICAL BACKGROUND

This chapter describes the approach taken in conducting research on Bahay Kubo: An Augmented Reality Application for the purpose of learning about and finding Out About the nutrition, diversity, and characteristics of filipino vegetables. It includes requirements analysis, user experience design, development of the system, and implementation of the overall system. All four phases are important to provide guidance for the creation of an educational augmented reality solution.

Research Approach

The mixed methods research design incorporates both qualitative and quantitative data into a comprehensive evaluation of augmented reality applications. Results obtained from quantitative methods, such as system response time and usability ratings collected via structured surveys and app analytics were used to provide an objective basis for evaluating how users engage with the augmented reality application and its functionality. By integrating qualitative data sources including user experiences, comments, perceptions of the augmented reality application, and identifying emotion-driven motives for engagement into the overall assessment process, mixed methods provide a richer understanding of the usability of the augmented reality application and any resultant learning experiences. The blending of both qualitative and quantitative data is fundamental to determining the learning effect, and user satisfaction associated with engaging with augmented reality technologies.

Software Development Life Cycle

The four-phase RAD model is confirmed as an effective framework by several recent studies and has been successfully used for rapid prototyping. The authors of these recent works have shown how to use RAD in the requirements planning phase of a fintech project to address scope creep through stakeholder collaborative workshops, which was mirrored in your study design. (Chen et al. 2024). The RAD User Design stage emphasizes

iterative prototyping, which allows for continual user feedback and ongoing improvement of the system. By adopting this approach, teams can rapidly determine, develop and modify requirements. The RAD Construction phase employs a modular development model, enabling reusability of components to increase workflow productivity and accelerate the development process (ResearchGate, 2020).

Requirements Planning To define objectives, scope, and user needs, it was necessary to gather input from students, teachers, and agricultural specialists to ensure that the application meets all of its educational goals. A thorough literature review was completed focusing on augmented reality technology, plant education tools, and applications for food nutrition education; this review formed the basis of the conceptual framework and technology decisions for the project. This early prediction of potential technical issues (AR model recognition accuracy, usability issues, and device compatibility), as well as the desire to minimize the likelihood of future problems, was a key focus throughout this stage.

User Design The development of working prototypes intended to collect user input regarding how easy it is to utilize an AR-based application developed with plant imagery as a representation of the user's physical environment. Using iterative prototypes allowed us to create AR interfaces on top of plant images as well as AR overlays with relevant information, thereby improving both the visual look and functional capabilities of the application. Collaboration with our primary stakeholders, including agriculture professionals, educators, and students, allowed us to customize the design and function of the application based on the actual requirements and expectations of users, thereby enhancing the overall effectiveness and utility of the application.

Construction The development of the mobile application was finished using Android Studio with the aid of the various AR libraries to create the primary AR functionality, in both a modular manner and with separate coding tasks assigned for AR view connectivity, data interactions and UI elements. Therefore, the development process was more organized because it separated the coding tasks from problems within the coding, thus allowing greater ease of troubleshooting. Additionally, testing and end-user validation occurred frequently throughout the development process so glitches could be resolved and users could provide feedback to the development team to be included in the ongoing development of the application and for ongoing development of the application toward its ultimate completion.

Cutover the project included extensive final testing and quality assurance procedures before the final release, thus providing a completely sure way to test the overall performance of the application under different operating conditions. At this stage, an application was made available to select users for "end-user acceptance testing". After that, there was a final application training session and the creation of orientation materials to assist users with the use of the AR development and the features associated with it so that the users could maximize their use of the application and establish a sense of ownership and participation in early adopter activities.

Requirement analysis This is a very important phase in creating the Augmented Reality application, "Bahay Kubo - An Augmented Reality App for Discovering and Learning About Nutrition Varieties and Secrets of Filipino Vegetables." During this phase, the research team is going to look at what is expected from the app by all of the different stakeholders, including students, educators, and agronomists (agricultural experts). The team will gather and review all of the information about what stakeholders want from the app in order to determine what types of functions the app needs to have. In addition to documenting, verifying and monitoring functional and non-functional requirements to ensure they have been well-defined, are actionable, traceable, measurable and testable, and are relevant to the application and end user, a well-traced and clearly articulated set of requirements will not only allow for successful design and implementation of the AR application but will also potentially create future opportunities for continued education in the fields of agriculture and technology. Thus, through a thorough requirement analysis, the project will validate that the application meets the users' expectations effectively and provides a fun, educational, interactive walkthrough for users.

Gathering Data. Research will collect both qualitative and quantitative data by observing the students' and educators' current practices when learning about Philippine vegetables. In this process, the researchers will evaluate how effective or ineffective current methods of teaching have been, what barriers people have encountered entering into or participating with their users' engagement levels, and what problems have arisen at the organization using the present teaching methods. Therefore, they will be able to clearly identify the issues with the Augmented Reality application that need to be solved to address these problems.

Interviews. To gain a further understanding of where the information deficits are around Bahay Kubo plants, we will do in-person interviews with all of the participants (ag educators, nutritionists, and students) in order to identify what type of contemporary and interactive learning opportunity the users need, as well as to find out their expectations for the AR-based application. The end result will be a system that responds to the user's actual learning needs and provides value. Survey questionnaire. The application will be developed and shared with an extensive audience involving young learners, teachers and students. The objective of this study is to collect both quantitative and qualitative information on the existing knowledge level of users (students/teachers/learners), their interests and preferences concerning AR Technologies, as well as any difficulties encountered when attempting to understand the contents related to Filipino Vegetables. The data collected through this survey will be used to rank the features and enhancements required for the application's continued success.

Review of Related Literature. The research team will conduct a comprehensive analysis of existing research articles, case studies, and the latest developments in industry practices concerning the deployment of Augmented Reality (AR) technology within education, the identification of plant species, and effective methods for teaching proper nutrition to consumers. The findings of this analysis will provide the basis for identifying best-practice models, as well as potential obstacles and/or hurdles which may arise during the development phase; therefore, they are to be considered when establishing the design and development process for the application’s User Interface.

Observation. An essential part of the requirement analysis will also be conducted through this method. Within this method, the researcher(s) will examine how traditional learning systems are utilized and what types of user-interactions occur in them (e.g., through classrooms, museums, etc.) to identify areas of opportunity. To this end, the research team will closely analyze how the users currently use these systems and identify the pain points within them (traditional learning systems) and identify where AR can enhance the overall experience through more engaging and immersive ways to learn.

Document analysis. It will be conducted to study relevant materials, including school curricula, agricultural textbooks, nutrition guides, and plant reference manuals. Through this method the researchers will ensure that all information included in the AR application is credible educationally appropriate and aligned with national or regional academic standards. It will also help in ensuring that the application content is comprehensive accurate and supports educational goals.

Source of Data

The AR application's developmental process will involve using both primary and secondary materials as data input areas/viewpoints. In terms of primary data sources, discussions/interviews will be conducted with agricultural professionals and educators and students about their experiences with existing methods of teaching. These discussions will include data resulting from field observations and surveys of both agricultural professionals and educators and agricultural students, as well as feedback from them as to their respective roles within the existing education system. All of these sources provide valuable insights into end user need(s), behaviour(s), and expectation(s) of the end user(s). The secondary data resources used during application creation may include peer-reviewed academic research articles, online books/databases, industry surveys/reports/research/journals/publications related to Filipino vegetable growing, plant nutrition and educational technology through Augmented Reality, which ultimately provides a greater technical context to the application designs and construction methodologies.

System Requirements

To develop an Augmented Reality app to educate users regarding the plants of a Bahay Kubo, system requirements must be met pertaining to the underlying operating system and program languages. System Requirements: Augmented Reality app to Educate Users on the Plants Found in a Bahay

Kubo: Windows 10/11, Java and Kotlin programming languages, Figma for Prototyping and wireframe SDK, ARCore. AR Capability for the AR Pillar was created using Google's ARCore SDK, which allows for the display of 3D models of the plants (created in Blender and found on Sketchfab) overlaid on top of what the camera sees (the background image).

There are two types of users of the app, the Administrator and the Student/End User, both of which have access to the same set of features and functions (Scan Plants – obtain Nutritional Information, Research Plant Lifespan, Research Plant Varieties, and Utilize Augmented Reality Learning Content). The overall success of the app will depend on how well the user interface is designed, and how easily the students can use the Augmented Reality interface.

Roles of Users

The students, who is the primary user of the application, is actively participating in the experience through the interactive nature of the learning experience, by scanning the vegetable markers or images with a mobile phone to trigger Augmented Reality (AR) visualizations. The app allows the users to access the nutritional value, age of the plant and types of vegetables that can be found in the local area. When transitioning between the different AR scenes, students are provided with the opportunity to learn and interact with a variety of educational materials. The delivery of these educational resources in an engaging way with visual representation will be culturally appropriate to the student. Also, how often and how the educational resources are used will be important indicators of how successful the app is and will help determine whether or not the app worked well as an education tool.

A student serves as the central character in the mission of the AR app the user interacts with, while also being an essential part of its effectiveness. The AR app serves primarily as a form of interactive learning where students engage in an active manner with the app; by using this interactive method of learning, the student has the potential to achieve greater retention of knowledge through stimulation of the senses. The student's engagement with the app has also been designed to encourage learning through all three ways in which senses can be stimulated, which are via visual, auditory and kinesthetic stimulation. Therefore, the student's interaction with the AR app

will enable the student to validate previously acquired knowledge, and additional knowledge related to agriculture, health, and Filipino culture. In other words, the student's experience with the app will not simply involve them passively using the app, rather it will also foster an ongoing development of a "curiosity-driven" approach to deepening their understanding of how the app can provide valuable information about agriculture, health, and Filipino culture.

Mobile Device Requirements to Download the App

To download and run the Bahay Kubo AR Educational App smoothly, your Android device must meet certain technical specifications. First and foremost, your smartphone or tablet needs to be running Android 11.0 or higher, with Android 13.0 or newer being highly recommended for the best augmented reality performance. Crucially your device must be AR Core-certified by Google meaning it is officially supported for AR applications. Most mainstream Android devices released in the last few years qualify, but you can verify your model on Google's official AR Core device list. In terms of hardware, your device should have a 64-bit ARM processor (an octa-core chip or better is ideal for handling AR tracking and 3D rendering) and at least 4 GB of RAM, though 6 GB or more is recommended to ensure smooth operation when loading detailed plant models. You will also need a minimum of 500 MB of free storage space for the app and its assets, with 1 GB or more being advisable. A functional back-facing camera is essential, and a higher-resolution camera with autofocus will significantly improve the AR experience by making virtual plants appear more stable and realistic in your environment.

An active internet connection such as Wi Fi or mobile data is not required for basic app functionality. You can view cached plant information and access previously downloaded AR models without a connection. However certain interactive features including the AR Hunt exploration game real time model downloads and leaderboard updates do require an internet connection to function. For the best experience with all dynamic and social features a stable connection is recommended. Upon installation the app will request necessary permissions primarily access to your camera to enable the AR scanning functionality.

Tools for Data Analysis

The recent research has shown how Data Flow Diagrams (DFDs) help in improving the transparency and efficiency of the design of a system. This is accomplished by displaying how the data is being exchanged between the user and the various processes that both the user and the system perform. The DFD will provide a framework that will allow us to visualize the interaction between the user and the system through real Time Tracking that will provide immediate feedback on different varieties of plants and their nutrients and the cultural significance of the plant. This will be done through the interaction of the user with the AR System with the Scan Function for a Furthermore, by using DFDs with the Bahay Kubo Augmented Reality application, developers can identify bottlenecks and redundancies within the system earlier. As a result, they are able to update their development processes prior to implementation. By taking this proactive approach, the Bahay Kubo Augmented Reality application becomes more efficient and provides a better user experience, resulting in increased satisfaction among users due to faster, more reliable, and easier access to the educational content.

The DFDs provide means through which communication is made streamlined with the development team since the team has a clear and same understanding about how the system will work.

Data Flow Diagrams (DFDs) serve as essential documentation tools that contribute to effective system maintenance and future scalability. As the Bahay Kubo AR application evolves possibly integrating more local vegetables, cultural content, or interactive features the DFDs can be easily updated to reflect these changes. This adaptability allows developers to manage the system's complexity without compromising its core functions.

Flowchart

This flowchart shows the entire workflow of Bahay Kubo: An Augmented Reality Application. It also shows how the system is navigated by users. The Workflow starts at a Start Node and leads to the login/register section. After successful login, the user proceeds to the homepage, which is a central location of the application where the user can access other areas of the app.

On the homepage of this application, each student can navigate between several core learning modules: AR Scanning Module, AR-Activities Module (also known also as AR Quiz Module), AR-Adventure and AR Watch AR-Adventure + (a supplemental AR learning) as well as add-on options, including the Student Profile Vegetable Combine and AR-Games. However the last module (AR-Activities) will have its own dedicated page, showcasing the app's unique AR capabilities.

By outlining a logical structure for the application and providing developers with an efficient way to develop their applications consistently, the flowchart helps both users and developers navigate through the application easily. It emphasizes the need for both educators to have control over what type of content is presented to students and for students to have easy-to- use learning tools aligned with the educational objectives of the Bahay Kubo augmented reality app.

The flowchart is a critical assistant for debugging and optimizing the app’s user interface. Creating such a blueprint enables the development team to monitor the journey and to reveal the areas of friction, ensure smooth transitions between features and smooth out user experience. Such clear structure does not just help to get the app up and running, but it also means students can interact with the system without any problems, which, naturally, will ensure the success of the app.

Use Case Diagrams

The diagram of the use case outlines the capabilities that an individual will have when using the application AR that is designed specifically for users. The individual or user is represented as a stick figure which represents the primary function of the application; the individual or user interacts with every feature within the application. From their menu of the application, the individual or user has access to many resources such as a library of tutorials that explain how to navigate through the application and understand the features that AR applications have available. They are also able to participate in an AR Quiz to evaluate what they have learned, featuring questions related to the application, with both a unique and interactive

format. The AR Scanner offers a way for users to scan and document any of the real world vegetables/a picture of the tomatoes with their device and obtain additional information about that vegetable. Another feature is called AR Activity 3D, where you can manipulate three dimensional representations of vegetables in augmented reality. The inclusion of games within the application add a fun way of learning combined with entertainment is the purpose of the feature called AR Game. Combining or matching vegetables is one of the features of the educational part of the application and comes under the title Vegetable Combine. The feature called AR Adventure allows the user to have an immersive experience in the world of augmented reality while seeing/determining what is inside these areas while exploring the areas or traveling within that area. Finally, there is a section of the application called Profile, where the individual or user may log into their profile and view personal information, monitor their progress, view their quiz results, and gain information regarding any awards they may have received. Overall, the diagram is a comprehensive overview of all the functionalities available to the individual/user of the application.

During its elaboration, the Augmented Reality Application for Bahay Kubo depicts how one actor (the student or regular user) engages with all features available within the application. This illustration focuses exclusively on the Student/User therefore demonstrating the educational opportunities and interactive experiences that are available via the system; furthermore, by illustrating user behaviours and consequent system responses within the use case diagram, this gives an indication of how the user will use the application thus allowing its design to be more closely aligned with the actual requirements/expectations from an educational perspective.

The student/user can use the features of this app to improve their learning and connection with the app, such as Viewing vegetables via Augmented Reality, Accessing information on plants through a comprehensive database, Viewing Educational videos to facilitate learning and engagement, and participating in Quizzes to reinforce knowledge. In addition to these core activities, users may also enjoy AR Games, Combination Tests with Vegetables and/or managing their profile depending on the final design of the application.

The graphical representation will simplify the users' experience by showing them how they can interact with the different parts of your Application, so that you can meet the project's learning goals through an easy-to-use

application Interface. This use case diagram outlines for the development team a reference for developing and implementing the use cases, which will enable the team to incorporate all the needed use cases into the design of the application.

A Use Case Diagram serves as a visual representation that combines the vision of the Project Team with the user's needs. The diagram outlines the expected use of the system and provides all relevant stakeholders, including Developers, Educators, and Students, a clear understanding of what the application should accomplish. The diagram serves as a point of reference throughout the development process, clarifying to all users their respective roles and how they will interact with the system. Also, the Use Case Diagram is used during testing and verification of the final system to ensure it meets the intended function(s) and aligns with the Educational Objectives for Bahay Kubo AR.

Entity-Relationship Diagrams (ERD)

The Entity-Relationship Diagram (ERD) illustrates the database design of the AR app and provides an overview of how it is structured around user management and the scanning of vegetables. The users table is at the core of the AR app database as it contains key details for each user, including their username, email address, job type, account status, and date of birth. The role column defines the user's type as either a student, teacher, or administrator. As per the original text, the quizzes will consist of the following components related to quizzes: quiz title, quiz description, and teacher when the teacher is associated with the quiz through teacher_id (FK). A quiz can have multiple questions, which will be linked to it through the quiz ID; each question is recorded in the questions table and each question will include the text of the question, four answer choices (A-D), and the correct answer for the question.

Database Instance

Bahay Kubo: An Augmented Reality App for Discovering and Exploring the Nutritional Values, Varieties, and Secrets of Filipino Vegetables, an active

real-time database must be integrated into the application or website. This database will enable the delivery of an interactive, responsive, and personalized learning experience for students. Its primary purpose is to store and manage information about various Filipino vegetables, including their nutritional values, and to provide accurate and accessible content for Senior High School TVL (Technical-Vocational- Livelihood) students. To effectively support this objective, the database must be capable of handling continuous and dynamic user interactions.

The database provides a real-time environment that tracks all user interactions within the application; scanning vegetables, examining nutrition info, taking quizzes, accessing AR educational content, etc. The database's user table contains profiles for each user that contains critical user information such as roles, status, and age. The vegetable scans table contains real- time logs of vegetable scanning activities. Each log includes the vegetable name, the time of scan and the quantity detected with each scan.

The database's dynamic functionality allows for the adaptation of instructional materials to individual learning styles. For example, if a user frequently scans a vegetable but performs poorly when completing associated quiz items, the system will automatically provide additional resources and/or reminders to continue studying until they have demonstrated mastery. This method of providing adaptive educational resources enhances not only the performance of the educational platform but also the overall engagement of users with the Bahay Kubo AR app.

Database Schema

Augmented reality (AR) will enhance the educational experience of Filipino Senior High School students through an interactive application. The database structure used to store the data relating to users and vegetables is tailored for Filipino Senior High School students and allows for proper monitoring of their participation in the system.

The "Vegetable" table tracks every user interaction with the digital vegetable models. Each vegetable that users scan is associated to the user via a foreign key (user ID). The "Vegetable" table includes the name of each vegetable scanned, when it was scanned, and how many were scanned. By tracking this data, educators can see how much the users engaged with the AR content and support learning patterns observed by students based on that same interaction.

CHAPTER 4

RESULTS AND DISCUSSIONS

This chapter provides the results of this project and discusses how they were arrived at and were tested over the course of the project. The chapter describes the Augmented Reality App, Bahay Kubo: An Augmented Reality Application to Discover and Explore the Nutritional, Varietal, and Other Unique Qualities of Filipino Vegetables, as well as how this project has achieved its objectives of identifying user needs, implementing program functions and design features, and assessing user satisfaction with the product.

Based on the principles of experiential learning and interactivity through technology, the Bahay Kubo App was created with the Philosophy of Education and Augmented Reality was used in the Bahay Kubo AR App to provide an interactive experience to learners. The Bahay Kubo AR App allows learner to scan either an actual vegetable or a printed image marker for that vegetable, and to receive information about the vegetable through 3D models of the vegetable. The information received on the 3D models includes the nutrition of the vegetable “vitamin and mineral content”, average time for the vegetable to grow and of varying types of that vegetable. Students became knowledgeable about vegetables in a manner that is much more hands-on than the experience of viewing static pictures of vegetables in textbooks, thereby creating active involvement in the learning process and enhancing the student's cognitive level to a much greater degree than the research of Akçayır (2020) and Kolb (2021) show and that studies of AR have shown that student interest increases, students are more

curious, and were able to understand better concepts when they were taught using AR.

System Design and Functionality

The Bahay Kubo AR Application was developed following the Rapid Application Development (RAD) model introduced in Chapter 3. The system integrates multiple functional modules each designed to enhance the user experience and fulfill the learning objectives.

User Interface Design

The interface was created with simplicity and usability in mind. Students can easily navigate between sections such as Plant Scanner, Nutritional Information, Varieties, and Learning Videos. Buttons, icons, and layouts were arranged intuitively to ensure that even first-time users could access features without difficulty. The use of natural colors and Filipino- inspired design elements provides a cultural feel while maintaining visual clarity.

Augmented Reality Function

Using the AR Core SDK, the system allows mobile devices to recognize vegetable images or models and overlay them with corresponding 3D representations. This feature immerses students in a virtual agricultural environment, where they can rotate, zoom, and interact with the vegetable models.

Students reported that being able to visualize plant structures in 3D improved their understanding of the vegetable's parts and nutritional properties-findings consistent with studies by Wu et al. (2020) and Chang et al. (2020).

Database Management

The integrated database serves as a repository for all vegetable information, including scientific names, nutritional facts, and lifespan data. It allows administrators or teachers to update content, add new plants, or modify existing entries as needed. This database ensures accuracy, scalability, and real-time data retrieval, making the system adaptable for future expansion.

System Features and Learning Experience

Scanning and Recognition

Users can scan real or printed vegetable images, triggering the AR overlay that shows 3D visuals and essential information. This process enhances visual recognition and helps students connect the digital models with real-life crops.

Nutritional Content and Lifespan Display

Each recognized vegetable provides users with details about its nutritional composition, such as vitamins, minerals, and health benefits, alongside its average growth duration. This supports classroom discussions on crop nutrition and sustainability.

Variety Classification

The system distinguishes multiple varieties of certain vegetables (e.g., different types of eggplant or squash), enabling users to appreciate biodiversity in Filipino agriculture.

Interactive Quizzes

The application includes short quiz modules that test users' understanding after viewing the AR content. These serve as formative assessments where students receive instant feedback-turning evaluation into an engaging, low-stress experience.

Educational Videos and Resources

Supplementary materials like tutorial clips and informational videos were added to strengthen learning and promote multimedia-based instruction, consistent with the principles of educational technology integration (Bates, 2022).

System Evaluation and User Acceptability

To determine the level of user acceptance, the researchers distributed acceptability questionnaires among students and teachers at Benigno V. Aldana National High School, the study's implementation site. Respondents evaluated the system based on Functionality, Usability, Educational Value, and Cultural Relevance.

Functionality

Users rated the application as highly functional. The AR features performed efficiently across multiple Android devices, and the real-time rendering of 3D models proved stable and responsive. Teachers appreciated the system's capability to store, update, and retrieve information accurately.

Usability

The application achieved a high usability score due to its simple layout, intuitive controls, and smooth navigation. Even users with minimal experience in AR technology reported that they could operate the app easily after a brief orientation.

Educational Effectiveness

Students expressed that the app significantly enhanced their understanding of plant identification, nutrition, and cultural significance. Compared to conventional lectures, the AR approach was found to be more engaging and effective in promoting long-term retention of knowledge.

Cultural Relevance

By integrating Filipino folk culture and indigenous vegetables, the Bahay Kubo AR Application resonated with users' cultural identity. This alignment between local heritage and digital learning supported DepEd's advocacy for contextualized and localized learning materials (DepEd Order No. 32, s. 2020).

System Performance and Observations

During pilot testing, the system performed consistently across devices that met ARCore compatibility requirements. Minor lag was observed on lower-end devices; however, this did not affect the overall user experience. Observations revealed that students were more motivated to participate in class activities involving the application. Teachers noted improved engagement and comprehension, particularly in topics related to plant varieties and nutritional awareness.

Summary of Findings

The Bahay Kubo AR Application successfully demonstrated how AR technology can enhance agricultural literacy and make learning interactive and culturally meaningful.

The system's user-centered design allowed both students and teachers to navigate features effortlessly, contributing to high levels of usability and satisfaction.

The AR-based quizzes and 3D interactions provided an engaging alternative to traditional learning, fostering better retention and motivation

The project aligns with educational modernization goals and supports DepEd's mission to integrate ICT and indigenous knowledge in classroom instruction.

Discussion

Research demonstrates that Augmented Reality usage in Agricultural Education meets project requirements through increased positionality participation and understanding by students. The "Bahay Kubo" AR app combines farmer's cultural knowledge and modern technology to create an innovative platform for preserving and teaching the Philippine agricultural system, as well as obtaining scientific knowledge of agriculture. Additionally, the research advances the educational technology field through demonstrating the application of AR in different cultural contexts and targeted curricula. It shows how to establish technological and cultural insights on the study of indigenous crops and their nutritional values.

Using the Admin Panel for the Bahay Kubo Augmented Reality application, Administrators have full access to create teacher and student accounts, view current activity, and manage user records. Administrators may create new accounts, review and update records, delete records when necessary, and monitor quizzes and interactions in the Bahay Kubo application to monitor teacher-student interaction within the application while providing efficient oversight of student progress through this technology supported educational experience.

Augmented Reality Object Placement Activity

The Bahay Kubo Augmented Reality (AR) app contains an interactive placement task in order to enable the user to create their own virtual garden. With the help of ARCore technology, users can use the camera of their device to scan the area and create a virtual garden on any flat location that has been detected. The user selects a vegetable from the "Bahay Kubo" song. A full-size 3D model of that vegetable can then be placed in their physical environment. Once the model is placed, the user can rotate, enlarge and

move the model so that they can view it from every angle. The interactive experience allows the student to create a fully developed virtual garden, and by using a physical medium, the student is able to view and interact with the digital representation of the garden as if it were real, thereby transforming abstract learning concepts into concrete, interactive experiences that support the learner's engagement, and understanding of the culture.

By progressively planting various vegetables, students are able to create a fully virtual garden over time, thereby gaining knowledge about the song's associated vegetables and how they relate to culture. Physical interaction with digital material allows students to think about the virtual garden like it is real. As a result, learning becomes a physical experience and the location of the learning takes on a new dimension, creating engaging and experiential opportunities for students to learn about a subject in-depth, become more involved in the learning process, and ultimately gain an appreciation for Filipino culture and heritage.

Architectural Framework

The architecture of the Bahay Kubo augmented reality app includes the combination of its core components into an integrated educational system. Built on top of the Data Layer, which contains 3D models of vegetables, nutrition information, plant growth data, and all cultural content, is the Application Layer. The application layer includes components responsible for recognizing the AR object as well as delivering quizzes and tutorials. The system is presented to students and teachers in a user-friendly way through the Presentation Layer of the app using mobile technology. This type of streamlined architecture allows for rapid connections between each part of the system (content storage, processing and delivery) and provides users of the app with a rich immersive education by connecting the knowledge of traditional Filipino agriculture with the technology of augmented reality, while upholding educational values and supporting the continued development of cultural relevance.

Functional Requirements

Functional requirements focus specifically on what actions and functions the Bahay Kubo AR application will require. Within this context, functional requirements define how users will be able to access the many forms of educational content related to Filipino culture and local vegetables, through interaction with augmented reality technology. Other aspects of the system, including the ability to use the application on Android devices, the ability to display the 3D models of vegetables, the ability to conduct quizzes and video lessons as well as the means for teachers and students to organize their use of the application through dashboards.

This Bahay Kubo Augmented Reality Application has been developed with an emphasis on functionality, usability, reliability of the application, and ultimately, the end user's experience, so as to achieve positive educational results. The functional specifications defined above will ensure that this application provides the user with an accurate representation of the real-world environment with all necessary features and capabilities for teachers and students to engage within an immersive, interactive augmented reality (AR) environment. Additionally, this application is designed to have smooth AR renderings, accurate recognition and tracking of objects, and responsive interactions with users in order to hold their attention throughout the lesson.

The usability of the system is prioritised by providing a simple and intuitive user interface that enables users to easily navigate throughout the Application without requiring any advanced technical skills. In addition, the clear instructions provided within the application, as well as the use of user-friendly controls and interactive visual elements, help to enhance the user's understanding of the content, while providing the means for teachers to easily incorporate the Application into their classroom activities. To support students with different types of learning needs, accessibility features have been included as part of the Application.

One of the most important functional requirements of the application is its reliability, which means that the application should work consistently regardless of device or usage conditions, and that the system has been designed to minimize errors, avoid crashes, and provide stable operation

during prolonged usage. In addition, quick loading times and effective management of resources are included within the application to further support performance. All of the functional requirements above are intended to create an engaging, immersive, and purposeful AR learning experience that meets educational goals and encourages active involvement.

Scaling System and Interpretation

This study employed a five-point Likert scale to measure respondents' level of agreement with the indicators assessed in the evaluation of the "Bahay Kubo: An Augmented Reality Application" educational game. The Likert scale is a widely recognized psychometric measurement tool that facilitates the quantification of subjective attitudes and perceptions (Likert, 1932). The scale enables the conversion of qualitative responses into quantifiable data, allowing for systematic statistical analysis and interpretation.

Profile of Respondents

This study utilized purposive sampling, a non-probability sampling method that involves the deliberate selection of participants based on specific characteristics relevant to the research objectives (Etikan et al., 2016). The target population consisted exclusively of respondents from the Agriculture strand at Benigno V. Aldana National High School, as their curriculum and academic background align closely with the agricultural and cultural content featured in the Bahay Kubo application.

Out of a total population of 854 senior high school students (Grades 11-12) enrolled at Benigno V. Aldana National High School, the study involved 300 respondents comprising 298 TVL students from the Agriculture strand, 1 Head Teacher, and 1 Principal.

The selection of Agriculture strand students ensures that respondents possess foundational knowledge of Philippine indigenous vegetables and farming practices, making them particularly qualified to evaluate the educational relevance and cultural authenticity of the augmented reality application. The inclusion of the head teacher and principal provides administrative and pedagogical perspectives on the application's potential integration into the curriculum.

Evaluation of attributes

Overall Interpretation

The overall mean score of 4.09 indicates a HIGH level of positive evaluation for the Bahay Kubo: An Augmented Reality Application across all measured attributes. This result demonstrates that the application successfully meets the educational needs and technological expectations of Agriculture strand students, educators, and administrators at Benigno V. Aldana National High School. The consistently high ratings across multiple dimensions suggest that the AR application effectively bridges traditional cultural knowledge with modern educational technology, creating an engaging and meaningful learning experience.

Knowledge About Filipino Culture and Bahay Kubo Vegetables (M = 4.17, High)

The mean score of 4.17 reflects a HIGH level of existing knowledge about Filipino culture and Bahay Kubo vegetables among respondents. This finding is particularly significant given that the sample consists primarily of Agriculture strand students whose curriculum emphasizes indigenous farming practices and traditional agricultural knowledge. The high score indicates that respondents possess substantial foundational understanding of

the cultural context and vegetable varieties featured in the application, which validates the appropriateness of the target audience selection.

This strong cultural and agricultural knowledge base suggests that students are well- positioned to critically evaluate the accuracy and authenticity of the content presented in the AR application. Their familiarity with traditional Filipino vegetables such as upo (bottle gourd), kalabasa (squash), talong (eggplant), and other indigenous crops mentioned in the Bahay Kubo folk song enables them to assess whether the application accurately represents these agricultural staples and their cultural significance. Furthermore, this high level of pre-existing knowledge may enhance the application's educational impact, as students can build upon their foundational understanding through the interactive AR experience.

Experience with Technology & AR (M = 3.80, High)

With a mean score of 3.80, respondents demonstrate a HIGH level of experience with technology and augmented reality applications. This result indicates that the target users possess adequate technological literacy to navigate and effectively utilize the AR features of the Bahay Kubo application. The high rating suggests that students are familiar with mobile devices, digital interfaces, and potentially other AR or interactive educational technologies, which reduces the learning curve associated with adopting the new application.

However, it is notable that this indicator received the lowest mean score among the three attributes evaluated, suggesting that while technological competence is present, there may be room for improvement in AR-specific experience. This finding aligns with the broader educational technology landscape in the Philippines, where general digital literacy is increasing but exposure to advanced technologies like augmented reality remains limited in many educational settings. The high but not very high rating underscores the importance of ensuring that the Bahay Kubo application includes intuitive design elements, clear user instructions, and accessible AR features that accommodate varying levels of technological proficiency among users.

App Features & Content Preferences (M = 4.31, Very High)

The mean score of 4.31 represents the highest rating among all evaluated attributes, achieving a VERY HIGH level of agreement regarding the application's features and content preferences. This exceptional result indicates that respondents strongly favor the specific design elements, interactive features, and educational content integrated into the Bahay Kubo AR application. The very high rating suggests that the application successfully aligns with user expectations and preferences in terms of visual design, gamification elements, cultural representation, and educational value.

The strong positive response to app features and content preferences demonstrates that the development team effectively incorporated user-centered design principles and culturally relevant content that resonates with the target audience. Features such as 3D visualization of Bahay Kubo vegetables, interactive learning modules, gamified elements, and culturally authentic representations of Filipino agricultural heritage appear to have been well-received by students and educators alike. This very high rating validates the application's potential as an effective educational tool that not only preserves and promotes Filipino cultural heritage but also enhances student engagement through innovative technological integration.

The particularly strong performance in this dimension suggests that the application addresses a genuine educational need and provides a learning experience that students find valuable, engaging, and culturally meaningful. This positive reception bodes well for the application's adoption and sustained use in agricultural education programs.