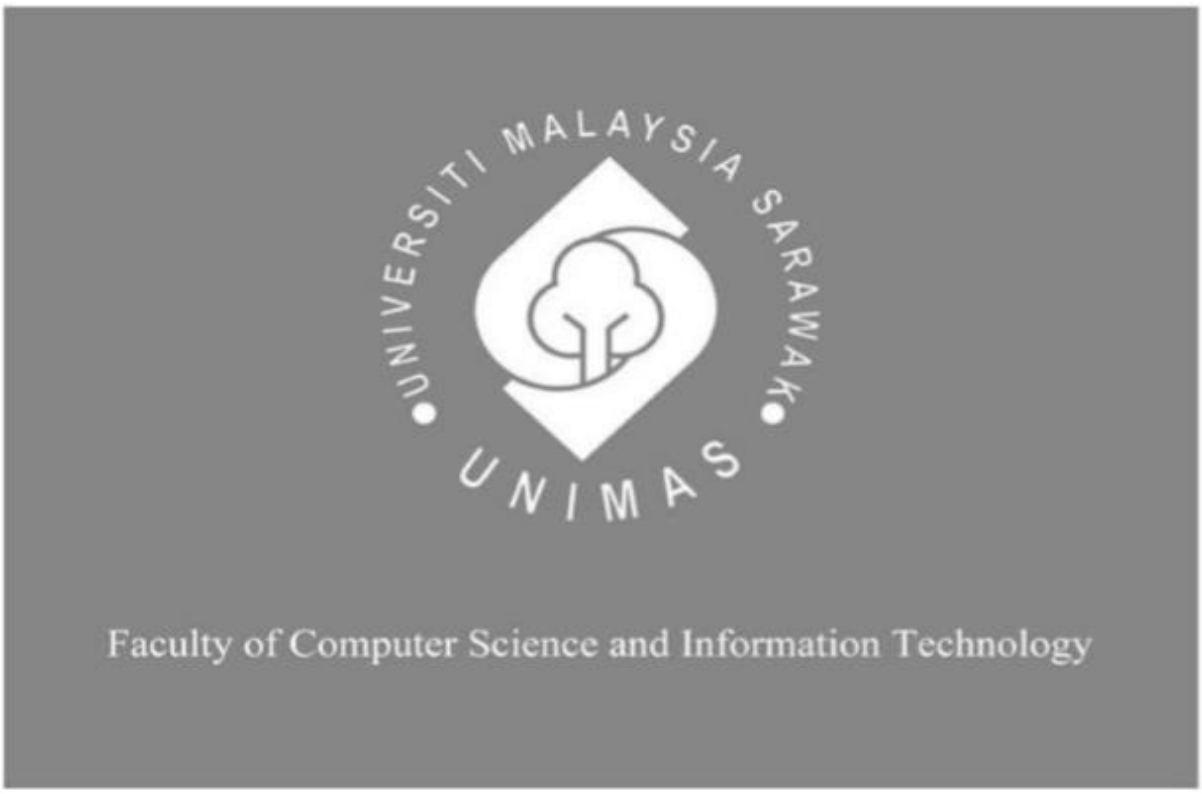

ENHANCING IBAN CUISINE COOKING USING AUGMENTED REALITY TECHNOLOGY

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77733

This project is submitted in partial fulfilment of the requirements for the degree of Bachelor of Computer Science with Honours

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ABSTRACT

The unique and rich culinary traditions of the Iban community in Sarawak, Malaysia, are increasingly at risk of being forgotten due to the influence of modernization on younger generations. This project aims to preserve and promote Iban cuisine through the development of a mobile application powered by Augmented Reality (AR) technology. The application offers an engaging interactive experience, featuring 3D models of traditional dishes such as Pansuh Ikan Sultan, Sup Salai Terung Asam, and Buah Dabai. Additionally, it provides step-by-step video tutorials, cultural insights about Iban food, and pronunciation guides for dish names in the Iban language. Users will have the opportunity to simulate the process of cooking Iban dishes through AR activities designed to enhance their understanding and appreciation of Iban culinary traditions. By combining cultural knowledge with modern technology, this project contributes to the preservation of intangible cultural heritage while making it accessible and appealing to a tech-savvy generation. Ultimately, this AR application serves as both an educational tool and a means of cultural preservation, ensuring the continuity of Iban culinary traditions for future generations.

ABSTRAK

Tradisi masakan Iban yang unik dan kaya dari Sarawak, Malaysia, semakin terancam untuk dilupakan akibat pengaruh pemodenan terhadap generasi muda. Projek ini bertujuan untuk memelihara dan mempromosikan masakan Iban melalui pembangunan aplikasi mudah alih berteknologi Realiti Terimbuh (Augmented Reality, AR). Aplikasi ini menawarkan pengalaman interaktif yang menarik, menampilkan model 3D hidangan tradisional seperti Pansuh Ikan Sultan, Sup Salai Terung Asam, dan Buah Dabai. Selain itu, aplikasi ini menyediakan tutorial video langkah demi langkah, maklumat budaya berkaitan makanan tradisional Iban, serta panduan sebutan nama makanan dalam bahasa Iban. Pengguna akan berpeluang melakukan simulasi memasak masakan Iban melalui aktiviti AR yang direka untuk memperkukuh kefahaman dan pengalaman mereka terhadap tradisi kulinari Iban. Dengan menggabungkan pengetahuan budaya dengan teknologi moden, projek ini menyumbang kepada pemeliharaan warisan budaya tak ketara sambil menjadikannya lebih mudah diakses dan menarik bagi generasi celik teknologi. Akhirnya, aplikasi AR ini berperanan sebagai alat pendidikan dan pemeliharaan budaya, memastikan tradisi kulinari Iban dapat diwariskan kepada generasi yang akan datang.

Chapter 1 Introduction

1.1 Background

Iban cuisine is more than just a food; it provides a window into the rich culture and traditions of Iban people from Sarawak, Malaysia deeply intertwined with their culture and traditions, and the way of life. Each dish tells a story that reflects centuries of heritage, community practices, and the intimate connection that the Iban people have with their land. Food in Iban culture is not just a means of nourishment but a central component of social gatherings, celebrations and rituals. From festive occasions like Gawai Dayak to everyday family meals, Iban dishes often carry deep cultural significance and convey the values and beliefs of the community.

Figure 1.1 Variety of Iban Dishes Served during Family Gathering

There is a possibility that many traditional traditions, such as culinary arts, will be overtaken because of the ongoing process of globalization that is reshaping cultural landscapes. There is a growing disconnection between younger generations and the traditions and knowledge that their elders have passed down to them. The rapid growth of digital media, which frequently promotes popular culinary techniques at the expense of local traditions,

contributes to this gap, which gets worse by such behaviors. As a consequence of this, a great number of traditional Iban recipes and methods of cooking can be forgotten. Both the creation and eating of Iban cuisine are filled with significance, as they frequently involve ingredients and methods that have been handed down from generation to generation. To give just one example, the creation of traditional meals such as pansuh (meat cooked in bamboo) or tuak (rice wine) requires not only the ability to cook but also an awareness of the cultural and spiritual value that lies behind these traditions. These dishes are more than simply a means of food; they are a means of establishing a connection with one's ancestors, celebrating significant life events, and building the links that bind the community together.

We need to find new ways to preserve and share Iban's culinary heritage to address this issue. This project utilizes Augmented Reality (AR) as a technique to create an educational platform that revitalizes interest in Iban cuisine. AR has already been used effectively in other culinary applications, such as the *Cooking Food Simulator Game* by Nadeem Munawar, which immerses users in a restaurant setting where they can prepare various dishes (Munawar, 2020), and *Chef Umami* by Li Yang, which focuses on offering a relaxed, open-ended cooking experience in a stylish kitchen (Yang, 2018). The potential of AR to engage users in interactive and enjoyable cooking experiences can be demonstrated in these examples. This project can foster a deeper appreciation for the cultural context instead of not only aiming to educate users about the preparation of traditional Iban dishes in which these foods exist. Users can learn about various dishes' significance and roles in Iban culture by providing engaging visual and auditory elements. Furthermore, the interactive nature of AR can enhance their learning experiences and allow users to virtually step into the kitchen by enabling them to practice cooking these dishes in a safe and informative environment. This will promote the continued sharing and preservation of Iban culinary knowledge in a format that is accessible, engaging, and relevant to today’s digital world. By blending technology with cultural education, this project also seeks to highlight how AR can be used as an effective technique in cultural preservation efforts.

Moreover, the application of Augmented Reality (AR) to enhance culinary experiences has been the subject of several research studies, which have provided valuable insights for this project centered on preserving and promoting Iban cuisine. For example, Ergun et al. (2020) proposed the AR-Supported Induction Cooker (AR-SI), which is a device that combines augmented reality, the Internet of Things, and induction cooking technologies to improve the capacity of users to pay attention to instructions in a more effective way. As a result of the fact

that this approach improves both the precision and energy efficiency of cooking while simultaneously stimulating learning in culinary contexts, it is particularly useful for teaching cooking skills in educational settings. Like the previous example, the ARtisan Bistro project, which was developed by Raikwar et al. (2022), creates a virtual kitchen environment that allows users to interact with various cooking chores in an augmented-reality setting. In addition to providing a substantial possibility for teaching traditional Iban cooking techniques within the context of a digital kitchen, the layout creates a genuine environment in which anyone can explore various culinary approaches. Furthermore, Magrey et al. (2023) reviewed the integration of augmented reality and scent dispensers to generate a multi-sensory eating experience. This was developed to improve the decision-making process that is involved in the choosing of dishes. Batat (2021) highlighted the impact that augmented reality (AR) has on dining experiences by focusing on the need to enhance food knowledge, foster social connections, and attract consumers via the use of visual and auditory aspects. The focal point of this research is on edutainment, which is aligned to teach users about Iban cuisine and the cultural significance of the cuisine, to develop a personal connection between users and the food. The findings of this research suggest that augmented reality represents a useful resource not only in the field of culinary education but also in the field of cultural preservation. As a result, it is a technology that is suitable for the promoting of Iban culinary traditions.

1.2 Problem Statement

The traditional cuisine of the Iban people is more than just meals—it's a deep connection to history, community, and identity. However, many of these culinary traditions are at risk of being lost, especially among younger generations, as the world moves toward modernization. Unlike other well-documented cuisines, Iban cooking lacks structured digital preservation efforts, leaving its unique preparation techniques, ingredients, and cultural significance vulnerable to being forgotten. Most existing digital resources like YouTube, TikTok, Instagram, and text-based recipes do provide some exposure to traditional Iban dishes. However, it fails to engage users actively or immerse them in the cultural context of cuisine as these platforms primarily present static or one-way learning experiences, where users passively watch videos without active participation. Studies such as Mardhiyyah et al. (2023) have shown that augmented reality (AR) is an effective tool for revitalizing culinary traditions by integrating interactive 3D elements that immerse users in the experience of preparing traditional food. However, they are more focused on Indonesian cuisine, not Iban. Similarly,

Levyta et al. (2023) demonstrated the potential of AR to enrich practical learning environments in culinary education, making it easier for users to engage with complex culinary techniques. Furthermore, Wei et al. (2012) argue that AR applications provide an opportunity to enhance not only the visual aspects of food but also the cultural and emotional connections that people have with their culinary heritage. By integrating 3D models and audio pronunciation guides, this project addresses the gaps in current digital resources, offering a more engaging, and culturally sensitive experience to preserve Iban cuisine.

This project addresses these gaps by applying Augmented Reality (AR) to create an interactive, hands-on cooking experience that goes beyond passive learning. Unlike conventional methods, where users only observe, AR allows them to engage directly with 3D models of ingredients and cooking tools, simulate traditional cooking processes, and explore the cultural significance of each dish. By integrating cultural storytelling, step-by-step cooking simulations, and real-time user engagement, this project ensures that Iban culinary traditions are not only documented but actively practiced and preserved. The use of AR makes this project a great effort in the digital preservation of Iban cuisine, offering an engaging and educational platform that bridges the gap between traditional practices and modern technology. To achieve this, the study will first identify gaps in existing digital resources, then design and develop an AR-based application that showcases Iban's traditional cuisine and finally evaluate its effectiveness in preserving Iban's culinary heritage.

1.3 Scope

This project will focus on the presentation and preservation of traditional Iban cuisine through the use of Augmented Reality (AR) technology. The scope will include three selected Iban dishes, represented as 3D objects, along with pronunciation guides for the correct Iban names of each dish. The first dish is Pansuh Ikan Sultan, second dish is Sup Salai Terung Asam, and the last dish is Buah Dabai.

1.4 Aims and Objectives

Aim:

To develop an interactive AR cooking learning that preserves and promotes Iban traditional cuisine by engaging experience through the use of AR technique.

Objectives:

1. To identify gaps in digital preservation of Iban cuisine cooking.
2. To design and develop a mobile application that showcases Iban traditional cuisine cooking employing AR technology.
3. To evaluate the effectiveness of AR technology in preserving Iban cuisine cooking.

1.5 Significance of Project

The "Enhancing Iban Cuisine Cooking using Augmented Reality Technology" project is significant for multiple reasons. First and foremost, it addresses the urgent need to preserve the cultural heritage of the Iban people, particularly their unique culinary traditions. As modernization continues to influence younger generations, traditional Iban recipes and cooking methods are at risk of being forgotten. This project bridges the generational gap by providing a digital platform that makes learning traditional cooking methods not only informative but also engaging and enjoyable.

By utilizing Augmented Reality, this project introduces an innovative approach to cultural education. AR enhances the user's sensory experience by allowing them to interact with 3D models of ingredients and cooking tools, simulate traditional cooking processes, and explore the cultural significance of each dish. This interactive format aligns with the digital preferences of younger generations, making the learning experience more accessible and memorable. Furthermore, this project serves as a model for other cultural preservation efforts, demonstrating how AR can be effectively used to promote and sustain cultural practices in a modern, digital context.

From a technological perspective, this project contributes to the use of AR in a less explored domain: the preservation of intangible cultural heritage. It highlights how AR can be used not only as an entertainment tool but also as an efficient teaching tool to instill appreciation for one's culture. By combining cultural education with cutting-edge technology, this project ensures that Iban culinary traditions are preserved and passed on to future generations in a way that is both meaningful and engaging.

1.6 Expected Outcome

The expected outcome of this project is a prototype of an interactive AR-based mobile application that showcases traditional Iban cuisine. This application will feature 3D models of selected traditional dishes, such as Pansuh Ikan Sultan, Sup Salai Terung Asam, and Buah Dabai, along with step-by-step cooking instructions and cultural insights that explain the significance of each dish. Users will also have access to audio pronunciation guides for Iban dish names, watching the full video tutorial on how to prepare or cook the dishes, ensuring a culturally sensitive and immersive learning experience.

The application will allow users to interact with virtual cooking tools and ingredients through markerless AR technology, simulating traditional cooking processes in real time. This hands-on approach will enhance knowledge retention and engagement, making the learning experience more effective than just through passive video tutorials. By combining cultural storytelling, interactive AR cooking activities, and real-time user engagement, the application will foster a deeper appreciation for Iban culinary heritage. Ultimately, the project will serve as a tool for preserving the culinary traditions of the Iban people, making them accessible and engaging to a broader audience, particularly younger generations.

1.7 Summary

In summary, the "Enhancing Iban Cuisine Cooking using Augmented Reality Technology" project focuses on preserving and promoting Iban culinary heritage by leveraging the power of Augmented Reality (AR). By providing an interactive platform, this project ensures that the rich cultural significance of traditional Iban dishes is not lost to future generations. The project bridges the generational gap in culinary knowledge, making learning about these traditions accessible and exciting for the younger audience. Through 3D models, cultural storytelling, and interactive AR cooking activities, the application offers a comprehensive and immersive learning experience. Ultimately, this project not only helps with cultural preservation but also demonstrates the important role that AR can play in educational and heritage-based initiatives. In the next chapter, a detailed literature review will be conducted to explore existing research on the digital preservation of culinary traditions, the use of AR in cultural education, and the challenges of integrating AR with traditional cooking methods.

Chapter 2 Literature Review

2.1 Introduction

This chapter will review the existing applications and the study that has been done on how digital tools, especially Augmented Reality (AR), can be used to keep traditional cooking skills alive, focus on Iban cuisine. It is the goal of this review to find gaps in the current research and to take a close look at how AR technology has been used to preserve culture, especially in the culinary arts. This chapter also explores the challenges of integrating AR with traditional cooking methods and cultural practices. It shows both the pros and cons of this new way of keeping culinary heritage. The chapter begins with cultural preservation in traditional cuisines in a wider sense. Following that, it delves into digital preservation techniques, particularly the use of technology to document and share recipes, cooking processes, and other aspects of culinary traditions. The discussion then shifts to AR's role in education and cultural heritage preservation, with a particular focus on its potential within the culinary field. Finally, the chapter highlights the challenges and limitations of using AR in the preservation of traditional foods. By the end of the chapter, the review will identify the key research gaps that this project seeks to address, specifically in the development of an AR-based method for preserving and promoting Iban cuisine.

2.2 Digital Preservation of Culinary Knowledge

2.2.1 Role of Digital Tools

Digital tools are increasingly an important aspect of keeping and sharing cultural knowledge, such as cooking practices. People used to pass on ancient recipes and ways of cooking via word of mouth or by showing them how to do it. Digital technology has made it possible to record, save, and distribute these once-unrecorded rituals all across the world. People can learn about and try traditional foods from many cultures on sites like YouTube, Instagram, and TikTok. They do this by watching pretty cooking videos, short clips, or recipe posts that seem nice.

These platforms do assist share knowledge about traditional foods, but they usually only allow for one-way, passive consumption. Videos and static posts show the steps, but they don't let the user actively participate in the process. For instance, viewing a TikTok about how to make a traditional Iban cuisine could be interesting, but it doesn't include the sensory and interactive parts that help people remember, absorb, and connect with the material. Also, these

formats often put speed, trendiness, or visual appeal first, which can lead to straightforward or culturally detached representations of traditional foods. This is where Augmented Reality (AR) has the potential to fill the gap. AR can create an interactive and hands-on learning experience, enabling users to virtually cook dishes and gain a deeper understanding of the cultural context behind each meal as proposed in this project. Hence, digital tools not only preserve culinary knowledge but also make it more engaging. As AR can also make learning more fun, the research conducted by Bischof et al. (2018) demonstrates that augmented reality applications associated with traditional recipe books offer more than just cooking instructions; they also create cultural narratives, thereby enriching the understanding of the culinary process and the cultural identity that underlies each dish. These technologies enable individuals to gain insight into, understand, and safeguard culinary traditions in a more engaging and significant manner.

2.2.2 AR and Culinary Preservation

Augmented Reality (AR) has been used as a powerful tool for preserving and promoting cultural heritage, including the culinary perspective. Unlike old methods, AR allows users to interact with digital content in the real world, creating an immersive experience that can bring cooking traditions to life. For culinary preservation, AR can improve learning by visually demonstrating the preparation of traditional dishes, making it easier for users to understand not just the recipe but also the cultural significance behind each meal. Through AR, users can explore the step-by-step process of cooking, see 3D representations of ingredients, and even hear audio guides explaining the history and cultural context of the dishes. This technology can provide an innovative approach to documenting and spreading traditional cooking methods, enhancing their accessibility and attract for younger viewers, creating a more captivating experience compared to typical recipes or instructional videos. In the research conducted by Ghasemi et al. (2023), the implementation of a spatial AR system for cooking training revealed notable enhancements in usability and user experience. The sAR Kitchen system significantly helped the perceived workload of participants while offering a more immersive and efficient approach to mastering culinary tasks in contrast to conventional video tutorials. This highlights the potential of digital tools, particularly augmented reality, to enhance the accessibility, efficiency, and enjoyment of learning traditional cooking techniques, thereby facilitating the passing down of culinary traditions to younger generations.

AR's ability to blend education with entertainment, often referred to as "edutainment," makes it a useful tool for preserving culinary traditions in a way that resonates with younger generations. For example, AR can provide interactive tutorials where users virtually "cook" a dish by following visual and auditory instructions, allowing them to engage with the content more deeply than with static media like videos or written recipes as what being proposed in this project. Levyta et al. (2023) demonstrate the significant impact that AR can have on culinary learning, especially during challenges such as the COVID-19 pandemic. As traditional learning methods face challenges, augmented reality develops as an appealing alternative, delivering engaging and interactive cooking lessons that can be accessed remotely. This is particularly beneficial for maintaining the understanding of traditional cuisines, which might otherwise be surpassed by worldwide culinary trends. By using augmented reality into Iban cuisine, it is possible to provide virtual lessons that lead users through the process of preparing traditional dishes, thereby preserving cultural practices even in remote learning settings. We can bridge the gap between traditional cooking methods and the modern digital world, ensuring that culinary heritage is not just remembered, but experienced and passed on to future generations by using AR technology.

2.2.3 Review on Similar Existing Applications

Chef Umami (Yang, 2018)

Chef Umami is a free mobile game application that using augmented reality features to guide users through various cooking tasks, allowing them to prepare dishes virtually by following the cookbook recipes provided during the game. It is developed by Li Yang from PINX studio, a digital art lab exploring and experimenting on new forms of app and game. This app released in 2018. This augmented reality-based app provides users with a relaxed, open-ended cooking experience in a virtual kitchen to have a cooking experience that concentrates on the nice feeling of cooking for others. The users will prepare and cook tasty meals for the hungry customers in the game by using a lot of different ingredients and kitchenware available. They need to fulfil the customers' orders in the way they want or having a creative creation of user's version of meals. With endless food combinations, user can experiment with ingredients in 3D and make their own unique recipes. There's no strict rule that can prevent users from make a mess, or keep tidy, and just enjoy these with no-rushing time. Figure 1.1 shows the environment setup of the app while Figure 2.2 below showing one of the cooking processes during the game engagement.

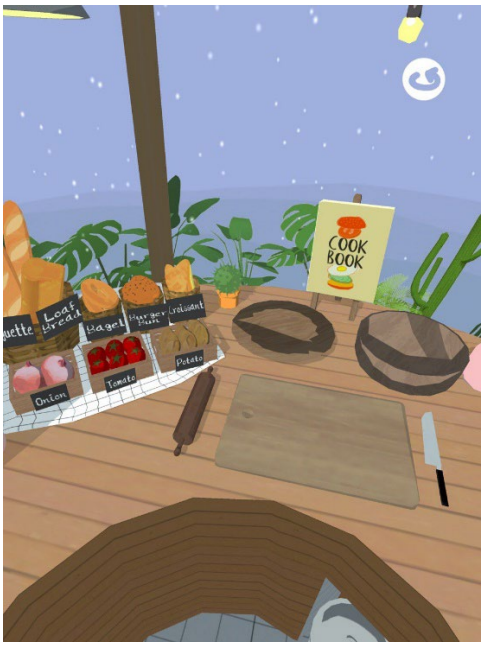


Figure 2.1 Chef Umami environment setup (Yang, 2018)

Figure 2.2 The cooking process from Chef Umami (Yang, 2018)

However, this app requires iOS 10 or higher. Chef Umami is only available in Apple App Store, not available for android. Plus, while Chef Umami offers a fun and interactive way to learn cooking skills, it primarily focuses on generic cooking tasks without delving into the

cultural significance of the dishes being prepared. It doesn't cater to the specific needs of preserving and promoting a cultural heritage. There is a noticeable absence of deeper educational content regarding the cultural heritage of the recipes or their history. In contrast, the proposed project focuses on preserving Iban cuisine, which is rooted in the unique culture, traditions, and spiritual significance of the Iban people.

Chef Umami's AR interface provides 3D models of ingredients and tools, but it lacks the kind of deep interaction that enhances understanding of the traditional methods and tools used in Iban cooking. The project can differentiate itself by allowing users to interact with 3D representations of traditional Iban cooking methods, such as bamboo, wood-fired stoves, or other unique tools used to prepare Iban dishes. This hands-on interaction would not only educate users about the dishes but also immerse them in the traditional cooking methods that have been passed down through generations.

The Cooking Food Simulator (Munawar, 2020)

The Cooking Food Simulator is also a free mobile game application that also using augmented reality of 3D Modelling environment to play as a real chef, allowing them to prepare dishes virtually by following the recipes provided every mission during the game. It is developed by Nadeem Munawar from InVogue Technologies. This app released in 2020 and available in both Apple and Google Play Store but named as Cooking Spices Food Simulator for android version. As user will play as a real chef serve the customer needs, they will cook in their own restaurant equipped with all kinds of utensils and ingredients in 3D features. The mission is to become best restaurant in town. The game contained best-selling 24 recipes and even contain the dishes from specific country which portray the food cultures in other country such as the Italian Florentine Soup Recipe as shown in Figure 2.3 below.

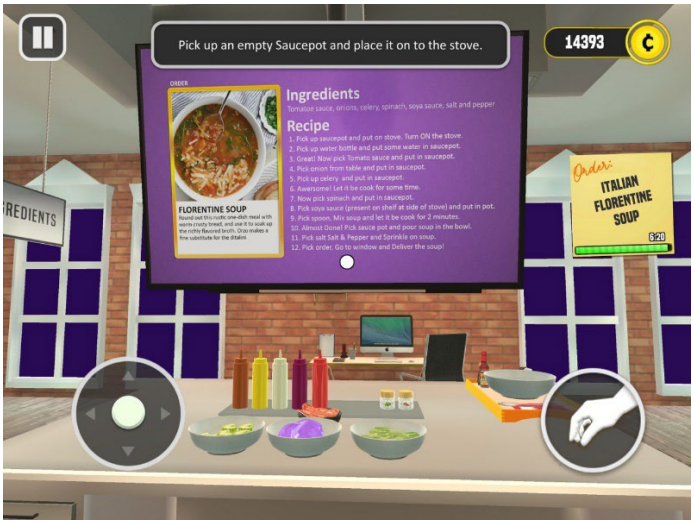


Figure 2.3 Instruction for the Italian Florentine Soup Recipe (Munawar, 2020)

During the game, user only need to follow the recipe steps-by-steps, also being guide by interactive instruction to make it easy to follow. All the ingredients already prepared, well cut and portioned. So, user just need to do the cooking process following the steps provided. This app is kind of similar to the concept of proposed project later on where user will need to do an Augmented Reality activities on cooking the 3D visualizations Iban cuisine after watching the videos, learning how to cook the dish by the guided recipes provided and also learn how to pronounce it in Iban language. However, this existing application didn't provide the specific name and way to pronounce the dish. The primary focus of the Cooking Food Simulator is to complete missions, making it more of a game than an educational tool, compared to the proposed project where the main purpose is to look at how far the AR activities measured the effectiveness of learning how to cook Iban Cuisines whether the users can remember the steps or not.

BrainPOP (BrainPOP, 1999)

BrainPOP was founded in 1999 by Dr. Avraham Kadar, as a creative solution to explain difficult concepts to his young audiences. Therefore, BrainPOP app apply interactive media to captivate young users, shifting the experience from passive learning to active exploration. While mainly utilized in educational settings, BrainPOP demonstrate the potential of technology to captivate children with learning materials, covering subjects like cultural and worldwide knowledge education. Through the delivery of information in an engaging and

accessible manner, if this application is in an AR technology, this also has the potential to safeguard culinary traditions and enhance their appeal to a tech-savvy younger audience, thereby ensuring the continual value of heritage knowledge.

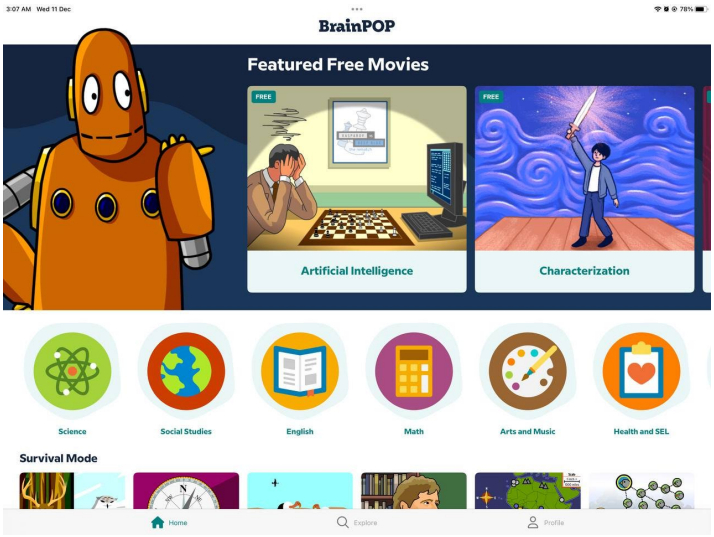


Figure 2.4 Screenshot of BrainPOP Homepage (BrainPOP 1999)

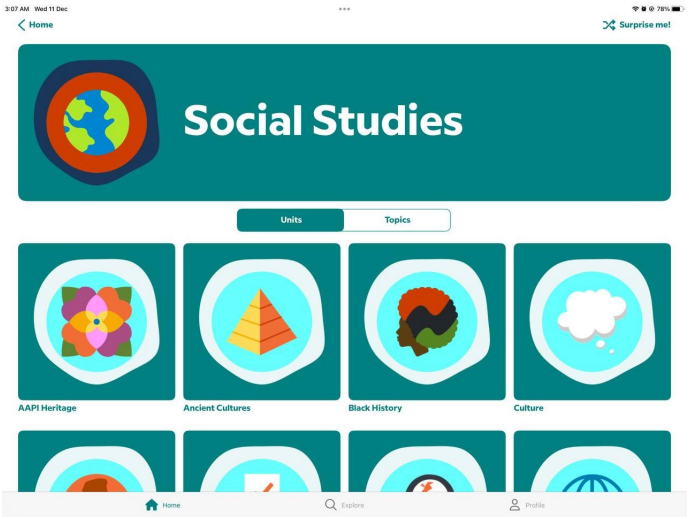


Figure 2.5 Social Studies Category in BrainPOP (BrainPOP,1999)

This app has been a great trusted learning resource supporting core and supplemental subjects, reaching millions of learners worldwide. As been shown in the Figure 2.5 and Figure 2.6, there's a lot of categories for the kids to learn about a topic. While BrainPOP does

introduce certain aspects of cultural knowledge, the treatment of cultural topics tends to be surface level. The app offers basic information about some countries' cultures, but it doesn't delve deeply into traditional practices, culinary heritage, or the nuances of specific cultural elements.

BrainPOP excels at interactive learning in subjects like math, science, and social studies but does not extend its interactive capabilities to the practical, hands-on experience required for culinary education. BrainPOP also not in Augmented Reality Technologies compared to the proposed project. Plus, there's no Iban culture involved in becoming the educational content in BrainPOP application.

Ma' Ugiz (Yulia et al., 2018)

The paper "Augmented Reality of Traditional Food for Nutrition Education" by Cica Yulia et al. explores the potential of augmented reality (AR) as a tool for nutrition education, particularly targeting teenagers. The study focuses on the development of AR Ma'Ugiz, an AR-based application designed to introduce traditional Sundanese food and its nutritional value. The authors emphasize the importance of incorporating local wisdom and traditional food into nutrition education, which can help make learning more relevant and engaging for young audiences.

The methodology of the study includes the development of the AR Ma'Ugiz application, which features 3D models of traditional food, videos demonstrating the food preparation process, and integration of these elements using Unity 3D and Vuforia SDK. The development involved creating 3D models of Sundanese food using Blender, making videos with Wondershare Filmora, and testing the functionality of the application using the black box testing technique. The testing focused on aspects like marker detection, video playback, and the installation process, ensuring a smooth user experience.

The findings show that AR Ma'Ugiz successfully engaged teenagers in learning about traditional Sundanese food. The interactive nature of the AR application made the learning process fun and informative, allowing users to explore both the preparation process and the nutritional information of the dishes. Teenagers found the app interesting and enjoyed the immersive, hands-on approach to learning about local cuisine. The study also found that the app effectively worked by detecting markers and displaying the corresponding 3D models and

videos as intended. These results suggest that AR can be a valuable tool in making nutrition education more interactive and relevant to younger audiences.

The discussion highlights that AR Ma'Ugiz successfully reduced the gap between traditional knowledge and modern educational techniques. The authors argue that the AR application not only helps educate teenagers about the nutritional benefits of local food but also encourages them to value cultural heritage. However, the paper does not explicitly discuss limitations, although potential concerns include the need for further testing with a larger and more diverse group of users. The study also may have biases related to the specific AR hardware and software used in the development process.

In conclusion, the paper asserts that AR Ma'Ugiz is an effective educational tool, promoting traditional Sundanese food and teaching teenagers about its nutritional value in an engaging and interactive manner. The authors suggest expanding the use of AR in other educational contexts and exploring its application in different levels of education.

Compared to the Iban cuisine project, this study shares a similar goal of preserving traditional food and using AR for educational purposes. However, while AR Ma'Ugiz focuses on Sundanese cuisine and nutritional education, the proposed Iban project goes beyond just teaching cooking techniques by also make user cook the cuisine in AR experiences. Your project aims to create a more culturally immersive engaging experiences, allowing users not only trying to cook Iban dishes but also their cultural significance, making it more comprehensive and educational.

Kulinaria (Mardhiyyah et al., 2023)

The paper by Alya Dhiya' Mardhiyyah et al., titled "Application of Augmented Reality Technology on the Kulinaria Website to Introduce Indonesian Culinary," focuses on utilizing Augmented Reality (AR) to preserve and promote Indonesian cuisine, particularly aiming to appeal to younger generations. The study explores how the Kulinaria AR application, combined with a website, can make Indonesian dishes more accessible and engaging by 3D models. The authors argue that AR technology is a valuable tool for modernizing the presentation of traditional dishes and ensuring the continued interest in Indonesia's culinary heritage.

The methodology of the study employs the Rapid Action Development (RAD) model to quickly prototype and test the app's functionalities, using Unity 3D with the Vuforia SDK and designing the website with Figma and VSCode. This approach allowed for efficient testing and rapid iteration of features, including app speed, scalability, and the stability of the 3D object loading process. The results of the testing show that the application effectively displays 3D models of Indonesian dishes within specific distances (20 cm to 80 cm) and angles (15° to 45°), demonstrating that the technology can support cultural preservation in a visually engaging way.

Figure 2.6 3D Object Rawon made by 3D Blender (Mardhiyyah et al.,2023)

Figure 2.7 3D Object Seblak by 3D Blender (Mardhiyyah et al.,2023)

Figure 2.8 3D Object when the target image is detected (Mardhiyyah et al.,2023)

Figures above shown the result of 3D Objects from the project. One of the strengths of the paper is its practical demonstration of how AR can be applied to cultural education, specifically culinary heritage. By integrating AR, the Kulinaria app provides users with an interactive platform where they can scan AR cards to view 3D models of Indonesian dishes,

thereby enhancing learning and engagement. However, the paper does not fully explore the limitations of the app, such as the small number of dishes presented and potential issues with device compatibility. While the authors suggest future improvements, such as expanding the range of dishes and refining the app's features, these aspects were not thoroughly addressed in the current study.

Compared to the proposed project on Iban cuisine, this study aligns well in its use of AR technology for cultural preservation, but there are key differences. The Kulinaria project focuses on Indonesian cuisine, offering a more generalized approach to cultural education. In contrast, the proposed project is more specific, focusing on the Iban culture and offering additional features such as pronunciation guides for dish names in the Iban language. The inclusion of these cultural details makes the Iban project more educational and immersive, aiming not only to teach users how to cook but also to foster a deeper understanding of the significance behind the dishes.

Overall, the research provides valuable insights into the potential of AR technology for cultural preservation, but it leaves room for further exploration, particularly in expanding content and ensuring broader accessibility. This aligns with the goals of the proposed project, which will focus on more immersive, culturally specific, and interactive learning experiences for Iban cuisine.

sAR Kitchen (Ghasemi et al., 2023)

The paper "Embedding Spatial Augmented Reality in Culinary Training: A Comparative Evaluation of sAR Kitchen and Video Tutorials" by Yalda Ghasemi et al. explores the use of spatial augmented reality (sAR) to enhance culinary training, comparing it with traditional video tutorials. The study specifically evaluates the sAR Kitchen, an AR-based cooking assistant, to assess its effectiveness in reducing perceived workload, improving usability, and enhancing performance in culinary tasks. The primary objective was to understand if sAR could offer a more engaging and efficient learning experience compared to standard video instructions.

In terms of methodology, the study involved a comparative evaluation between sAR Kitchen and traditional video tutorials, using a playdough-making task as a representation of a cooking task. The research design included 22 participants, and the tools used in the study

included Microsoft Azure Kinect, a projector, and a desktop computer. Data were collected using various methods, including NASA-TLX questionnaires for workload assessment, SUS (System Usability Scale) for usability, and performance metrics such as task completion time, product quality, and cooking station messiness. Statistical analyses were performed using the Wilcoxon signed-rank test, and qualitative feedback was analyzed to understand participant experiences.

The findings of the study reveal that sAR Kitchen significantly reduced perceived workload compared to video tutorials. The usability scores were also higher for sAR Kitchen, indicating that it was more user-friendly and efficient in terms of interaction. While there were no significant differences in product quality and cooking station messiness, participants were able to complete the task more quickly when using sAR Kitchen. These findings suggest that sAR technology offers a more effective and engaging way to guide users through cooking tasks, providing interactive, real-time feedback that enhances the learning process.

The discussion of the paper suggests that sAR Kitchen improves the user experience by reducing cognitive load and allowing users to control the pace of instructions. The interactive nature of sAR provides a more engaging and personalized learning experience compared to video tutorials. The authors propose that sAR can be a valuable tool in culinary training, making it more immersive and efficient. However, the study acknowledges limitations, such as its controlled lab-based setting, which may not reflect real-world cooking conditions. The study also lacks a diverse range of culinary tasks and real-world applications, suggesting that future research could explore these aspects further.

When comparing this paper with the proposed project on Iban cuisine, there are both similarities and differences. Like the sAR Kitchen project, this project also uses AR technology to enhance culinary learning. However, while sAR Kitchen focuses on general cooking tasks and usability, the project is specifically aimed at preserving and promoting Iban culinary heritage. It goes beyond just improving cooking performance by incorporating cultural and linguistic elements, such as pronunciation guides, how to cook the cuisine and historical context for each dish. This makes the project more educational and culturally immersive, offering a deeper understanding of the significance behind traditional Iban dishes.

In conclusion, the study on sAR Kitchen highlights the potential of spatial augmented reality to improve culinary training by enhancing usability and reducing cognitive load. However, unlike the general cooking tasks explored in this research, the proposed project aims

to preserve specific cultural knowledge, making it more focused on Iban culinary traditions. While sAR Kitchen offers valuable insights into how AR can streamline cooking processes, this project will provide a more culturally immersive learning experience that connects users to the heritage and history of Iban cuisine.

Interactive Recipe Book – for Corona Guest Farm (Bischof et al., 2018)

The paper "Interactive Recipe Book – Enhance Your Traditional Recipe Book" by Bischof et al. addresses the challenge of preserving cultural heritage through traditional recipes, enhanced with augmented reality (AR) to provide a richer and more interactive experience. The study focuses on creating an interactive recipe book combined with an AR application designed to digitize cultural content, making traditional recipes more engaging and informative. The primary objective was to make the recipes not only easier to follow but also to connect them to their cultural contexts, providing users with a deeper understanding of the food and its significance.

In terms of methodology, the study involved developing the recipe book and the AR application, with content collected through interviews, videos, and photographs of traditional cooking methods and cultural practices at the Corona Guest Farm in Namibia. The AR application was developed using Unity 3D and Vuforia, with the main focus on integrating 3D content, videos, and interactive markers to enhance the user experience. The researchers employed the black box testing technique to evaluate the functionality of the AR application, including aspects such as marker detection and video playback.

The findings indicate that the AR application effectively enhanced the traditional recipe book by providing additional cultural context and instructional videos. Users found the AR content engaging and informative, particularly enjoying the cultural stories and backgrounds of the recipes. The integration of traditional media (the recipe book) with digital technologies (AR) enriched the overall experience, promoting not just learning but also cultural exchange. The AR system successfully detected markers and displayed videos and images, fulfilling its intended purpose to provide a more immersive cooking experience.

In the discussion, the authors interpret the results, suggesting that the interactive recipe book is a valuable tool for cultural heritage preservation and education. The AR technology helped bridge the gap between traditional culinary knowledge and modern learning methods

by making traditional food more accessible and engaging for users. They highlight the potential of AR to transform cultural education by enhancing the interactivity of the learning process.

Comparing this paper with the Iban cuisine project, both studies aim to use AR technology to preserve and promote traditional food and cultural knowledge. However, while this study focuses on Sundanese cuisine and integrates AR to teach nutrition and food preparation, the proposed Iban project will have a more culturally immersive approach. Unlike the general focus of the interactive recipe book, which combines AR with basic culinary learning, the Iban project will incorporate not only cooking techniques but also cultural and linguistic elements, such as pronunciation guides and historical context, which will make the learning experience more interesting. In conclusion, the study demonstrates the value of AR in enhancing traditional recipe books and promoting cultural heritage. However, the proposed Iban cuisine project will take a more holistic approach to offer an enriched learning experience that goes beyond food preparation.

These reviews illustrate the potential of AR and various digital tools to establish appealing ways for the preservation of culinary traditions. In the context of Iban cuisine, these initiatives provide important insights into the adaptation of traditional culinary knowledge through a digital format. This approach ensures that such knowledge remains accessible and relevant to younger generations, all while maintaining its cultural richness.

2.3 AR for Cultural Heritage Preservation

2.3.1 Overview of AR Technology

The technology known as augmented reality (AR) creates realistic and interactive experiences by fusing digital content with the physical world. AR enhances physical settings by putting virtual features, such text, voice, or 3D models, onto them using gadgets like smartphones, tablets, or AR glasses. AR improves the actual world by introducing digital layers that users may interact with in real time, in contrast to Virtual Reality (VR), which fully submerges users in a simulated environment.

The core components of augmented reality are hardware (such smartphones, AR glasses, or smart screens) and software (like ARCore for Android, ARKit for iOS, or platforms like Vuforia). These technologies allow devices to recognise the user's surroundings and integrate digital material in ways that seem natural and intuitive. For example, augmented

reality (AR) technology can effectively enhance learning experiences by directing a user through a cooking process by projecting virtual recipe steps or instructions straight onto their kitchen environment. AR is an ideal tool for teaching traditional cooking methods, such as those employed in Iban cuisine, because of its immersive potential in the culinary arts, which can make cooking more interesting and educational.

The possibilities of AR technology in real-world applications are wide-ranging, particularly within the fields of education, training, and culinary arts. A significant benefit of AR lies in its capacity to deliver immediate, context-sensitive information, thereby enriching the user's comprehension and engagement with their surroundings. For example, Hasada et al. (2019) investigated the application of AR goggles for presenting cooking instructions. Their research indicated that 3D animation emerged as the most effective display method, leading to a notable decrease in task completion time when compared with alternative formats such as video or text. This highlights the effectiveness of AR in delivering straightforward, user-friendly guidance, which proves especially beneficial in intricate activities like cooking.

AR in Education

The integration of augmented reality (AR) into educational settings has opened new possibilities for interactive and immersive learning experiences. Traditional teaching methods often rely on static resources like textbooks and videos, which may fail to fully engage students. AR, however, bridges this gap by combining digital elements with real-world environments, fostering dynamic interactions that encourage hands-on learning and deeper engagement. Recent studies highlight the versatility of AR across diverse educational contexts. For example, AR applications have been shown to enhance students' understanding of abstract concepts in subjects like mathematics, physics, and language learning by visualizing content in interactive, three-dimensional formats (Yiannis Koumpouros, 2024). The use of AR has proven particularly effective in fostering student motivation, spatial awareness, and problem-solving skills. Moreover, AR's ability to overlay real-world settings with virtual information makes it a valuable tool for experiential learning, allowing students to engage with content in meaningful and contextually relevant ways. In addition to fostering student engagement, AR supports educators by providing innovative teaching aids that simplify the explanation of complex ideas. According to Wei et al. (2021), AR technologies, such as mobile-based applications and markerless systems, are increasingly being adopted due to their ease of use

and alignment with modern teaching strategies. By creating an engaging and interactive learning environment, AR empowers both educators and students to achieve enhanced learning outcomes while aligning with the goals of 21st-century education.

Besides, platforms like Microsoft HoloLens 2 are advanced augmented reality (AR) platform that merges the physical world with digital content, creating an immersive, interactive learning environment. This unique feature makes HoloLens 2 particularly effective in educational settings, where it can be used to visualize complex concepts in real-time. The device can act with precision, as it has cool features like hand tracking, prompting commands using voice, eye tracking, and special mapping (Microsoft, n.d).

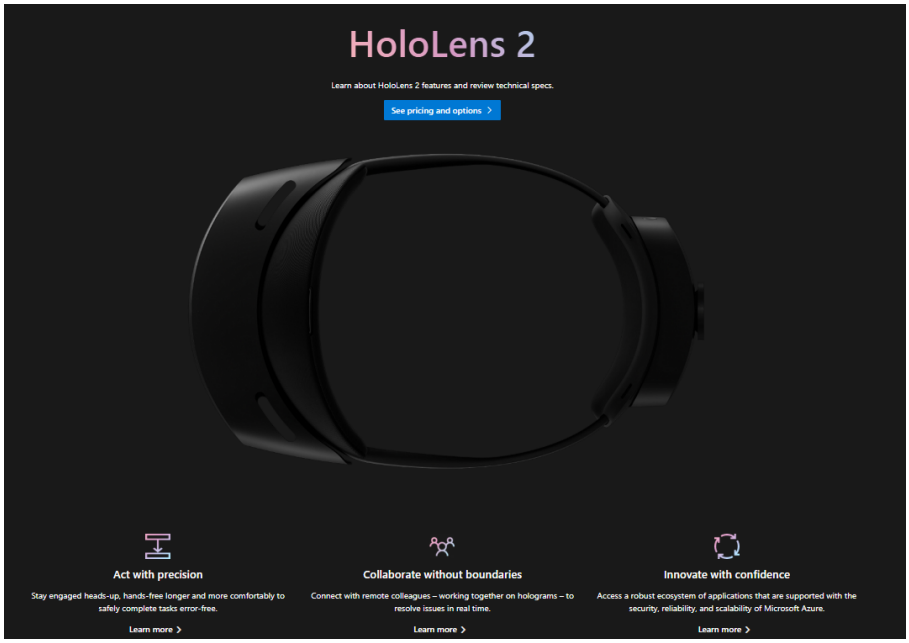


Figure 2.9 Microsoft HoloLens 2 gadget (Microsoft, n.d.)

Figure 2.10 shows the gadget of Microsoft HoloLens 2. Unlike traditional VR, which isolates users in a fully digital space, HoloLens 2 device overlays digital objects onto the real world, allowing users to interact with both physical and virtual elements simultaneously.

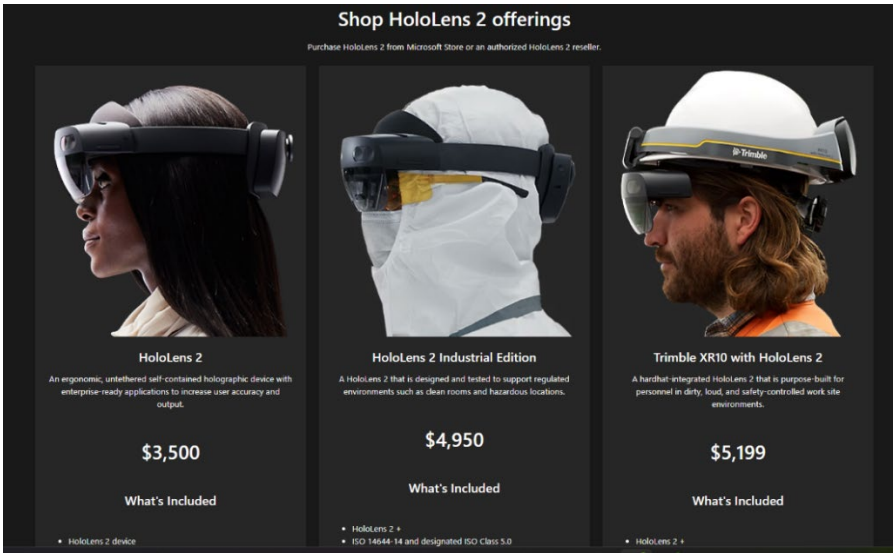


Figure 2.10 HoloLens 2 marketplace categories (Microsoft, n.d.)

HoloLens 2 sell different of marketplace categories as been shown in Figure 2.11. In the field of education, HoloLens 2 significantly enhances the learning experience by facilitating experiential learning. It allows users to engage with virtual models, get involved in hands-on demonstrations, and immerse themselves in interactive scenarios, all from any location. In addition to its impact on education, HoloLens 2 has significantly influenced various other sectors. In manufacturing, it contributes to minimising downtime and streamlining onboarding and upskilling processes. In engineering and construction, it facilitates faster construction timelines and helps identify risks earlier in the project cycle. Moreover, in healthcare, it improves patient treatment directly at the point of care. The HoloLens 2 transforms the learning environment into a dynamic and adaptable space for fostering high engagement (Microsoft, n.d.). This makes it an exceptional resource for preserving and providing traditional culinary practices through interactive, hands-on experiences, while simultaneously enhancing productivity across diverse industries. This approach to education accommodates various learning preferences while promoting self-directed learning, enabling students to understand complex concepts through visual and engaging methods. The influence of AR on education extends beyond just young learners. The application of this technology extends into the areas of higher education and vocational training. This approach provides practical, engaging experiences that replicate real-life situations, proving especially advantageous in areas such as healthcare, engineering, and culinary disciplines. Integrating AR into training and educational frameworks allows institutions to offer students a more hands-on, immediate grasp of the material, enhancing their retention and skill acquisition.

AR in Culinary Arts

Augmented reality introduces a heightened sense of immersion, transforming cooking into a more interactive and captivating experience. The Cooking Food Simulator Game (Munawar, 2020) conveys how augmented reality enriches the culinary experience. This interactive experience enables users to craft virtual culinary creations through engagement with three-dimensional representations of various ingredients and cooking utensils. The app not only just a simple cooking simulator game, but it also contains some worldwide authentic recipes even though it is still limited to few recipes provided, As users navigate the recipe steps, the app offers simple yet explainable recipes, assisting them throughout the process with visual aids, thereby ensuring they acquire cooking techniques correctly. This can be especially beneficial for users who might require extra assistance when experimenting with new recipes or culinary methods.

Beyond improving practical learning, augmented reality can make the experiences more engaging and fun while learning how to cook the dish. For example, Chef Umami (Yang, 2018) adopts a more friendly approach by providing an open-ended culinary experience in a virtual setting. The application provides users with the opportunity to explore an extensive range of culinary creations within an engaging kitchen environment, delivering interesting visual instructions throughout the cooking process. The allure of these applications stems from their engaging functionalities and their ability to transform the process of mastering culinary skills into an enjoyable and approachable experience. These augmented reality tools simplify the complicated process of cooking, allowing users to explore and try out various techniques in a safe and pressure-free environment. The app even provides cute cookbook recipes as references for the user, as been shown in Figure 2.12 below.

Figure 2.11 Cookbook Recipes Guide (Yang, 2018)

Additionally, Hasada et al. (2019) explored the usefulness of employing AR goggles to present cooking instructions for complex tools, including an avocado cutter or can opener. The research indicated that 3D animations emerged as the most effective approach, offering clearer guidance and decreasing the time required to complete tasks. Using augmented reality, individuals can obtain immediate feedback and direction, simplifying the process of adhering to recipes and techniques while also safeguarding and transmitting culinary knowledge efficiently. In the context of traditional cuisines such as Iban cooking, augmented reality can significantly contribute to the preservation of cultural heritage. Utilising visual elements that point out the cultural importance of ingredients or cooking methods can transform the educational journey into a great experience. Individuals can discover not only the methods of dish preparation but also the narratives that accompany them, enriching their bond with the cuisine and its cultural heritage.

2.3.2 AR and Cultural Heritage Preservation

Augmented Reality (AR) has emerged as a transformative tool in the preservation and dissemination of cultural heritage, offering novel methods to engage audiences with historical artifacts and traditions. By seamlessly integrating digital content into the physical world, AR provides immersive and interactive experiences, enhancing the way individuals connect with

cultural heritage. This technology bridges the gap between traditional methods of preservation and modern, user-friendly approaches. Recent studies have highlighted AR's potential to reconstruct and present cultural artifacts and historical sites in an accessible format. For example, AR technology has been applied to create 3D reconstructions and interactive virtual environments, enabling users to explore cultural artifacts in their original contexts (Boboc et al., 2022). Such applications make historical knowledge more engaging and accessible, particularly to younger audiences and those without direct access to cultural heritage sites.

Additionally, AR applications support the integration of intangible cultural heritage, such as rituals, oral histories, and traditional practices, into interactive experiences. This approach preserves and revitalizes cultural knowledge, ensuring its continuity for future generations (Ibiş & Çakici Alp, 2024). Developers have created dynamic applications that allow users to explore ancient sites and participate in virtual reconstructions, making history tangible in real-time through tools like Unity3D and ARCore.. Furthermore, AR has proven effective in engaging users with location-based storytelling and gamification, enhancing the learning experience and creating deeper connections with cultural content (Upasani et al., 2023). This approach contributes to the sustainable promotion of cultural heritage by leveraging innovative technologies, not only fostering educational engagement but also to create meaningful and lasting impressions. These advancements demonstrate AR's capacity to go beyond static museum exhibits, transforming cultural heritage into an interactive, educational, and widely accessible domain. By incorporating AR into preservation efforts, societies can ensure that cultural knowledge remains relevant, vibrant, and engaging for future generations.

2.4 Comparison between The Existing Application and The Proposed Project

Application/ System	Chef Umami (Yang, 2018)	The Cooking Food Simulator (Munawar, 2020)	BrainPOP (BrainPOP, 1999)	Kulinaria (Mardhiyyah et al., 2023)	Ma' Ugiz (Yulia et al., 2018)	sAR Kitchen (Ghasemi et al., 2023)	Interactive Recipe Book (for Corona Guest Farm) (Bischof et al., 2018)	Proposed Project
Augmented Reality Features	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Cultural Focus	No	Minimal	Basic	Yes (Indonesian Cuisine)	Yes (Sundanese Cuisine)	No (Culinary Training)	Yes (Namibian Cuisine)	Yes (Iban Cuisine)
Content	Interactive AR cooking game	Interactive AR cooking game	General knowledge kids' education	Cultural Preservation	Nutrition education for teenagers	Cooking task performance	Enhancing traditional recipe books with AR	Cultural Preservation and Fun Learning
Target Audience	Public	Public	Kids (8-14 years old)	Culinary Student	Teenagers	Culinary Student	Public	Non-Iban
Preservation of Cultural Knowledge	No cultural context	Contain only limited traditional cuisine recipes	Provide basic culture knowledge	Highlights cultural significance	Preserve Sundanese culinary traditions	Lab-based testing, lacks real-world applicability with limited cultural depth	Preserve Namibian cultural heritage	Preserves Iban culinary heritage

Table 2.1 Comparison between The Existing Applications and Proposed Project

Table 2.1 shows the comparative analysis of existing applications and the proposed AR-based project for preserving Iban cuisine. The table evaluates key aspects, including augmented reality (AR) features, cultural focus, content, target audience, and preservation of cultural knowledge. Existing applications like Chef Umami and Cooking Food Simulator excel in gamified cooking experiences but lack cultural context, making them primarily entertainment focused. Educational platforms like BrainPOP provide general cultural insights but do not integrate AR or culinary elements. Applications such as Kulinaria, Ma' Ugiz, and the Interactive Recipe Book contribute to cultural preservation but are limited to specific regions (e.g., Indonesian, Sundanese, or Namibian cuisines) and often lack linguistic features or interactive learning for broader engagement. sAR Kitchen emphasizes task efficiency but does not incorporate cultural depth or real-world application. The proposed project distinguishes itself by integrating markerless AR technology with cultural insights, interactive 3D models, and linguistic elements. It aims to bridge the gap between cultural preservation and modern interactive learning, offering a comprehensive and immersive experience tailored to a diverse audience, particularly non-Iban users.

The existing applications and works reviewed for this project exhibit notable strengths in leveraging technology, particularly augmented reality (AR), to enhance learning and engagement in culinary contexts. Applications like Chef Umami and Cooking Food Simulator successfully create interactive experiences through 3D models and gamified cooking, making them engaging and user-friendly. Tools like Ma' Ugiz and Kulinaria highlight cultural elements, bringing traditional cuisines to life using AR. Meanwhile, sAR Kitchen demonstrates how AR can be utilized for practical, real-world culinary training, emphasizing usability and task efficiency. These strengths showcase the potential of AR to transform how users engage with cooking and cultural learning.

However, several weaknesses are also evident in these applications. Most notably, many tools lack a deep cultural immersion or specific focus on preserving traditional heritage, limiting their educational value. For instance, while Ma' Ugiz and Kulinaria incorporate cultural aspects, they are narrowly tailored to Sundanese and Indonesian cuisines, respectively, and fail to cater to a broader cultural audience. Similarly, Chef Umami and Cooking Food Simulator focus primarily on entertainment rather than education, offering little to no cultural or historical context. Other applications, like Interactive Recipe Book, miss opportunities to incorporate linguistic features or hands-on AR interactions, which are vital for fully engaging users in a culturally rich experience. Additionally, many of these tools are constrained by

limited testing or audience reach, which affects their applicability and adaptability in diverse settings. By identifying these strengths and weaknesses, the proposed project addresses existing gaps by offering an AR-based application that balances cultural preservation, culinary education, and immersive technology. By incorporating features such as pronunciation guides, step-by-step AR-based cooking simulations, and detailed cultural insights into Iban cuisine, this project provides a more comprehensive and engaging learning experience tailored to the needs of the target audience.

While digital preservation tools offer considerable benefits, numerous challenges must be addressed to ensure their effectiveness in preserving the Iban culinary heritage. One major challenge is the lack of structured documentation for traditional Iban cooking techniques, such as cooking in bamboo (Pansuh) or preparing dishes like Sup Salai Terung Asam. These methods are primarily passed down orally or through hands-on practice, making them difficult to preserve in a structured and accessible format. Additionally, existing digital resources like YouTube, Instagram or even TikTok provide passive, one-way learning experiences, where users watch videos without actively engaging in the cooking process. This limits their ability to retain knowledge or connect with the cultural context of the dishes. Furthermore, AR technology can be resource-intensive and may not work seamlessly on all devices. Users with older or less powerful smartphones may face difficulties running the AR application, limiting its accessibility. Non-Iban users also often lack access to Iban culinary knowledge due to geographical and cultural barriers. These challenges highlight the need for a more interactive, accessible, and culturally immersive approach to preserving Iban cuisine.

To address these challenges, the proposed AR-based application applied markerless AR technology to create an engaging and interactive learning experience. Unlike passive video platforms, the app allows users to interact with 3D models of ingredients and cooking tools, simulating traditional cooking processes in real time. This hands-on approach enhances knowledge retention and makes learning more effective. The app also integrates cultural storytelling, providing insights into the historical significance of each dish, such as the role of Pansuh Ikan Sultan in Iban celebrations. To ensure accessibility for non-Iban users, the app is designed with a user-friendly interface and includes interactive features that cater to a diverse audience. Additionally, the application is optimized for Android devices with ARCore support, ensuring compatibility with a wide range of smartphones. By using markerless AR, the app eliminates the need for physical markers, simplifying the user experience and making it more accessible.

Application/ System	Chef Umami (Yang, 2018)	The Cooking Food Simulator (Munawar, 2020)	BrainPOP (BrainPOP, 1999)	Kulinaria (Mardhiyyah et al., 2023)	Ma' Ugiz (Yulia et al., 2018)	sAR Kitchen (Ghasemi et al., 2023)	Interactive Recipe Book (for Corona Guest Farm) (Bischof et al., 2018)	Proposed Project
Augmented Reality Type	None	None	None	Marker-based AR	Marker-based AR	Marker-based AR	Marker-based AR	Markerless AR
Cultural Representation	Very low	Low	General	High (Indonesian Cuisine)	High (Sundanese Cuisine)	None	High (Namibian Cuisine)	High (Iban Cuisine)
Interaction Type	Gamified	Gamified	Passive	Interactive	Interactive	Task-based	Passive	Hands-on
Linguistic Integration	None	None	Basic language info	Medium	Medium	None	Some native terms	High
Immersion Level	Low	Medium	Medium	Medium	Medium	Low	Low	High
Educational Value	Very low	Low	Medium	Medium	High	High	Medium	High
Accessibility	High	High	High	Medium	Low - Medium	High	Low-Medium	Medium-High
Engagement and Curiosity	Medium	Medium	Medium	Medium	Medium-High	Low	Low	High

Table 2.2 Comparative Matrix Based on Cultural Dimension

Table 2.2 above introduces a structured set of dimensions used to evaluate the capabilities and gaps in each system to strengthen the comparative review of existing applications and emphasize the systems approach towards cultural preservation. These dimensions are specifically chosen to align with and preserve Iban culinary heritage through immersive, accessible, and educational means.

A set of eight dimensions has been defined to help methodically judge how culturally relevant and technologically sound each application is. These dimensions show the main ideas of preserving culture, interacting with users, and making education effective. The first dimension, AR Technology Type, tells you if the system has augmented reality and what kind it is (marker-based, markerless, or not at all). This impacts how realistic and useful it is. Cultural Artefact Representation looks at how deep and real traditional things like dishes, utensils, and rituals are shown. The Interaction Type checks how involved the user is, from just watching to doing interactive simulations or real-life activities. Linguistic Integration looks at if the app has native terminology, dialects, or pronunciation hints that can help keep a culture's language alive. Immersion Level, on the other hand, looks at the quality of the stories, the depth of the visuals and sounds, and the environmental cues that pull users into the cultural experience.

When looking at educational value, think about how much content there is in terms of learning goals, including guided instructions and built-in tests. System Accessibility is how well the software works on different devices and how many people can use it, especially those with different levels of technical skill. Finally, User Engagement & Cultural Curiosity measures how the app affects people's emotions and how much it makes them want to learn more about other cultures. This is generally based on feedback and reflection after using the app. These aspects were very helpful in the comparison study and in deciding what the goals of the proposed app should be.

2.4.1 Mapping Dimensions to Cultural Preservation Goals

Each cultural dimension directly helps to keep traditional cultural and culinary knowledge alive. The AR Technology Type dimension makes things more genuine and encourages people to get involved, which helps them learn about traditional traditions more engagingly. Cultural Artefact Representation makes sure that the Iban cuisine's particular equipment, procedures, and looks are shown in a way that is true to life, preserving its cultural

value. Interaction Type lets users learn by doing, which helps them remember what they've learned. Linguistic Integration helps keep the Iban language alive by using native words and pronunciations throughout the encounter. Immersion Level makes the emotional and aural connection to the cultural environment stronger, while Educational Value gives you structured ways to learn and test your knowledge. Accessibility makes the cultural content available to more people, no matter what their level of technical knowledge is. Finally, Engagement & Curiosity keep users interested, which encourages them to keep learning about and appreciating Iban culture. By connecting these areas to the goals of cultural preservation, the proposed project provides a complete and culturally relevant learning experience.

2.4.2 Implications for Proposed Project (NyamaiAR)

The results show that a lot of current apps are either too general or don't have enough cultural depth. Some include AR or interactive elements, but very few look at cultural learning as a whole. For example, Chef Umami and Cooking Simulator let users play games, but they don't give any cultural background. BrainPOP is all about general education and passive involvement. Kulinaria and Ma' Ugiz are both culturally rich, but their AR format or narrow language range makes them less useful. NyamaiAR fills in these gaps by adding markerless AR, which makes interaction more fluid and immersive. The software has culturally specialized foods like Dabai, Pansuh, and Terung Asam. It also supports the Iban language and has guided instructions, gesture-based controls, and quizzes. The design focuses on making it easy to use and getting people very involved, even for people who don't speak Iban. This meets both educational and emotional purposes. This analysis shows that NyamaiAR not only overcomes the constraints of current digital technologies but also goes beyond them by using a systematic, educationally sound strategy that connects AR technology with cultural values.

2.5 Summary

This chapter has explored the role of digital tools, particularly Augmented Reality (AR), in the preservation and promotion of culinary and cultural heritage. It highlighted how AR can transform traditional cooking methods into interactive and immersive learning experiences, making cultural knowledge more accessible and engaging. The written reviews demonstrate different aspects of AR’s potential in culinary education and cultural preservation. Thus, Key insights include the effectiveness of AR in providing hands-on, interactive learning

experiences that go beyond traditional methods like videos or written recipes. Applications like sAR Kitchen and the Interactive Recipe Book have shown how AR can enhance user engagement, reduce cognitive load, and provide cultural context, making the learning process more meaningful. However, challenges such as content creation, accessibility, and maintaining cultural authenticity were also identified.

The review identified specific gaps that this research aims to fill, particularly the need for a more culturally immersive and comprehensive approach to preserving Iban cuisine. Unlike existing applications, this project will integrate AR to not only teach cooking techniques but also provide interesting content of Iban cuisine, thereby offering a deeper understanding of the cultural significance behind Iban dishes. In Chapter 3, the methodology of this project will be detailed, including how AR will be integrated into preserving Iban cuisine and evaluating its effectiveness. This will involve the development of AR content, user interaction design, and the assessment of educational outcomes, ensuring that the project meets its goals of cultural preservation and education.

Chapter 3: Methodology

3.1 Introduction

This chapter presents the methodology employed for developing the AR-based mobile application aimed at preserving and promoting Iban traditional cuisine. The Waterfall methodology was selected due to its structured and sequential approach, ensuring each phase is thoroughly completed before progressing to the next. The chapter details the stages of the development process, including requirement analysis, system design, implementation, testing, and maintenance. Each phase is meticulously outlined to demonstrate how the project objectives are met, emphasizing the integration of tools and technologies essential for creating an engaging and culturally significant application.

3.2 Proposed Architecture

The design architecture of this project illustrates how different components interact to deliver the intended functionalities of the AR-based mobile application. It focuses on creating an engaging and seamless user experience while ensuring the system effectively integrates user input, AR technologies, and content management. The architecture consists of several components. These components are interconnected to support the core features of the

application, including interactive AR cooking activities, 3D model visualization, video playback, and survey integration.

A flowchart helps in understanding the sequence of processes within a system. For the proposed project, the flowchart visually represents the application's workflow, outlining the user's journey from opening the app to completing a cooking activity. As shown in Figure 3.8 below, the flowchart outlines the list and sequence of activities users will engage with. The process begins with the user launching the application, represented by the "User Opens App" step. Upon entering the app, the user will go to the homepage and get started to let the user go to choosing a dish they wish to learn from the app's menu, which includes options like Pansuh Ikan Sultan, Sup Salai Terung Asam, and Buah Dabai.

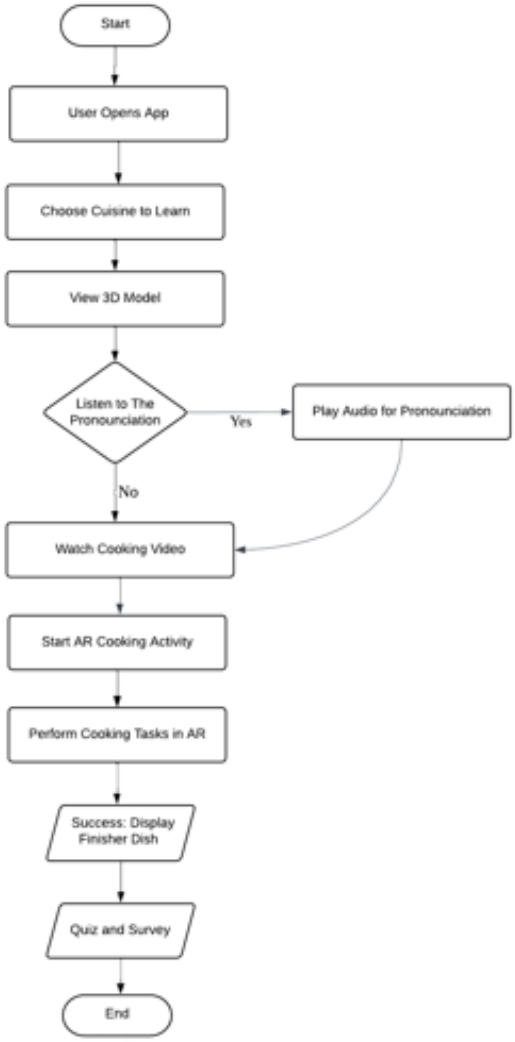


Figure 3.1 Flowchart of Proposed Project

Figure 3.2 Iban Cuisines that will be used in the Project

Those cuisines mentioned can be shown in Figure 3.2 above, to show examples of selected Iban cuisines in this project, and how the dish looked like before implementing AR technology. The first picture is Pansuh Ikan Sultan, the next is Sup Salai Terung Asam, and the third picture is Buah Dabai.

After choosing a cuisine, the user proceeds to view the 3D model picture of the selected dish first and learn about some dish insights, then they can decide whether they want to listen to the clickable audio pronouncing the dish in the Iban language or skip the option. Next, users will watch a step-by-step cooking video tutorial, providing them with a clear demonstration of the preparation process. The user then moves to the core feature of the app: the AR cooking activity. In this stage, the app transitions to AR mode, allowing the user to perform interactive cooking tasks based on the recipe listed and allowing users to interact with the 3D models. Upon successful completion of these tasks, the app displays a success message and lets the user see the finished 3D model dish in AR. Finally, the user can move to the Quiz section before answering the System Usability Scores Survey for the last part of the app testing. This quiz and survey evaluate the effectiveness of the AR learning experience and collect feedback to assess user satisfaction. The flow concludes with the "End" step, marking the completion of the user's interaction with the app. This flowchart effectively highlights the structured and engaging journey users undertake while interacting with the app, ensuring both educational and interactive elements are seamlessly integrated.

Client Side

On the client side, the User interacts with the application through the User Interface (UI) on an Android mobile device. The interface serves as the main access point for all features, including:

- Viewing 3D model pictures of Iban dishes alongside cultural insights.
- Watching cooking video tutorials.
- Participating in markerless AR cooking activities.

The AR Engine (powered by Unity and ARCore) processes user interactions in the AR environment. It detects flat surfaces and enables markerless AR features gestures such as

dragging the ingredients, as dish steps of preparation. The engine retrieves the required 3D assets from the 3D Model Repository, ensuring smooth rendering and interaction.

Server Side

The system includes integration with external tools for specific functionalities:

- Google Form: Embedded in the QR code and will be shown on the interface. This form allows data collection from users for System Usability Scores after using the application.
- Video & Audio Module: Stores and delivers step-by-step instructional videos and audio clips for Iban pronunciation guides.

Flow of Interaction

The typical flow begins with the user interacting with the app via the UI. Depending on the activity selected:

- The AR Engine manages the AR functionalities.
- The video module plays instructional content.
- The system delivers and evaluates the in-app quiz based on the user's AR activity.
- The mobile device acts as the platform for executing all features.

The project eliminates the need for external markers by focusing on a markerless AR approach, ensuring greater flexibility and user convenience. This architecture simplifies the process by managing all assets locally on the device or through lightweight external integrations.

The complete flow of interaction in NyamaiAR begins the moment the user launches the app. The user is greeted with a culturally themed welcome screen where they can tap "Get Started" to begin their journey of discovering Iban cuisine. From there, users are taken to the dish collection interface, where three traditional Iban dishes are featured: Buah Dabai, Sup Salai Terung Asam, and Pansuh Ikan Sultan. Upon selecting a dish, the user is directed to a dish information page that includes a representative 3D model of the dish, a description of its

origin and ingredients, and interactive features such as clickable fun fact buttons. Additionally, there is an option to play a short audio clip of the dish's name being pronounced in the Iban language.

Once users are familiar with the background, they proceed to the tutorial section, where all ingredients are visually listed, followed by a complete step-by-step cooking video made from scratch. After watching the video, users can start the AR Activity by first reading the instructions provided in the Hint button. Then, they open the "Recipe Book" button and begin surface detection using their device camera to find a yellow plane. Once a surface is detected, users follow the instructions to click the 3D models listed buttons at the bottom of the screen in order from left to right. These buttons guide them through the sequence of cooking steps. As the AR session starts, users spawn 3D models of ingredients or utensils onto the plane and perform cooking simulations by interacting with the AR objects—using gestures such as dragging, rotating, and scaling to mimic real-life cooking techniques.

Each step follows the recipe instructions, and upon completing all stages of the simulation, users spawn the Dish Finisher to reveal the final completed 3D version of the selected Iban cuisine dish. The experience concludes with an in-app quiz consisting of questions related to the specific dish's ingredients and cooking steps, followed by a prompt to scan a QR code linking to a Google Form containing the System Usability Scale (SUS) survey. This final step helps gather user feedback and assess the effectiveness of the application in preserving and educating users about traditional Iban culinary heritage.

3.3 Waterfall methodology

The Waterfall methodology is a traditional software development approach characterized by its linear and sequential structure. Each phase of the development process is completed before moving on to the next, ensuring a clear and systematic workflow. This methodology is well-suited for projects with clearly defined requirements, such as the AR-based mobile application for Iban cuisine cooking, as it emphasizes thorough documentation and planning at each stage. The following paragraphs detail how each phase of the Waterfall model was applied to this project.

The first phase is Requirement Analysis. During this phase, the project's purpose, objectives, and scope were established by gathering all necessary information. A survey

involving 30 non-Iban participants was conducted to assess their familiarity with Iban cuisine, their interest in learning traditional cooking methods, and their preferences for interactive learning tools. This survey provided valuable insights into user needs, which were then used to define the functional and non-functional requirements of the application. Proper analysis during this phase ensures the app aligns with user expectations, addresses knowledge gaps in Iban culinary heritage, and provides an engaging platform for cultural preservation.

The System Design phase translated the insights from Requirement Analysis into actionable plans for the application's development. This phase involved defining the system architecture, creating diagrams to represent user interactions, and designing a user-friendly interface. Key outputs of this phase include a Use Case Diagram illustrating how users interact with the app, a Use Case Scenario outlining specific workflows, and a Flowchart showing the logical flow of activities. Additionally, a System Design Architecture was created to represent the technical structure of the app, alongside detailed interface designs for key screens such as the Home Screen, Quiz Screen, Cuisine Selection Screen, Cuisine Details Screen, and AR Activity Screen. This phase ensured that the app's design is both logical and visually appealing, while aligning with the project's educational and cultural objectives.

The Implementation phase focused on the actual development of the application. Based on the finalized designs, the app was developed using Unity, with ARCore integrated to provide markerless AR functionality. The 3D models of ingredients use for Iban dishes, and tools were created and embedded into the app to enable interactive AR cooking activities. Additionally, the user interface was implemented to ensure smooth navigation between screens, providing a seamless experience for users. This phase aimed to transform the conceptual designs into a functional prototype that adhered to the system design and met the identified user requirements.

The Testing phase ensured that the application met its functional and non-functional requirements while delivering a reliable user experience. This phase involved rigorous testing to validate the app's performance, usability, and compatibility. Unit testing was conducted to verify individual features, such as AR interactions and 3D model rendering, while integration testing ensured seamless functionality across different components. Usability testing was performed with non-Iban participants to evaluate the app's cultural appropriateness, engagement, and ease of use. Compatibility testing further ensured the app's smooth operation across various Android devices, guaranteeing an optimal experience for users.

The Deployment phase focused on releasing the application for testing and use. For this project, the app was pre-installed on a dedicated Android device to facilitate controlled usability testing without requiring users to download and install it independently. This approach ensured a streamlined evaluation process, allowing for focused feedback collection and refinement. After validating the application through this controlled deployment, it will be prepared for broader distribution, ensuring accessibility and cultural relevance.

Finally, the Maintenance phase ensures the application remains functional and up to date after deployment. This phase involves addressing user feedback, resolving any technical issues, and introducing updates or new features as needed. For this project, planned maintenance activities include periodic updates to ensure compatibility with Android and ARCore updates, refining features based on user feedback, and potentially expanding the app's content with additional Iban dishes or cultural insights. These efforts aim to maintain the app's relevance and effectiveness over time.

In conclusion, the Waterfall methodology provides a structured and systematic approach to the development of the AR-based mobile application for Iban cuisine cooking. By progressing through distinct phases, the methodology ensures that the app is thoroughly planned, carefully developed, and rigorously tested, resulting in a high-quality educational platform that promotes and preserves Iban culinary heritage.

3.3.1 Requirement Analysis

The Requirement Analysis phase is a critical component of the project methodology, focusing on identifying and understanding the user needs and technical requirements necessary to develop the proposed AR-based mobile application for Iban cuisine cooking. This phase ensures the application aligns with the target audience's preferences while meeting the project's goals of preserving and promoting Iban culinary heritage through engaging and interactive technology. By understanding the needs of the target audience, this analysis forms the foundation for the application design and development. Through careful assessment, this phase aims to bridge the gap between the cultural richness of Iban cuisine and modern technological tools.

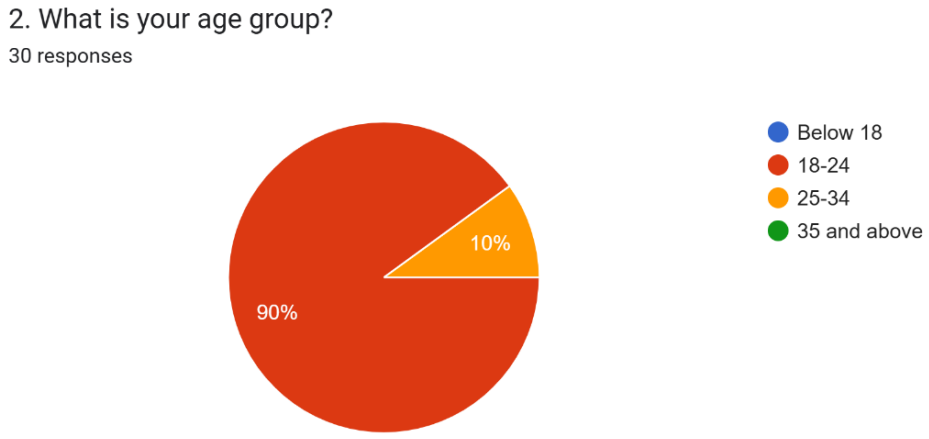


Figure 3.3 Age Distribution of Respondents

A survey involving 30 respondents, primarily non-Iban individuals, was conducted to assess their familiarity with Sarawak culture, their interest in learning Iban cuisine, and their preferences for interactive learning tools. The survey targeted young adults, with 90% of respondents aged 18-24 years and 10% aged 25-34 years, as shown in Figure 3.1 above. This focus ensures the application is designed to appeal to a digitally savvy audience.

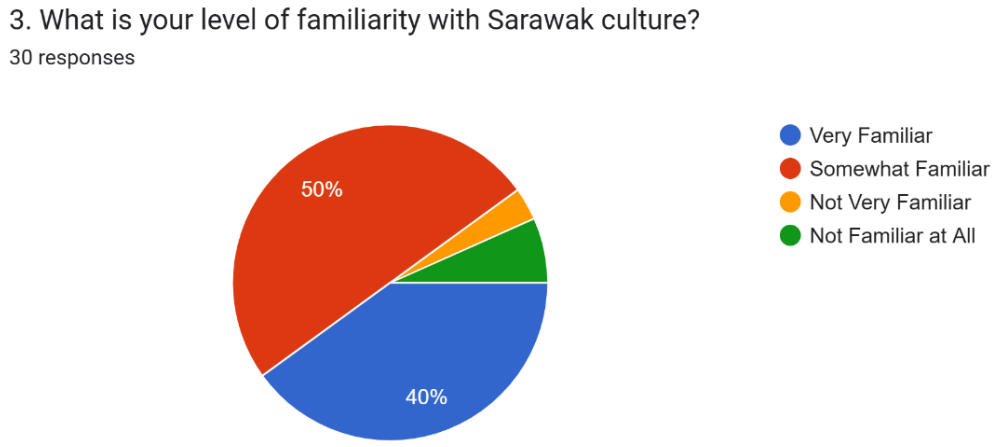


Figure 3.4 Level of Familiarity with Sarawak Culture

Based on Figure 3.2, most respondents (90%) indicated a level of familiarity with Sarawak culture, with 40% describing themselves as "Very Familiar" and 50% as "Somewhat Familiar." A smaller percentage of respondents reported being "Not Very Familiar" (6.7%) or "Not Familiar at All" (0%). These findings highlight a solid foundational interest in Sarawak culture,

suggesting that the target audience already possesses some contextual understanding of the region, which can enhance their engagement with the app's content. However, the variation in familiarity levels emphasizes the need for the app to cater to both highly familiar users and those with limited exposure. Incorporating cultural insights about Iban cuisine in the app will address knowledge gaps while enriching the understanding of users less familiar with Sarawak's traditions. This dual approach ensures the app serves as both an educational tool and an enga'Ing platform for cultural preservation.

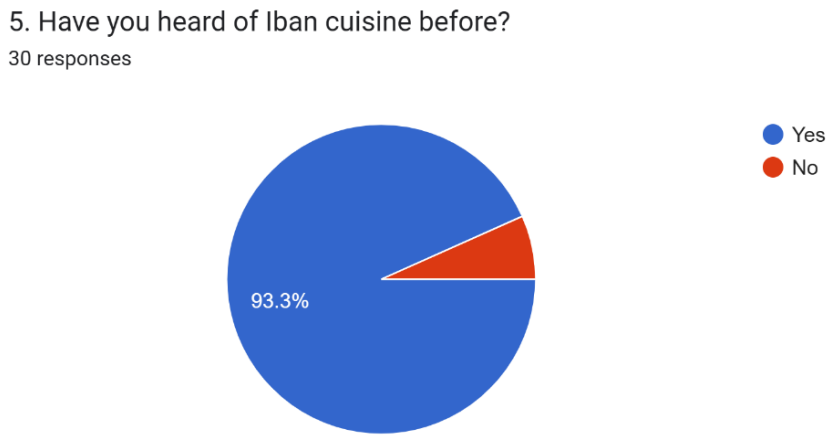


Figure 3.5 Awareness of Iban Cuisine Among Respondents

As shown in Figure 3.3, 93.3% of respondents had heard of Iban cuisine, while 6.7% were unfamiliar with it. Although awareness of Iban cuisine is high, this does not necessarily translate to an in-depth understanding of its specific dishes or preparation methods. This underscores the need for the application to provide detailed insights into Iban cuisine, including its cultural significance and cooking techniques.

Moreover, most respondents were introduced to Iban cuisine through friends or family (89.3%) and cultural events or festivals (85.7%). Social media also played a significant role (67.9%), followed by travel to Sarawak (46.4%). These findings highlight the importance of leveraging personal and cultural connections in promoting Iban cuisine. The app can extend this reach by incorporating shareable content such as video tutorials and interactive AR features, ensuring users can connect with and promote Iban culinary traditions across various platforms.

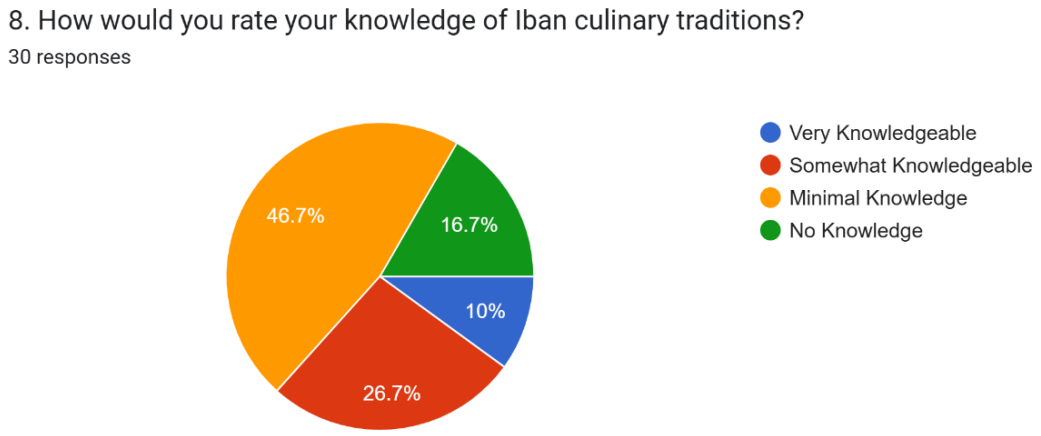


Figure 3.6 Knowledge of Iban Culinary Traditions

According to Figure 3.4, 46.7% of respondents rated their knowledge of Iban culinary traditions as "Minimal Knowledge," and 16.7% reported "No Knowledge." Only 10% considered themselves "Very Knowledgeable," while 26.7% felt "Somewhat Knowledgeable." This significant knowledge gap highlights the importance of designing the app by providing contextual info about Iban dishes, including their origins, cultural significance, and preparation methods as it not only teaches cooking techniques but also can serve as an educational tool for individuals with minimal exposure while also deepening the understanding of those interested in learning more by addressing this gap.

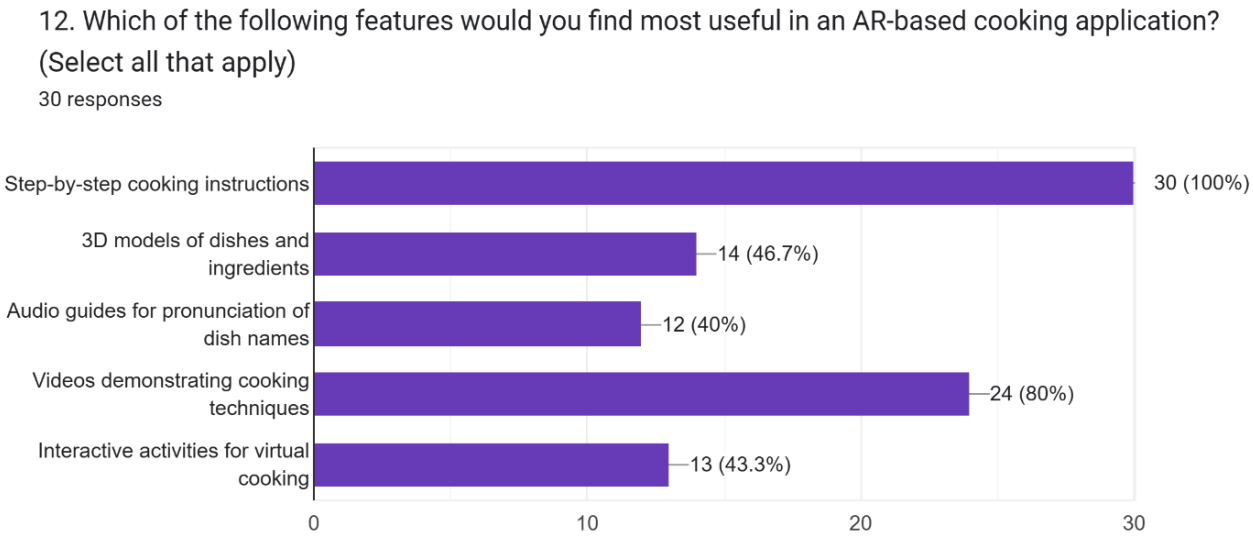


Figure 3.7 Most Useful Features Found in an AR-Based Cooking Application

As shown in Figure 3.5, respondents identified several features they find essential. Step-by-step cooking instructions were the most preferred, selected by 100% of respondents, emphasizing the need for clear and structured guidance. Videos demonstrating cooking techniques were favored by 80%, highlighting the importance of visual aids in learning. Additionally, 3D models of dishes and ingredients were chosen by 46.7%, while audio guides for dish name pronunciation and interactive activities for virtual cooking were preferred by 40% and 43.3%, respectively. These preferences support the inclusion of multiple features in the app, such as interactive AR simulations, realistic 3D models, and audio-visual aids, to create an engaging and practical learning experience. By addressing these user preferences, the app can deliver a comprehensive and effective educational platform.

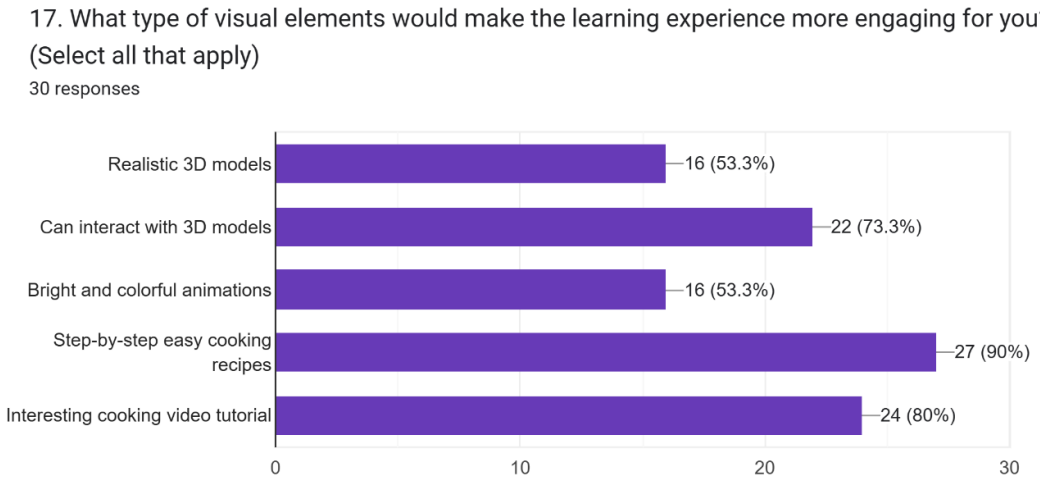


Figure 3.8 Preferred Visual Elements for Enhancing Engagement

Based on Figure 3.6, respondents expressed a strong preference for step-by-step easy cooking recipes (90%) and interesting cooking video tutorials (80%). Interactive 3D models were favoured by 73.3% of respondents, while realistic 3D models and bright, colourful animations were chosen by 53.3%. These insights reinforce the importance of integrating realistic and interactive 3D models, video tutorials, and step-by-step recipes into the app. These features align with user preferences and ensure the app delivers a visually rich, interactive learning platform tailored to various learning styles.

The insights gained from the Requirement Analysis phase were instrumental in defining the technical and functional requirements of the proposed application. With a clear understanding of user needs and preferences, the next step involves identifying the necessary hardware and software requirements to support the development and operation of the AR-based mobile application. These requirements are crucial to ensure compatibility, smooth performance, and an engaging user experience.

3.3.2 Hardware Requirements

The development and implementation of the AR-based mobile application require specific hardware to ensure smooth operation and compatibility. Table 3.1 below shows the following hardware components that were identified for this project.

Hardware	Descriptions
Laptop	Laptop will be used for programming, app development, AR integration, and testing in Unity. The specifications needed are as below: • Intel Core i5 or higher • 8GB RAM • 256GB SSD • NVIDIA GeForce GTX 1050 • Window 10 or later operating system
Smartphone (Android)	Smartphone will be used for testing the application during development to ensure proper AR interactions and usability. The specifications needed are as below: • Android version 8.1 or higher • ARCore support • Gyroscope and accelerometer for AR functionality. • 4GB RAM • 64GB of Storage • Minimum 8MP camera with autofocus
iPad Pro 2018 (Apple)	iPad will be used for creating 3D models of traditional Iban dishes and tools using the Forger app, in cases where pre-made models are unavailable or when custom models are required. Stylus pen is needed in sculpture. The specifications needed are as below: • Processor: A12X Bionic chip. • Display: 11-inch or 12.9-inch Liquid Retina Display. • Storage: Minimum of 256GB

Table 3.1 Hardware Requirements

The selected hardware requirements for Android smartphones support the implementation of markerless AR, a technology that eliminates the need for physical markers, offering a more intuitive and seamless user experience. By leveraging ARCore, the application enables users to interact with virtual elements directly on detected flat surfaces, such as tables or floors. This approach ensures accessibility and reduces complexity, as users can engage with the AR features without requiring additional materials or setups.

3.3.3 Software Requirements

The software tools used in this project are critical for designing, developing, and testing the AR-based application. The following software components were identified for this project as shown in Table 3.2 below.

Software	Descriptions
Unity Engine	Acts as the primary development platform for the mobile application, supporting AR development through the AR Foundation framework.
Nomad Sculpt	Used for sculpting and creating custom 3D models of Iban dishes and cooking tools. Models created in Nomad Sculpt can be exported in compatible formats for integration into Unity.
Polycam	A 3D scanning app used to capture and generate realistic 3D models of cooking tools and dishes for integration into the AR environment.
Sketchfab/ TurboSquid	Online repositories for sourcing pre-made 3D models of cooking tools, dishes, or other elements that may be difficult to create from scratch.
AR Foundation	Unity's AR Foundation package, supports markerless AR via ARCore (Android) to provide AR features, including environment detection and interaction functionalities.
Visual Studio	Used to implement interactive features, app logic, and user interface functionalities using C# scripting
Capcut	Used to edit cooking videos into clear, step-by-step instructional clips.
Voice Memos	Used to record and edit audio for Iban pronunciation guides and other sound effects.
Canva/Figma	Used for UI design elements and enhancing visual appeal.

Table 3.2 Software Requirements

The integration of ARCore for markerless AR functionality provides a user-friendly experience by utilizing advanced environment detection capabilities. This technology detects

flat surfaces and anchors virtual objects in real-world spaces, making it easier for users to interact with the application. Markerless AR aligns with the project's goal of engaging younger audiences by eliminating the dependency on physical markers, which could otherwise limit usability and accessibility.

3.3.4 Use Case Diagram

The use case diagram provides a visual representation of how the user interacts with the proposed AR-based application for Iban cuisine cooking. It highlights the core functionalities of the app, including completing surveys, viewing cultural insights, watching cooking videos, engaging in AR cooking activities, and a quiz activity. This diagram ensures a clear understanding of the user's interactions and the system's key components, as shown in Figure 3.7 below.

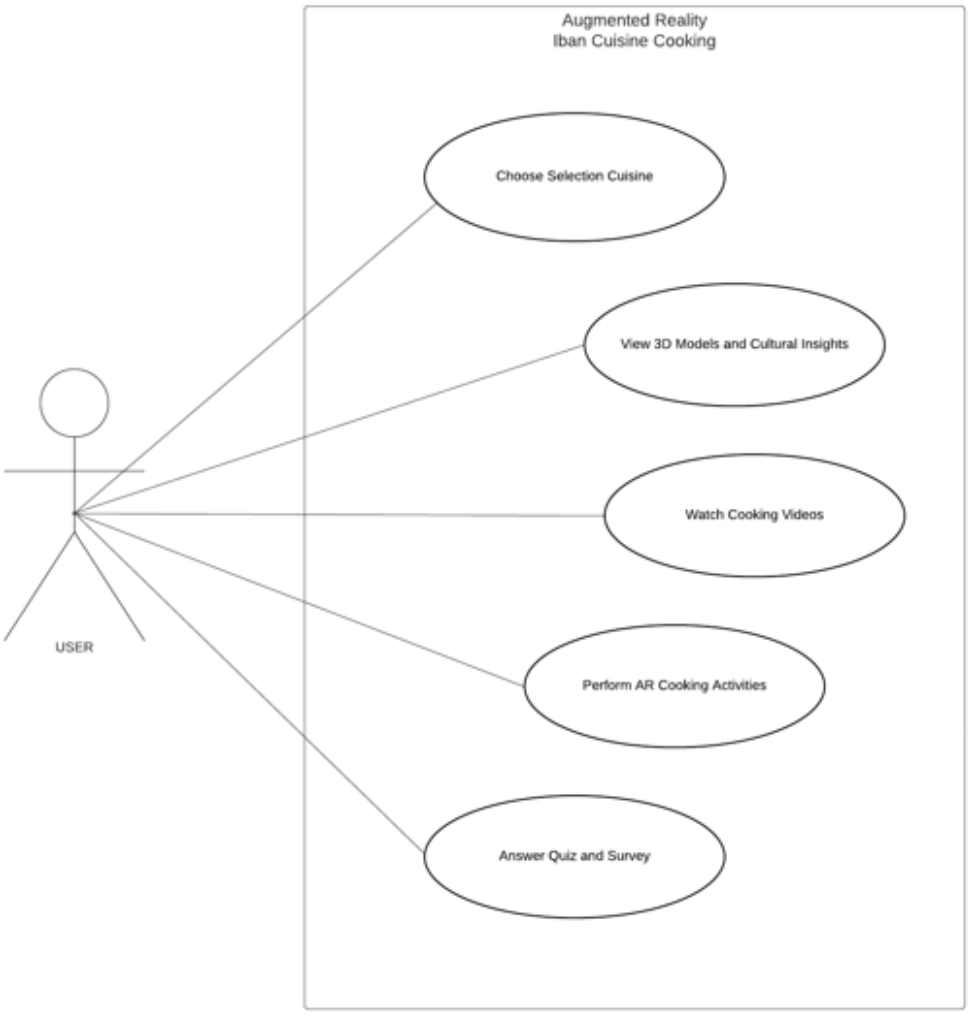


Figure 3.9 Use Case Diagram for Proposed Project

3.3.5 Use Case Scenario

The use case scenarios outline the detailed interactions between the user and the proposed AR-based application for Iban cuisine cooking. Each scenario represents a specific functionality, such as choosing a selection cuisine, exploring cultural insights, watching cooking videos, performing interactive AR cooking tasks, and answering the quiz and survey feedback. These scenarios ensure a comprehensive understanding of how the application meets user needs and achieves its objectives.

Table 3.3 below shows the use case scenario for the user to select the dish collection.

Use Case	Dish Selection
Goal in Context	To allow the user to choose an Iban dish to explore and begin the learning process.
Primary Actor	User
Description	The user selects one of the available Iban dishes to begin learning about its background, ingredients, and cooking process.
Precondition	The app is installed, and running
Success end Condition	The app navigates to the selected dish's information screen.
Failed End Condition	If the selection fails, the app displays an error or does not proceed.
Trigger Event	User clicks on a dish option from the collection screen.
Main Flow	1. User opens the app and navigates to the collection screen. 2. User clicks on one of the available dish buttons (e.g., Buah Dabai, Sup Salai Terung Asam, or Pansuh Ikan Sultan). 3. The app loads the dish detail screen, showing the dish description, image, and further options.
Extensions	If the screen fails to load, an error message prompts the user to try again or restart the app.

Table 3.3 Use Case for Dish Selection

Table 3.4 below shows the use case scenario for the user viewing 3D models and cultural insights, outlining the activities involved and potential limitations.

Use Case	View 3D Models and Cultural Insights
Goal in Context	To provide cultural knowledge and context about Iban dishes
Primary Actor	User
Description	User selects a dish to explore a 3D model and read cultural insights.
Precondition	The app is running, and the user selects a dish from the menu.
Success end Condition	User successfully views the 3D model and reads cultural insights.
Failed End Condition	The app fails to load the 3D model or display cultural information.
Trigger Event	User clicks on a dish from the main menu.
Main Flow	1. User selects a dish from the menu. 2. The app displays the 3D model and cultural insights below it. 3. User reads the information and explores the model.
Extensions	The app includes optional audio playback for dishes name.

Table 3.4 Use Case for Viewing 3D Model and Cultural Insights

Table 3.5 below shows the use case scenario for the user watching cooking videos, detailing the step-by-step process and conditions for success.

Use Case	Watch Cooking Video
Goal in Context	To teach users the preparation steps for Iban dishes.
Primary Actor	User
Description	User watches a detailed step-by-step cooking video for the chosen dish.
Precondition	User has selected a dish and has access to internet for video streaming.
Success end Condition	Video plays successfully, and the user understands the preparation steps.
Failed End Condition	Video fails to load, and the user cannot proceed.
Trigger Event	User clicks the “Watch Cooking Video” button.
Main Flow	1. User selects the video button. 2. The app plays the step-by-step cooking video. 3. Below the video, the app displays an audio button for pronunciation and a textual guide. 4. User completes watching the video.
Extensions	If the video fails, the app prompts the user to check their internet connection.

Table 3.5 Use Case for Watching Cooking Video

Table 3.6 below shows the use case scenario for the user performing AR cooking activities.

Use Case	Perform AR Cooking Activities
Goal in Context	To allow users to practice cooking using AR interactions.
Primary Actor	User
Description	User interacts with virtual tools and ingredients to simulate the cooking process.
Precondition	AR camera is functioning, and a flat surface is detected.
Success end Condition	User successfully completes the cooking tasks.
Failed End Condition	AR fails to load, or tasks cannot be completed.
Trigger Event	User clicks "Start AR Activity."
Main Flow	1. User selects the AR cooking activity. 2. The app detects a flat surface and places virtual objects. 3. User performs cooking tasks (e.g., stirring, adding ingredients). 4. App validates each task and progresses to the next step. 5. A success message is displayed upon completion.
Extensions	If AR fails to load, the app provides troubleshooting tips.

Table 3.6 Use Case for AR Cooking Activities

Table 3.7 below shows the use case scenario for the user answering the Quiz and Survey.

Use Case	Answer Quiz and Survey
Goal in Context	To evaluate the user's understanding of the AR cooking activities and gather usability feedback.
Primary Actor	User
Description	After completing all AR cooking activities, the user answers a 10-question quiz followed by a usability survey to evaluate their learning and app experience.
Precondition	All AR dish activities have been completed.
Success end Condition	User completes the quiz and submits their SUS form via the Google Form link.
Failed End Condition	Quiz or survey fails to load or submit due to connection or system error.
Trigger Event	User clicks the "Start Quiz" button after finishing all AR activities.
Main Flow	1. User completes AR activities for all dishes. 2. User is directed to the quiz screen. 3. User answers 10 multiple-choice questions based on their AR experience. 4. After the quiz, user sees their score.

	5. User scans the provided QR code to access the SUS survey in Google Form. 6. User fills in nickname, quiz score, gender, and submits SUS feedback.
Extensions	If the survey is skipped, the app reminds the user of its purpose for improving future versions.

Table 3.7 Use Case for Answering Quiz and Survey

3.3.6 User Interface Design

The user interface (UI) design of the proposed AR-based mobile application prioritizes a visually engaging and user-friendly experience. Each screen has been carefully crafted to guide users through the learning process of Iban cuisine, ensuring intuitive navigation and interactive features aligned with the project's objectives. The interface includes five main screens: the Home Screen, Survey Screen, Cuisine Selection Screen, Cuisine Details Screen, and AR Activity Screen. These screens combine simplicity and interactivity to create an immersive learning environment.

The visual theme of the app draws inspiration from Pua Kumbu, a traditional handwoven textile that holds profound cultural significance in Iban society. The background and decorative elements feature patterns inspired by Pua Kumbu, while the app's color palette reflects the strength, vitality, and harmony symbolized in Iban culture. This integration not only enhances the visual appeal but also deepens the cultural connection for users, bridging modern technology with Iban heritage.

Figure 3.10 Process of making the Pua Kumbu pattern (I Love Borneo, n.d.)

Figure 3.10 above illustrates the intricate process involved in creating Pua Kumbu patterns, which are renowned for their unique designs and cultural significance. Pua Kumbu patterns vary widely as it reflect different myths, stories, and spiritual beliefs of the Iban community. Its intricate designs are deeply symbolic, often rooted in Iban myths, legends, and spiritual traditions. Beyond their decorative value, the patterns are imbued with protective and symbolic meaning, elevating Pua Kumbu to a sacred art form. Historically, it has been used in ceremonies and rituals for healing, blessings, and protection, showcasing its importance in cultural and spiritual practices (I Love Borneo, n.d.). Incorporating Pua Kumbu elements into the app reflects the rich storytelling and spiritual legacy of the Iban people as the colours predominantly feature shades of maroon, and red, ranging from light to deep and strong tones, symbolizing strength, vitality, and bravery.

Colors of Pua Kumbu

The color palette of Pua Kumbu is derived from natural dyes, often sourced from plants, which further ties its design to the Iban community's connection with nature.

- **Red**: A prominent color symbolizing strength, bravery, and vitality.
- **Earth tones** (e.g., brown and cream): Reflect harmony, balance, and a deep connection to the environment.

These colours, paired with intricate patterns, elevate Pua Kumbu as both a functional textile and an artistic masterpiece. By subtly incorporating these design elements into the app's interface, the project pays homage to Iban heritage while maintaining a cohesive and culturally rich design. This approach ensures the UI not only meets the functional needs of the app but also resonates with its cultural preservation goals.

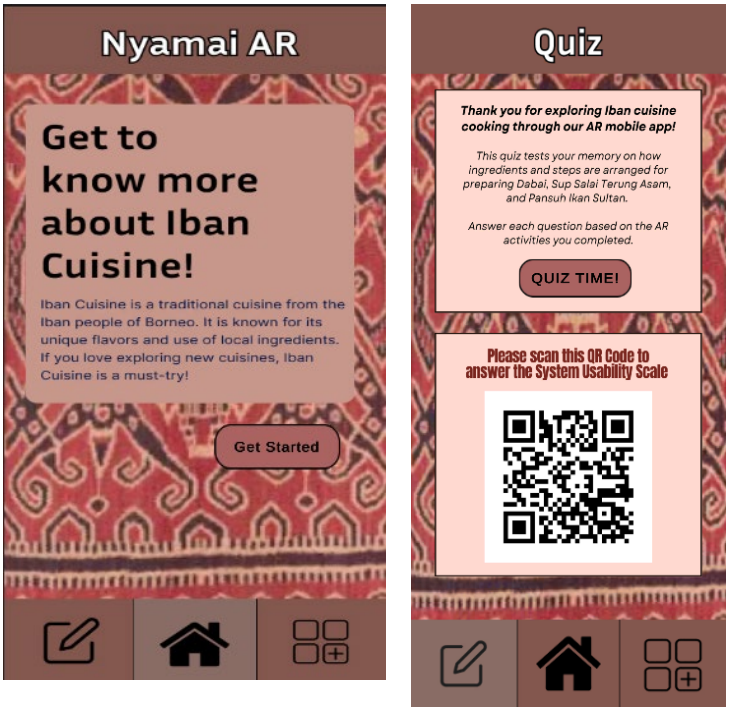


Figure 3.11 Home, Quiz & Survey Screen of Nyamai AR

Home Screen

The Home Screen serves as the first point of interaction for users, introducing the application's purpose and connection to Iban cuisine. As shown in Figure 3.10, the top of the screen displays the app's name, which is Nyamai AR, followed by a brief description: *"Get to know more about Iban Cuisine!"* The interface design is kept minimal and welcoming, with a prominent "Get Started" button to guide users to the next step.

Quiz and Survey Screen

The Quiz and Survey Screen is the final section of the NyamaiAR application, where users complete a short quiz and submit their feedback, as shown in Figure 3.11. After finishing all AR cooking activities, users are directed to this screen, which includes the following features:

- **Start Quiz Button**: Launches a 10-question multiple-choice quiz designed to test the user's understanding of the ingredients and cooking steps they learned through the AR activities. The quiz provides immediate feedback by displaying the user's score at the end.
- **Survey QR Code**: After the quiz, users are prompted to scan a QR code that links to a Google Form. This form collects additional feedback through a System Usability Scale (SUS), along with the user's nickname, quiz score, and gender.

This screen helps assess both the learning outcome and overall usability of the app, ensuring that user experience data is gathered for future improvements.

Figure 3.12 Cuisine Selection and Cuisine Details Screen

Cuisine Selection Screen

The Cuisine Selection Screen, illustrated in Figure 3.12, enables users to choose from three available dishes: Pansuh Ikan Sultan, Sup Salai Terung Asam, and Buah Dabai. Each dish is represented by a clickable box with an accompanying image or icon. This screen is designed to engage users by presenting visually appealing options for exploration.

Cuisine Details Screen

The Cuisine Details Screen, as illustrated in Figure 3.13, provides a comprehensive and interactive overview of the selected dish. At the top of the screen, the name of the cuisine is prominently displayed, followed by a static 3D model of the dish. To enhance user engagement and cultural learning, the screen includes a playable audio feature that provides the correct pronunciation of the dish's name in Iban. Additionally, a section dedicated to cuisine insights offers a brief description of the dish's cultural significance and its key ingredients. The next screen will feature an embedded video tutorial as shown in Figure 3.13 below with step-by-step of the cooking process for the dish, accompanied by a recipe list above the video for quick and easy reference. Lastly, a clickable "AR Activity" button is located at the bottom of the screen, allowing users to seamlessly transition to the AR Activity Screen. This screen combines

educational content with interactive features, offering users a rich and immersive learning experience.

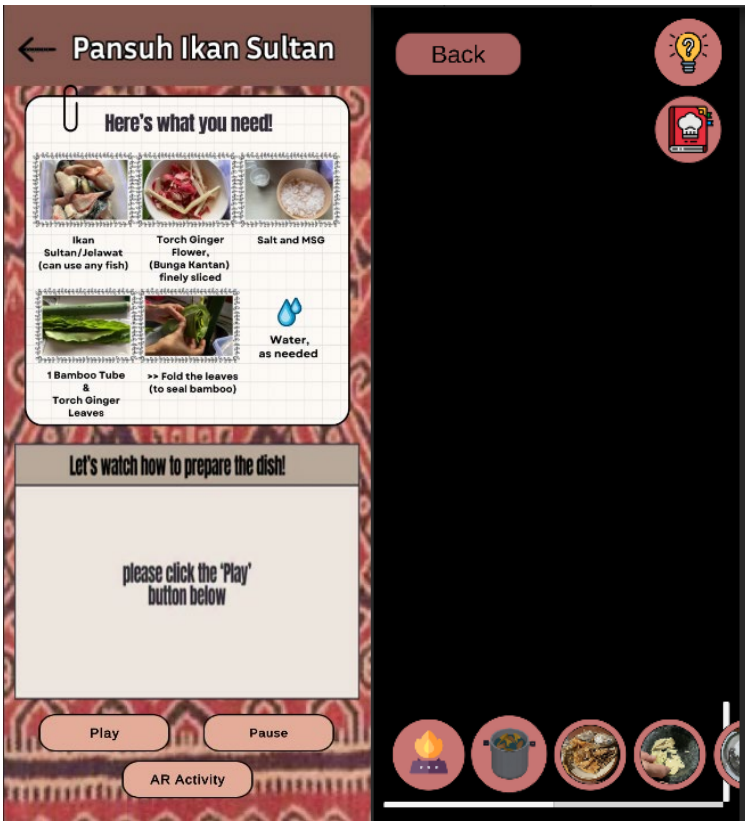


Figure 3.13 Video and AR Activity Screen

AR Activity Screen

The AR Activity Screen, as shown in Figure 3.14, immerses users in interactive cooking tasks using markerless AR technology. This screen features an AR Camera View, which utilizes the device's camera to detect flat surfaces and anchor virtual objects. At the top of the screen, instruction text guides users through each recipe step, such as "Add ingredients to the bamboo," ensuring clarity and ease of use. Interactive 3D models, including virtual cooking tools and ingredients, are displayed on the detected surface, allowing users to engage directly with the cooking process. Upon completing a task, users will be notified with completion messages such as "Step Completed!". This screen seamlessly bridges virtual and real-world interactions, delivering an engaging and immersive user experience. The interface design prioritizes user engagement, accessibility, and cultural education. By integrating interactive elements such as 3D models, audio guides, video tutorials, and markerless AR activities, the application provides a comprehensive platform for learning and preserving Iban's culinary heritage. The clear and

intuitive layout of each screen ensures users can easily navigate the app, fostering an enjoyable and educational experience.

3.4 Implementation

The implementation phase focuses on developing the NyamaiAR application based on the finalized design and actual workflow of the project. This stage involves turning ideas and prototypes into a working AR-based mobile application, followed by several cycles of testing and refinement to ensure it meets the project's objectives and user expectations.

The development process began with setting up the environment using Unity, integrating AR Foundation and ARCore for markerless augmented reality capabilities. The app is developed specifically for Android devices and tested on a Samsung A14 5G phone. The core implementation included building functional scenes such as the homepage, dish selection screen, dish info pages, cooking video screens, AR activity scenes, and the quiz and survey section.

The key highlight of the implementation is the markerless AR cooking activity, where users can place 3D models of ingredients and kitchen tools on real-world surfaces. Users interact with the models using gestures like dragging, rotating, and scaling to simulate cooking steps based on simplified traditional recipes. Although there are no animated actions, users experience an interactive learning process by imitating the preparation steps.

Other features implemented include:

- Video Playback of cooking tutorials recorded and edited by the developer.
- Audio Playback of dish name pronunciations in the Iban language.
- A 10-question Quiz that evaluates user memory after AR activities.
- A Survey Section linked via QR code to a Google Form that collects feedback using the System Usability Scale (SUS).

Each feature was iteratively tested and refined to ensure smooth performance and ease of use. The implementation emphasized accessibility, cultural authenticity, and educational value.

3.5 Testing

Testing was a crucial part of the development to ensure the app functions correctly and delivers an engaging and educational experience. The application was deployed directly onto an Android test device to conduct in-person user testing, which allowed close observation of user behavior and performance.

A group of 30 non-Iban students was invited to test the full application, from selecting a dish and watching the cooking video, to performing the AR activities, completing the quiz, and submitting the final survey. Users were first guided through the initial setup and shown how to begin AR interaction using the yellow plane for object placement.

The following aspects were tested:

- **Functionality**: Verifying that each button, video, AR activity, and quiz question worked as expected.
- **AR Performance**: Checking surface detection in various lighting conditions and the responsiveness of gesture-based interactions.
- **Ease of Use**: Observing how quickly users understood instructions and interacted with 3D models.
- **Quiz Effectiveness**: Measuring how well users could recall cooking steps and ingredients after using the app.

Some users initially struggled with understanding the hint instructions or detecting the AR plane, especially in areas with poor lighting. However, once they completed the first AR scene, most users were able to continue with minimal guidance. Lag in video playback was observed occasionally, especially after switching from AR mode, but restarting the scene usually resolved the issue.

The final SUS survey helped gather user feedback on usability, and most participants reported finding the app useful, easy to use, and culturally informative.

3.6 Maintenance

The maintenance phase ensures that NyamaiAR remains functional, relevant, and compatible with evolving technologies and user expectations even after its initial development. Although the current version is a working prototype, several areas have been identified for ongoing updates and improvements.

First, regular bug fixes and performance optimization are planned to address minor issues such as occasional video lag or inconsistencies in AR plane detection. These adjustments will help enhance the smoothness of user interaction, especially during AR activities. In terms of compatibility, the app will be monitored and updated to remain fully functional with newer versions of Android, Unity, and ARCore, ensuring long-term stability.

Next, future updates may include the addition of more traditional Iban dishes, allowing users to explore and learn about a broader range of cultural recipes. Feature enhancements are also considered, particularly the inclusion of more interactive elements such as cooking animations and realistic sound effects to make the learning experience even more immersive and engaging.

Finally, feedback gathered through the System Usability Scale (SUS) surveys will be reviewed regularly to guide improvements in usability and overall user satisfaction. With these efforts, the maintenance phase will ensure that NyamaiAR continues to grow into a comprehensive and meaningful educational tool for promoting Iban culture through interactive technology.

3.7 Summary

The AR-based application for preserving and promoting Iban cuisine was developed using the Waterfall Methodology, which provided a structured and sequential framework for project execution. Each phase of the methodology which consists of Requirement Analysis, Design, Implementation, Testing, and Maintenance was clearly defined, ensuring smooth progression and clarity throughout the development process. Requirement analysis involved collecting and analyzing user needs through a survey distributed via Google Forms, with 30 respondents to shape the app's features and functionalities. The design phase involved creating the project architecture and workflow. These tools provided a detailed representation of user interactions and system functionalities. In the implementation phase, the app's core functionalities were built, focusing on a user-friendly interface that incorporated cultural insights, interactive 3D models, and step-by-step cooking guides. Markerless AR technology

was implemented to enable immersive cooking activities, allowing users to engage with virtual tools and ingredients. The app also has quiz section and SUS survey to assess its effectiveness in enhancing users' knowledge retention. Lastly, the maintenance phase provides a strategy for ongoing updates and support to ensure the app remains relevant, functional, and aligned with user needs. Overall, this project demonstrates how augmented reality can be effectively leveraged as a tool for cultural preservation. By combining education and technology, the application provides an engaging platform to promote Iban cuisine, bridging traditional culinary practices with modern interactive learning. The following chapter will detail the implementation of the proposed project.

Chapter 4 Implementation

4.1 Introduction

This chapter presents the implementation phase of NyamaiAR, which transforms the initial design into a working prototype. The implementation focuses on how each part of the system has been built based on the proposed design framework, including how the assets, interactions, and user experience were developed. It begins with the setup of the development environment, followed by the creation and integration of 3D models, user interface (UI) designs, augmented reality (AR) features, videos, and audio. This chapter also explains how each scene of the application was implemented, ending with the quiz section and System Usability Scale (SUS) integration for user feedback.

4.2 Development Environment Configuration

Setting up the development environment was a crucial first step in the implementation phase of NyamaiAR. It involved preparing both the software and hardware tools required to build, test, and run the application effectively. Given that NyamaiAR utilizes markerless Augmented Reality, a solid and compatible development configuration was essential to ensure accurate tracking, real-time interactions, and optimized rendering performance. This section explains the software setup, AR frameworks integration, and the devices used during development.

4.2.1 Unity Engine and Build Setup

The core development of NyamaiAR was carried out using Unity version 2022.3.11f1. Unity was chosen because of its strong support for AR development, real-time rendering capabilities, and ease of integration with external AR frameworks like AR Foundation and ARCore. Unity's cross-platform flexibility also made it possible to build the application primarily for Android devices, while leaving room for potential iOS deployment in the future. To begin, a new 3D project was created to accommodate the AR requirements. Several essential packages were then installed using the Unity Package Manager:

- **AR Foundation 5.1.6** – A cross-platform framework that supports both ARCore (Android) and ARKit (iOS).
- **Google ARCore XR Plugin 5.1.6** – Enables access to ARCore functionalities such as plane detection and raycasting.

- **XR Interaction Toolkit 2.5.4** – Supports user interactions like drag, rotate, and scale in an AR environment.

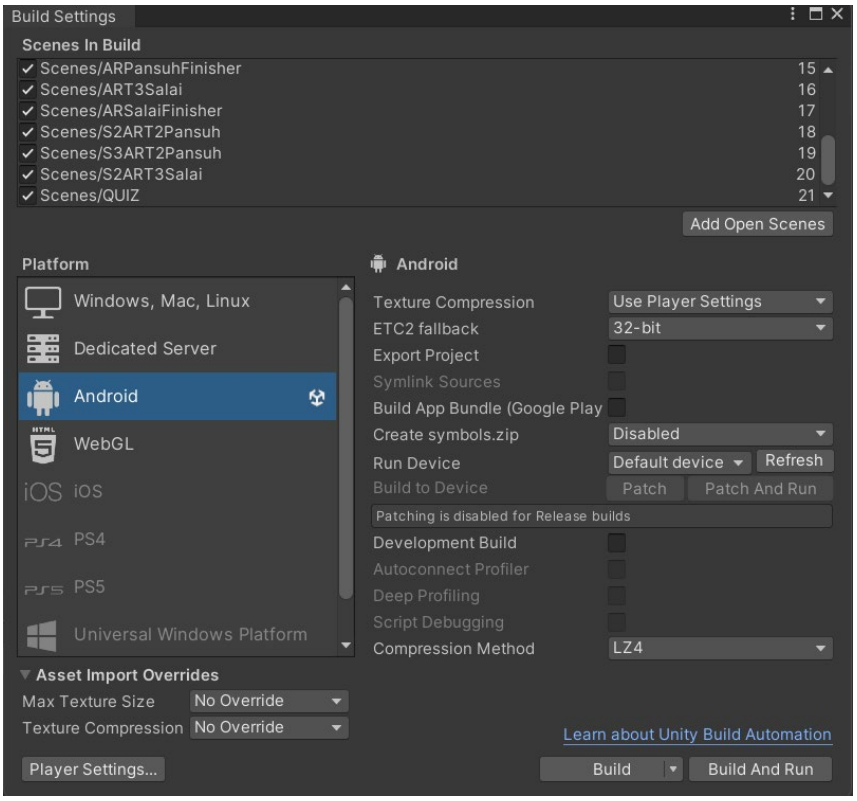


Figure 4.1 Interface for Build Settings

Figure 4.2 Google ARCore XR Plugin used

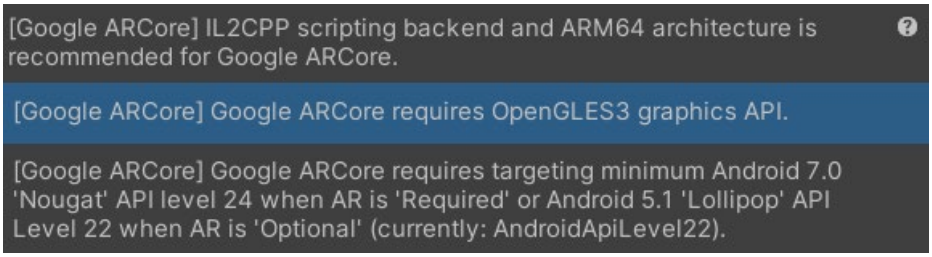


Figure 4.3 Requirements to set up the Google ARCore

The Build Settings were configured with Android as the target platform, as shown in Figure 4.1 above. The scripting backend was set to IL2CPP, and the API compatibility level was adjusted to meet the requirements of ARCore, as mentioned in Figure 4.3. The ARCore option was enabled in the XR Plug-in Management settings to ensure compatibility with AR-enabled Android devices. To ensure performance consistency, the build settings were tested and adjusted using the Samsung A14 5G, which served as the primary development and testing device. The screen resolution of 1080x2408 pixels provided a reliable display for testing UI layout, model rendering, and AR interactions.

4.2.2 AR Foundation & XR Toolkit Setup

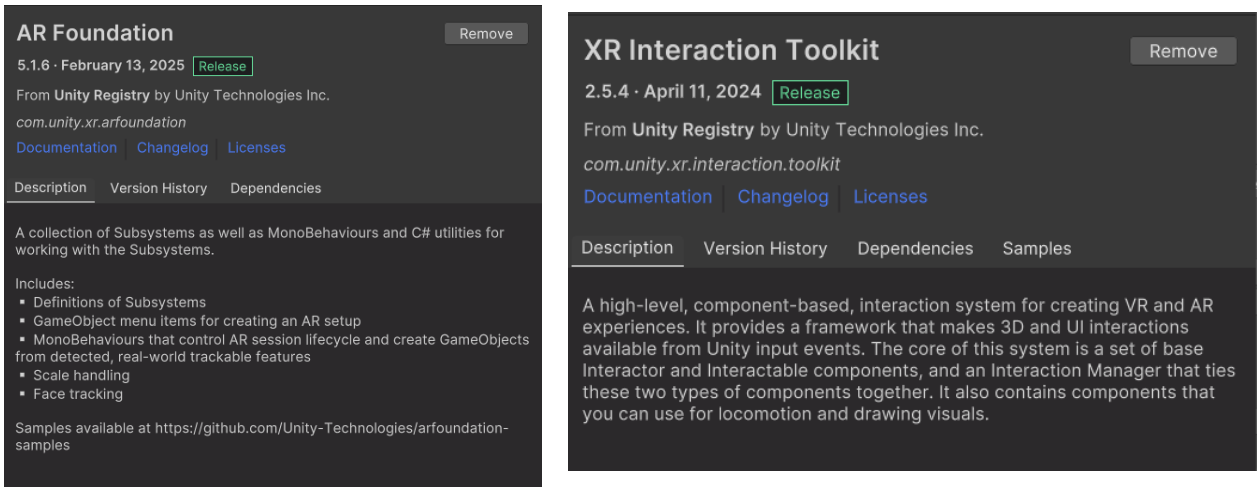


Figure 4.4 AR Foundation and XR Interaction Toolkit used in Unity

Figure 4.4 shows the packages used in this project. With the AR Foundation framework in place, the necessary AR components were added to the Unity scene to support surface detection and object placement. This included:

- **AR Session**: Manages the lifecycle of the AR experience.
- **XR Origin**: Contains the AR Camera and defines how virtual content is rendered relative to the physical world.
- **AR Plane Manager**: Enables detection of flat surfaces in the real environment.
- **AR Raycast Manager**: Allows users to interact with real-world points and anchors.

Additionally, the XR Interaction Toolkit was integrated to enable intuitive gesture-based interactions within the AR environment. This toolkit extends Unity's capabilities by translating screen touches into meaningful AR gestures, such as placing, selecting, translating, rotating, and scaling virtual objects. To support these interactions, an XR Interaction Manager was added to the scene to manage communication between AR components.

The Main Camera was configured with an AR Gesture Interactor, which allowed for natural user input: single-finger drag to move objects, two-finger gestures to rotate them, and pinch gestures to scale. These interactions were mapped to the AR interactables, enabling users to manipulate 3D content as if they were part of the physical world. **Furthermore,** to maintain a clean and immersive interface, the XR Interactor Line Visuals were disabled for both the left and right controllers. This design decision removed unnecessary UI clutter, helping users focus on the AR content and interactions without visual distractions.

4.2.3 Target Device and Performance Optimization

The implementation of NyamaiAR relied on three key hardware devices to support various stages of development and deployment: mobile testing, 3D asset creation, and Unity development. Each device played a specific role to ensure the app performed reliably and met the desired user experience goals.

6) Samsung A14 5G

This Android smartphone was used as the primary test device for deploying and running NyamaiAR. With a screen resolution of 1080x2408 pixels and support for ARCore, the Samsung A14 5G offered a reliable platform to test AR interactions, object placements, UI responsiveness, and overall usability. It also helped verify that the app functions well on mid-range Android devices, representing the typical performance level of most users' phones.

b) iPad Pro 2018 (Apple)

The iPad Pro 2018 served a different but critical role in the development process. This device was used for creating high-quality 3D models of traditional Iban dishes and kitchen tools using the Nomad Sculpt app. With I12X Bionic chip, stylus (Apple Pencil) support, and high-resolution Liquid Retina display, it enabled precise sculpting, painting, and texturing. These 3D assets were then exported in FBX format and later imported into Unity for integration into the AR scenes.

c) Laptop

All Unity-based development, coding, and debugging were carried out on a personal laptop. This device was used to configure Unity settings, manage scripts, organize scenes, and test build performance before deploying to mobile devices. It served as the main workstation throughout the app development cycle, handling tasks such as script compilation, package integration (AR Foundation, ARCore), UI design implementation, and initial play mode testing.

Performance Optimization Measures

To ensure optimal performance, several measures were taken during development:

- UI layouts and images were designed to scale across various screen sizes.
- 3D models were optimized by reducing polygon count and adding colliders only where necessary.
- Video resolutions were configured to match the target device's playback capabilities to prevent lag.
- Real-time AR interactions were tested for accuracy and smooth response, especially when handling object manipulation like dragging, rotating, and scaling.

4.3 Asset Preparation

4.3.1 3D Models Creation

To build an immersive AR experience, various 3D models representing dishes, ingredients, and kitchen tools were developed. Two primary tools were used:

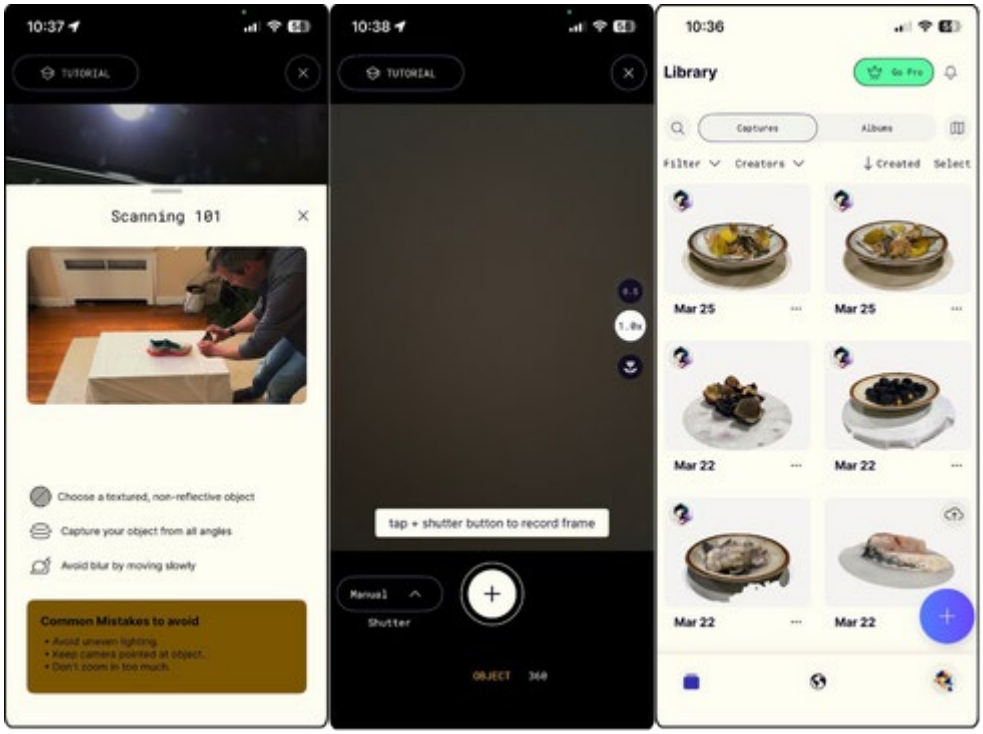


Figure 4.5 Process of Converting the Dishes into 3D models

6) **Polycam:** This app was used to scan real traditional Iban dishes and convert them into accurate 3D models as shown in Figure 4.5. The scanning process required capturing the dish from multiple angles under even lighting to avoid shadows and noise. The resulting models were cleaned and exported in FBX format for integration into Unity. This approach allowed the app to present authentic visual representations of the food.

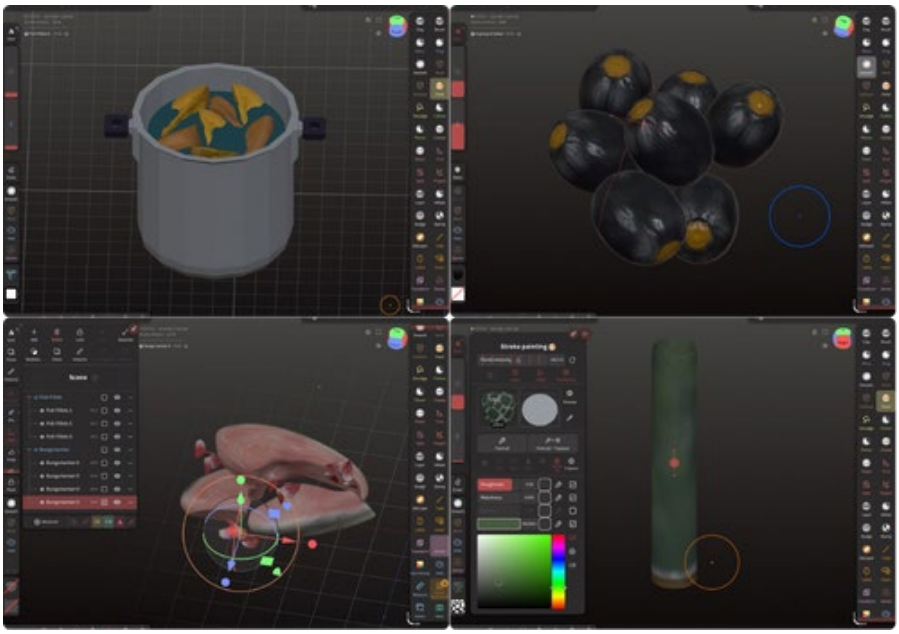


Figure 4.6 Example of 3D Models Sculpting Process in Nomad Sculpt

b) Nomad Sculpt (on iPad Pro 2018): This sculpting app was used to sculpt detailed and custom models of cooking ingredients such as fish, vegetables, and local ingredients as shown in Figure 4.6. The iPad's stylus provided precision for 80icrosoft and painting textures. However, Unity did not preserve these painted colors by default, so a custom vertex coloring script was used to apply the colors as materials. These models were optimized by adjusting the polygon count and applying box colliders to ensure smooth interaction and performance during runtime.

c) External 3D Resources: Additional kitchen tools such as stoves, pots, bowls, firewood, and ladles were sourced from Sketchfab. These models were modified where necessary, reducing their complexity and applying interaction components using Unity scripts such as SetupInteractables.cs.

4.3.2 User Interface and Infographic Design

NyamaiAR was designed with a clean, attractive, and culturally engaging user interface to enhance the user experience. The design process emphasized simplicity, clarity, and interactivity to ensure users could navigate the application smoothly, regardless of their technical background.

Figure 4.7 Ingredients listed Design using Canva

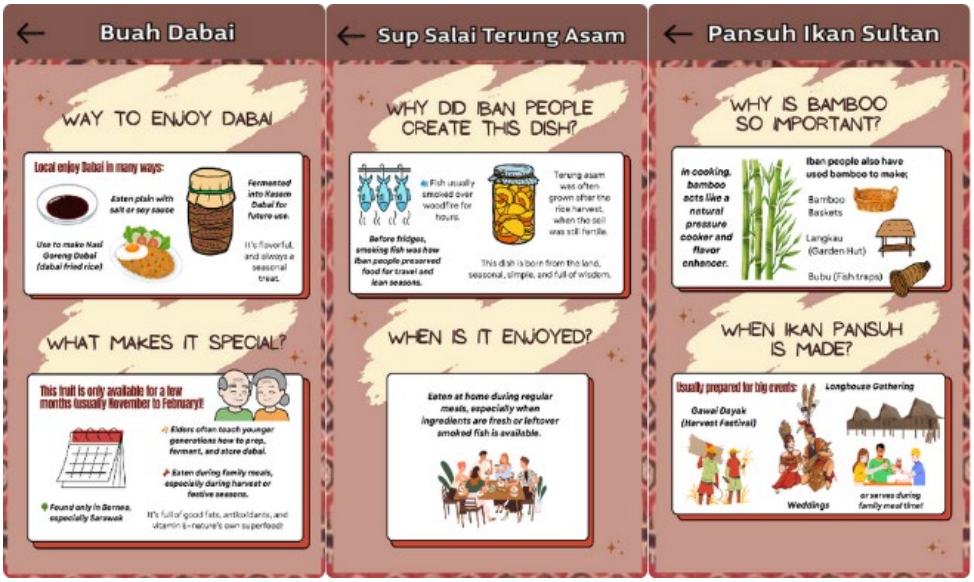


Figure 4.8 Infographics Design for each dish using Canva

6) **Canva:** Canva was primarily used to design static visual elements such as buttons for the interfaces, some of the interface's background like quizzes, infographics, and ingredients about the dishes as shown in Figure 4.7 and Figure 4.8, and custom screen backgrounds. It also served as a tool for creating visual infographics that guide users during the AR activities. For example, instruction cards for a pop-up panel, such as "How to Start AR" and "Gesture Controls," were designed in Canva using clear icons and readable fonts to ensure ease of understanding for first-time users.

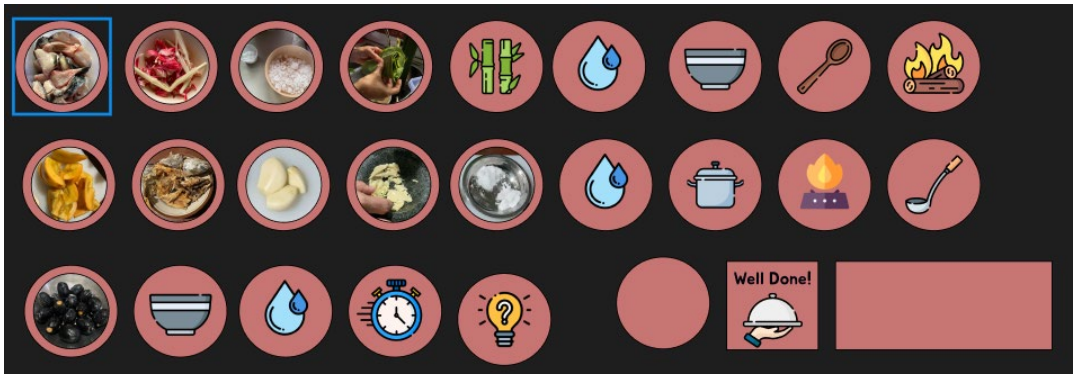


Figure 4.9 Example of Button Design for AR Activity using Figma

b) **Figma:** Figma is also used to build wireframes and full-screen mockups of the homepage, collection screens, individual dish pages, adjusting the colour, and more. Figure 4.9 above shows that the buttons used for AR Activity were made using Figma.

After the design phase, all graphics and UI layouts were exported as high-resolution PNG files. These assets were then imported into Unity and positioned using the Canvas system. This approach ensured pixel-perfect placement and visual consistency across a range of screen sizes and resolutions.

4.3.3 Video and Audio Production

Cooking videos and audio elements played an important role in connecting users to the cultural essence of Iban cuisine. These multimedia components were not just educational tools but also enhanced immersion by showcasing real cooking scenarios with complete cooking tutorials and authentic local pronunciations.

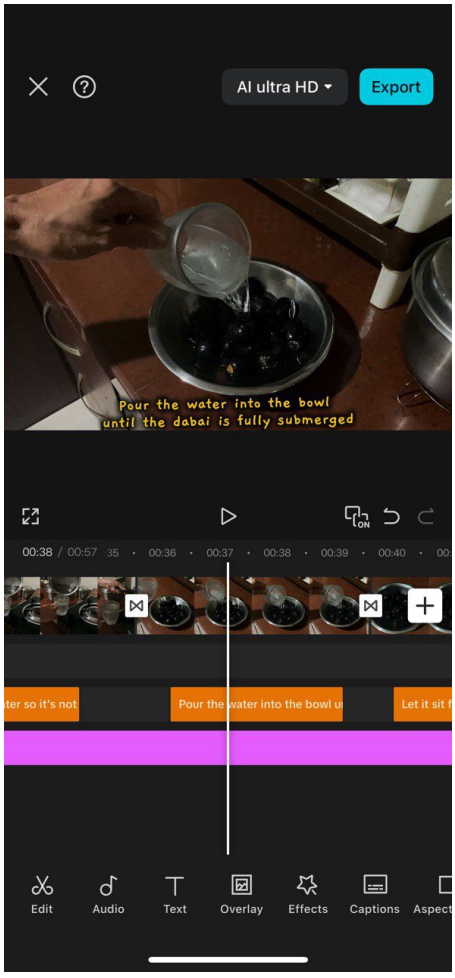


Figure 4.10 Video Editing Process for Dabai Dish using Capcut

6) **Video Recording and Editing:** The cooking tutorials were self-recorded using an iPhone SE 2020. Each video featured the developer's aunt name Betty Anak Entering, preparing traditional dishes step-by-step in a home kitchen setting while she was being

recorded by the developer herself. Care was taken to capture clear visuals, appropriate lighting, and steady framing for clarity. The raw footage was then edited using CapCut as shown in Figure 4.10 above, where unnecessary scenes were trimmed, instructional captions were added, and transitions were smoothed out to maintain user attention. Each video was concise and focused on important preparation steps to avoid overwhelming the viewer.

The final video files were optimized for mobile performance by adjusting resolution and compression settings. They were imported into Unity using the built-in Video Player component. In the cooking video scenes, users could start or pause the video using UI buttons linked to playback controls, enabling a smooth learning experience.

b) **Audio Pronunciation Clips:** To preserve cultural authenticity, pronunciation clips were recorded for each dish name using the Voice Memo app. These audio files helped users learn how to pronounce traditional Iban dishes correctly, promoting not just understanding but also appreciation of the language.

Once recorded, the audio clips were trimmed and cleaned to remove background noise. They were organized according to dish names before being imported into Unity as AudioClips. Dedicated audio buttons were placed on the dish info screens, allowing users to play each pronunciation on demand with a single tap.

4.4 Front-End Implementation

This section details the front-end implementation of NyamaiAR, focusing on the key user interface screens and the interactivity structure built using Unity and supported tools. The flow has been designed to guide users through an educational yet engaging experience with Iban cuisine

4.4.1 Homepage

Figure 4.11 Homepage Screen

Figure 4.11 above shows the homepage screen, which serves as the user's first interaction with NyamaiAR. It features a culturally inspired background with a clear introductory message: "Get to Know More About Iban Cuisine." A brief description below this message introduces the app's purpose. A centrally placed 'Get Started' button enables users to begin their journey. The layout was designed in Figma, exported to Unity, and implemented within a Canvas object to ensure consistency across various screen sizes.

4.4.2 Collection Screen

Figure 4.12 Collections of Iban Dishes

Upon clicking ‘Get Started,’ users are directed to the Collection Screen as shown in Figure 4.12. Here, they can choose from three Iban dishes represented by clickable buttons: Buah Dabai, Sup Salai Terung Asam, and Pansuh Ikan Sultan. Unity’s Button and EventSystem components were used to handle clicks, directing users to their selected dish’s learning screen.

4.4.3 Dish Learning

Figure 4.13 Iban Dishes Infographic sections

According to Figure 4.13 above, the screen educates users about the selected dish. It includes:

- A description of the dish
- A static image of the real dish (captured during development)
- A 'Did You Know?' button showing fun facts in a pop-up
- An audio pronunciation button (top-right corner), which plays Iban voice clips recorded with Voice Memo and imported as AudioClips

These elements help users gain cultural insights before proceeding to the interactive activities. The layout was again structured in Figma and implemented in Unity's Canvas with AudioSource components tied to buttons.

4.4.4 Cooking Video

Figure 4.14 User Interfaces for Video Sections of every Dish

After learning about the dish, users can click ‘Let’s Cook!’ to proceed to a video screen as shown in Figure 4.14 above. This screen includes:

- A list of ingredients with icons, arranged above the video player
- A central video showing the full cooking process
- Play and Pause buttons connected to Unity’s VideoPlayer API

The video was shot using an iPhone SE 2020, edited in CapCut, and compressed to a mobile-friendly format before integration. This section helps bridge the knowledge between traditional recipes and modern learning tools.

4.4.5 AR Activity

Figure 4.15 Pop-up Panels for Instructions and Book Recipe Buttons

Figure 4.16 Example of AR Activity

Each dish has a unique AR Activity scene as examples can be shown through Figure 4.16. Upon entering:

- A yellow plane appears using the AR Plane Manager
- Users are guided via a Hint button on how to interact

- Object buttons below allow users to spawn ingredients and tools on the plane
- A Recipe Book button provides step-by-step cooking instructions

After the user reads the instructions and the recipes provided as a pop-up panel shown in Figure 4.15 above, once objects are spawned, users can interact with them using gestures:

- Drag (1 finger)
- Rotate (2 fingers)
- Scale (pinch)

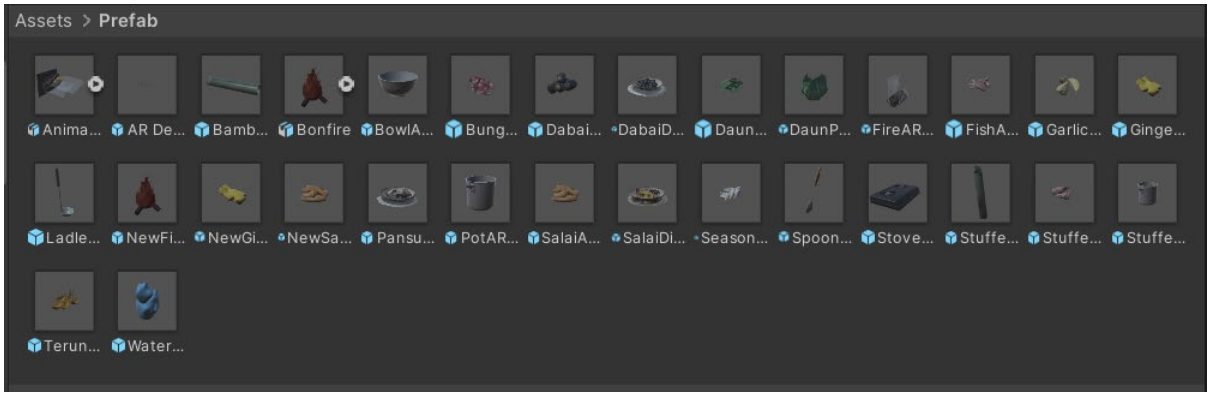


Figure 4.17 Lists of AR Prefabs for 3D Models needed

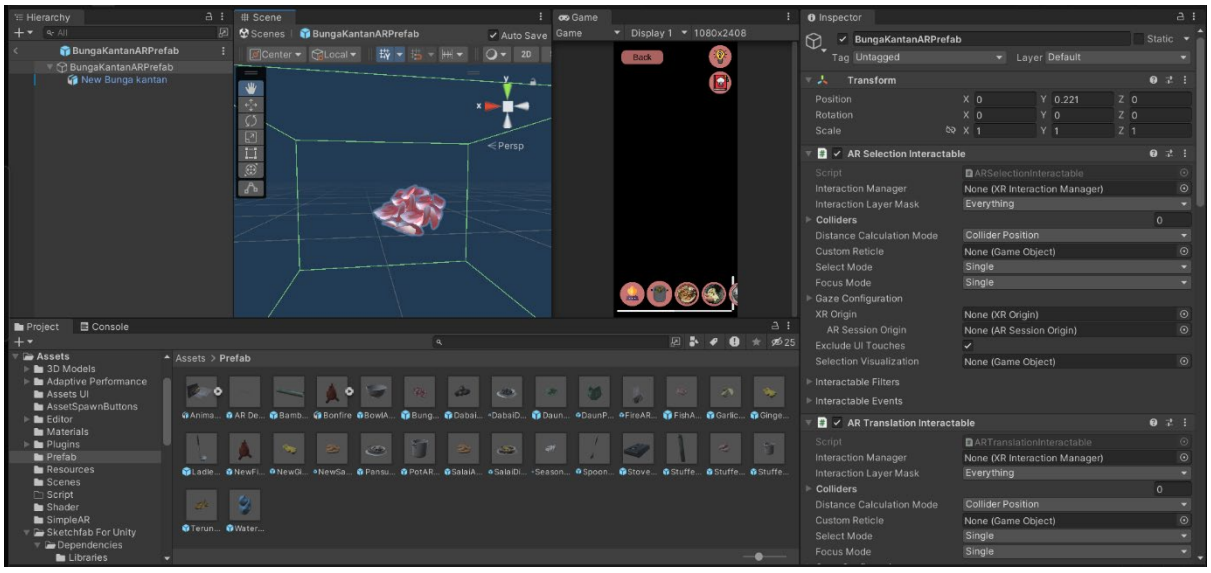


Figure 4.18 Example of Setting up the AR Prefab for the 3D Models

Figure 4.17 above shows the AR Prefabs that have been set up before assigning them to each button. Each AR Prefab will be assigned to the AR Placement Interactable for the spawning function. All the interactions needed are added into the AR Prefab component to allow other Gestures to happen, as shown in Figure 4.18. This is made possible using the AR Foundation framework and the XR Interaction Toolkit. Scripts such as ARPlacementManager.cs, SinglePlacementController.cs, and SetupInteractables.cs manage prefab spawning, object selection, and interaction layers. Each dish varies in complexity:

- Buah Dabai: 1 AR Scene
- Sup Salai Terung Asam: 2 AR Scenes
- Pansuh Ikan Sultan: 3 AR Scenes

Users progress by completing each step and tapping the ‘Next’ or ‘Well Done!’ buttons.

4.4.6 Final Dish Spawn

Figure 4.19 Final Dishes Spawn on The Ground Plane

After completing the cooking steps in the AR activity, users can spawn a final 3D model of the completed dish. This model serves as a visual reward as the user has already achieved the final steps of cooking, as shown in Figure 4.19 above. The 3D models of the dish also allow

the user to do gestures like rotation, zoom, and movement for close inspection. Each final dish model was created using Polycam to make it more realistic 3D models.

4.4.7 Quiz Section

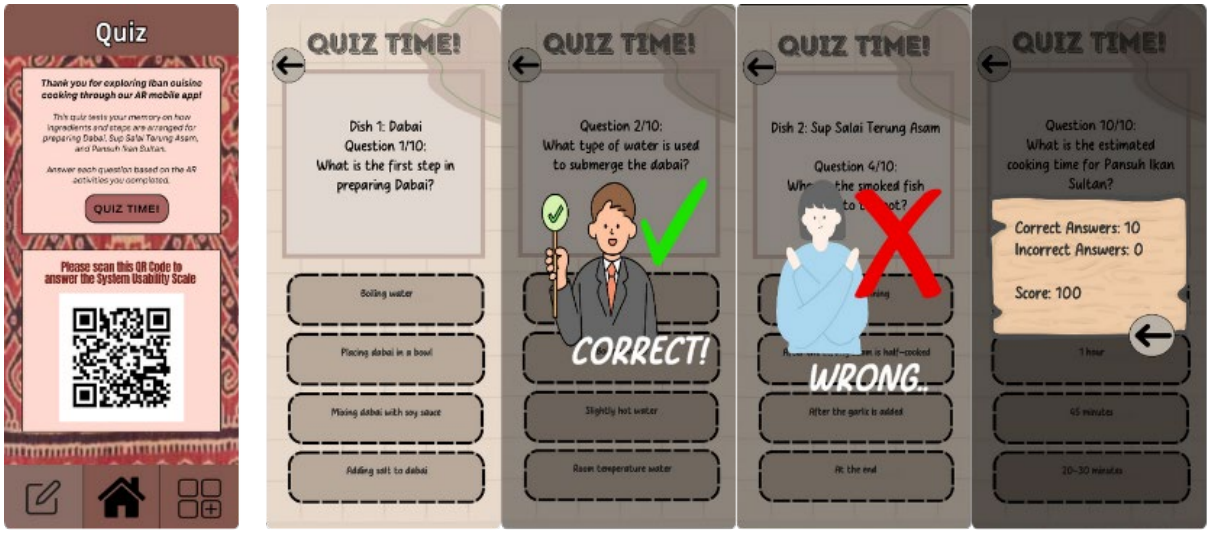


Figure 4.20 Interface Design for Quiz Section

Figure 4.20 above shows the interface design of the quiz. Once all three dishes are completed, users are directed to the quiz section. The quiz consists of 10 questions:

- 3 on Buah Dabai
- 3 on Sup Salai Terung Asam
- 4 on Pansuh Ikan Sultan

The QuizManager.cs script reads questions from a text file and manages logic such as answer validation and score calculation. After the quiz:

- Users are shown their score
- They are instructed to scan a QR code to fill in the scores they get and answer the System Usability Scale (SUS) form for their feedback on app usability.

4.5 Back-End Implementation (Scripts & Logic)

This section explains the main C# scripts used in Unity to support the functionality and interactivity of NyamaiAR. These scripts control scene navigation, interactive UI components, object placement in AR space, quiz evaluation, and vertex color application for 3D assets.

4.5.1 ScreenSwitchers.cs

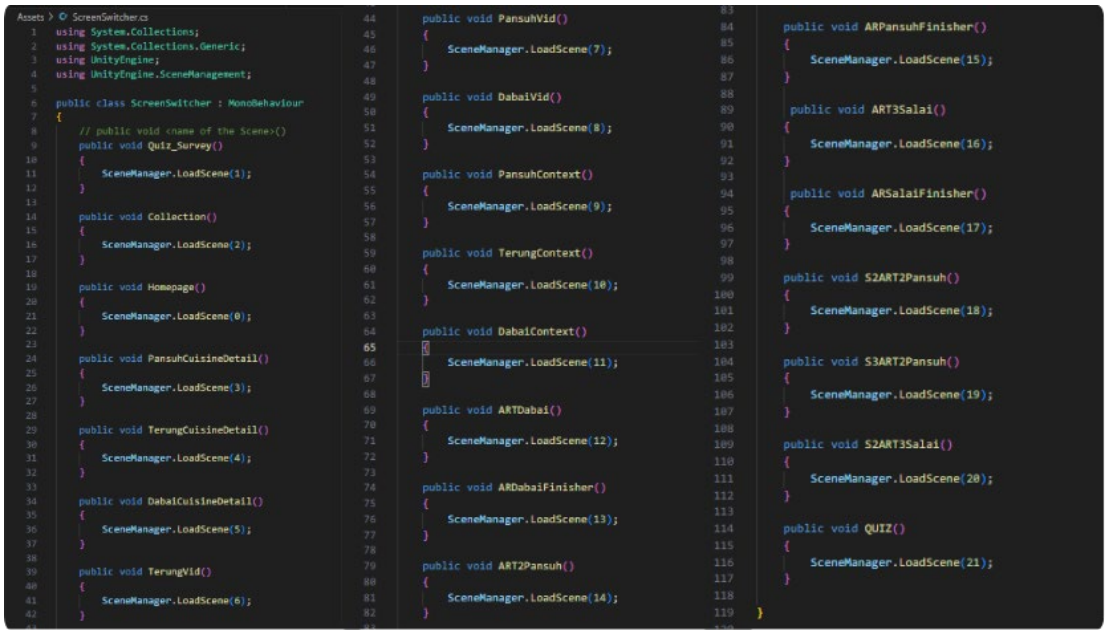


Figure 4.21 Script for Switching the Scene

The ScreenSwitchers.cs script, as shown in Figure 4.21 above, was created to manage navigation between Unity scenes. It is attached to UI buttons such as “Get Started”, “Let’s Cook!”, and “Next” in the AR activity scenes. This script uses Unity’s built-in SceneManager to load the corresponding scene index or name when clicking a button. This allowed for a smooth transition across the app’s flow — from the homepage to the collection screen, dish details, cooking videos, AR scenes, and quiz sections.

4.5.2 PanelOpeners.cs

Assets > PanelOpener.cs

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;

public class PanelOpener : MonoBehaviour
{

    public GameObject Panel;

    public void OpenPanel()
    {
        if(Panel != null)
        {
            bool isActive = Panel.activeSelf;

            Panel.SetActive(!isActive);
        }
    }

}
```

Figure 4.22 Script for Panel Opener

The PanelOpeners.cs script, as shown in Figure 4.22, manages the visibility of UI panels, such as pop-up messages, cooking instructions, and time alerts. It toggles the panel's active state based on button clicks. It is primarily used in the AR Activity scene to show information when the user taps the "Hint", "Recipe Book", or "Time" buttons.

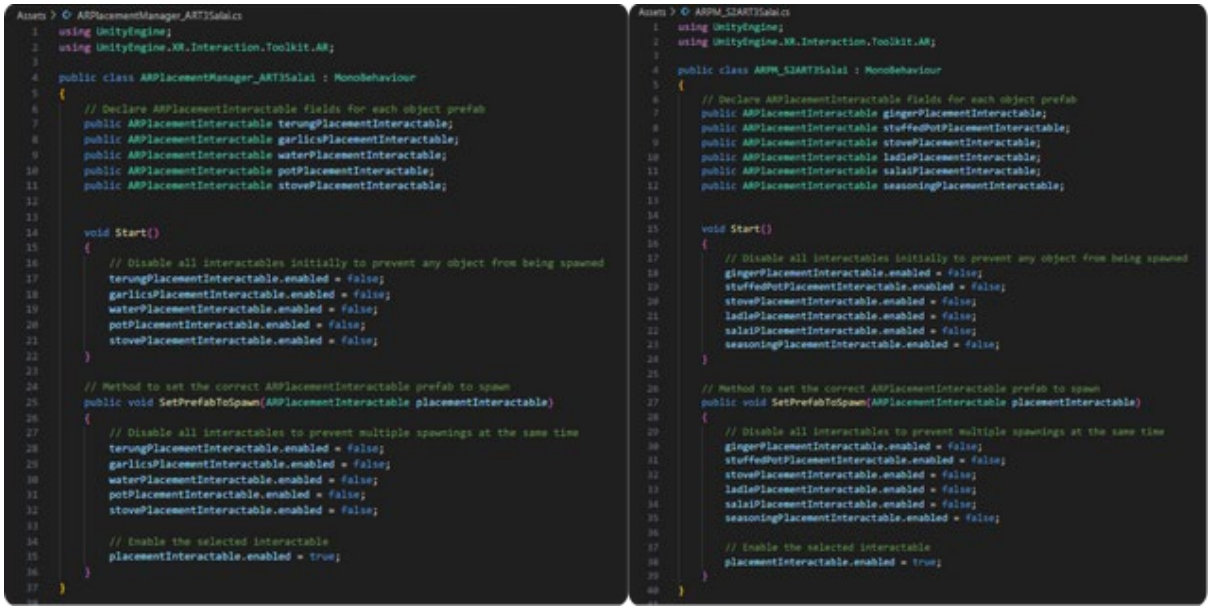
4.5.3 ARPlacementManager.cs and SetupInteractables

These two types of scripts were central to enabling interaction within the AR scenes.

Assets > ARPlacementManager_ARTDabai.cs

```
using UnityEngine;
using UnityEngine.XR.Interaction.Toolkit.AR;

public class ARPlacementManager : MonoBehaviour
{
    public ARPlacementInteractable dabaiPlacementInteractable;
    public ARPlacementInteractable bowlPlacementInteractable;
    public ARPlacementInteractable waterPlacementInteractable;

    void Start()
    {
        // Disable all interactables initially to prevent any object from being spawned
        dabaiPlacementInteractable.enabled = false;
        bowlPlacementInteractable.enabled = false;
        waterPlacementInteractable.enabled = false;
    }

    // Method to set the correct ARPlacementInteractable prefab to spawn
    public void SetPrefabToSpawn(ARPlacementInteractable placementInteractable)
    {
        // Disable all interactables to prevent multiple spawnings at the same time
        dabaiPlacementInteractable.enabled = false;
        bowlPlacementInteractable.enabled = false;
        waterPlacementInteractable.enabled = false;

        // Enable the selected interactable
        placementInteractable.enabled = true;
    }
}
```

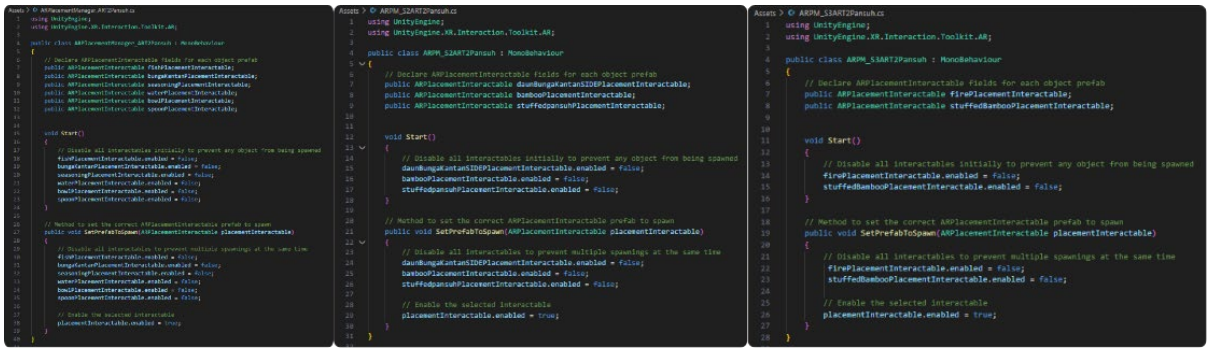
Figure 4.23 AR Placement Manager Script for Dabai Dish



```
using UnityEngine;
using UnityEngine.XR.Interaction.Toolkit.AR;

public class ARPlacementManager_ART3Salai : MonoBehaviour
{
    // Declare ARPlacementInteractable fields for each object prefab
    public ARPlacementInteractable terungPlacementInteractable;
    public ARPlacementInteractable garlicsPlacementInteractable;
    public ARPlacementInteractable waterPlacementInteractable;
    public ARPlacementInteractable potPlacementInteractable;
    public ARPlacementInteractable stovePlacementInteractable;


    void Start()
    {
        // Disable all interactables initially to prevent any object from being spawned
        terungPlacementInteractable.enabled = false;
        garlicsPlacementInteractable.enabled = false;
        waterPlacementInteractable.enabled = false;
        potPlacementInteractable.enabled = false;
        stovePlacementInteractable.enabled = false;
    }

    // Method to set the correct ARPlacementInteractable prefab to spawn
    public void SetPrefabToSpawn(ARPlacementInteractable placementInteractable)
    {
        // Disable all interactables to prevent multiple spawnings at the same time
        terungPlacementInteractable.enabled = false;
        garlicsPlacementInteractable.enabled = false;
        waterPlacementInteractable.enabled = false;
        potPlacementInteractable.enabled = false;
        stovePlacementInteractable.enabled = false;

        // Enable the selected interactable
        placementInteractable.enabled = true;
    }
}
```

```
using UnityEngine;
using UnityEngine.XR.Interaction.Toolkit.AR;

public class ARPM_S2ART3Salai : MonoBehaviour
{
    // Declare ARPlacementInteractable fields for each object prefab
    public ARPlacementInteractable gingerPlacementInteractable;
    public ARPlacementInteractable stuffedPotPlacementInteractable;
    public ARPlacementInteractable stovePlacementInteractable;
    public ARPlacementInteractable ladlePlacementInteractable;
    public ARPlacementInteractable salaiPlacementInteractable;
    public ARPlacementInteractable seasoningPlacementInteractable;


    void Start()
    {
        // Disable all interactables initially to prevent any object from being spawned
        gingerPlacementInteractable.enabled = false;
        stuffedPotPlacementInteractable.enabled = false;
        stovePlacementInteractable.enabled = false;
        ladlePlacementInteractable.enabled = false;
        salaiPlacementInteractable.enabled = false;
        seasoningPlacementInteractable.enabled = false;
    }

    // Method to set the correct ARPlacementInteractable prefab to spawn
    public void SetPrefabToSpawn(ARPlacementInteractable placementInteractable)
    {
        // Disable all interactables to prevent multiple spawnings at the same time
        gingerPlacementInteractable.enabled = false;
        stuffedPotPlacementInteractable.enabled = false;
        stovePlacementInteractable.enabled = false;
        ladlePlacementInteractable.enabled = false;
        salaiPlacementInteractable.enabled = false;
        seasoningPlacementInteractable.enabled = false;

        // Enable the selected interactable
        placementInteractable.enabled = true;
    }
}
```

Figure 4.24 AR Placement Manager Script for Sup Salai Terung Asam Dish



```
using UnityEngine;
using UnityEngine.XR.Interaction.Toolkit.AR;

public class ARPM_S2ART2Pansuh : MonoBehaviour
{
    // Declare ARPlacementInteractable fields for each object prefab
    public ARPlacementInteractable daunBungaKantanSIDEPlacementInteractable;
    public ARPlacementInteractable bambooPlacementInteractable;
    public ARPlacementInteractable stuffedpansuhPlacementInteractable;


    void Start()
    {
        // Disable all interactables initially to prevent any object from being spawned
        daunBungaKantanSIDEPlacementInteractable.enabled = false;
        bambooPlacementInteractable.enabled = false;
        stuffedpansuhPlacementInteractable.enabled = false;
    }

    // Method to set the correct ARPlacementInteractable prefab to spawn
    public void SetPrefabToSpawn(ARPlacementInteractable placementInteractable)
    {
        // Disable all interactables to prevent multiple spawnings at the same time
        daunBungaKantanSIDEPlacementInteractable.enabled = false;
        bambooPlacementInteractable.enabled = false;
        stuffedpansuhPlacementInteractable.enabled = false;

        // Enable the selected interactable
        placementInteractable.enabled = true;
    }
}
```

```
using UnityEngine;
using UnityEngine.XR.Interaction.Toolkit.AR;

public class ARPM_S3ART2Pansuh : MonoBehaviour
{
    // Declare ARPlacementInteractable fields for each object prefab
    public ARPlacementInteractable firePlacementInteractable;
    public ARPlacementInteractable stuffedBambooPlacementInteractable;


    void Start()
    {
        // Disable all interactables initially to prevent any object from being spawned
        firePlacementInteractable.enabled = false;
        stuffedBambooPlacementInteractable.enabled = false;
    }

    // Method to set the correct ARPlacementInteractable prefab to spawn
    public void SetPrefabToSpawn(ARPlacementInteractable placementInteractable)
    {
        // Disable all interactables to prevent multiple spawnings at the same time
        firePlacementInteractable.enabled = false;
        stuffedBambooPlacementInteractable.enabled = false;

        // Enable the selected interactable
        placementInteractable.enabled = true;
    }
}
```

Figure 4.25 AR Placement Manager Script for Pansuh Ikan Sultan Dish

The figures above show the ARPlacementManager.cs for every dish in the AR Activity. The scripts manage which prefab is spawned when a specific spawn button is tapped. It is responsible for updating the reference prefab and placing it on the detected AR plane when tapped.

Assets > SetupInteractables.cs

```
using UnityEngine;
using UnityEngine.XR.Interaction.Toolkit;
using UnityEngine.XR.Interaction.Toolkit.AR;
using Unity.XR.CoreUtils;

public class AutoAssignation : MonoBehaviour
{
    void Awake()
    {
        Debug.Log("[AutoAssignation] Running on object: " + gameObject.name);

        XRInteractionManager interactionManager = FindObjectOfType<XRInteractionManager>();
        XROrigin xrOrigin = FindObjectOfType<XROrigin>();

        if (interactionManager == null)
        {
            Debug.LogWarning("[AutoAssignation] XRInteractionManager not found in scene.");
        }
        else
        {
            Debug.Log("[AutoAssignation] XRInteractionManager found.");
        }

        if (xrOrigin == null)
        {
            Debug.LogWarning("[AutoAssignation] XROrigin not found in scene.");
        }
        else
        {
            Debug.Log("[AutoAssignation] XROrigin found.");
        }

        var selection = GetComponent<ARSelectionInteractable>();
        if (selection != null)
        {
            selection.interactionManager = interactionManager;
            Debug.Log("[AutoAssignation] ARSelectionInteractable assigned.");
        }

        var translation = GetComponent<ARTranslationInteractable>();
        if (translation != null)
        {
            translation.interactionManager = interactionManager;
            translation.xrOrigin = xrOrigin;
            Debug.Log("[AutoAssignation] ARTranslationInteractable assigned.");
        }

        var rotation = GetComponent<ARRotationInteractable>();
        if (rotation != null)
        {
            rotation.interactionManager = interactionManager;
            rotation.xrOrigin = xrOrigin;
            Debug.Log("[AutoAssignation] ARRotationInteractable assigned.");
        }

        var scale = GetComponent<ARScaleInteractable>();
        if (scale != null)
        {
            scale.interactionManager = interactionManager;
            scale.xrOrigin = xrOrigin;
            Debug.Log("[AutoAssignation] ARScaleInteractable assigned.");
        }
    }
}
```

Figure 4.26 Script for Setup Interactables

Figure 4.26 shows the script for SetupInteractables.cs, which was used to ensure every prefab object had proper assignation of the XR Interaction Manager and XR Origin components. The script also helps with interaction components such as translation, rotation, scaling, and selection. This ensured that users could drag, rotate, or scale objects with intuitive multi-touch gestures in each AR activity scene.

4.5.4 QuizManager.cs

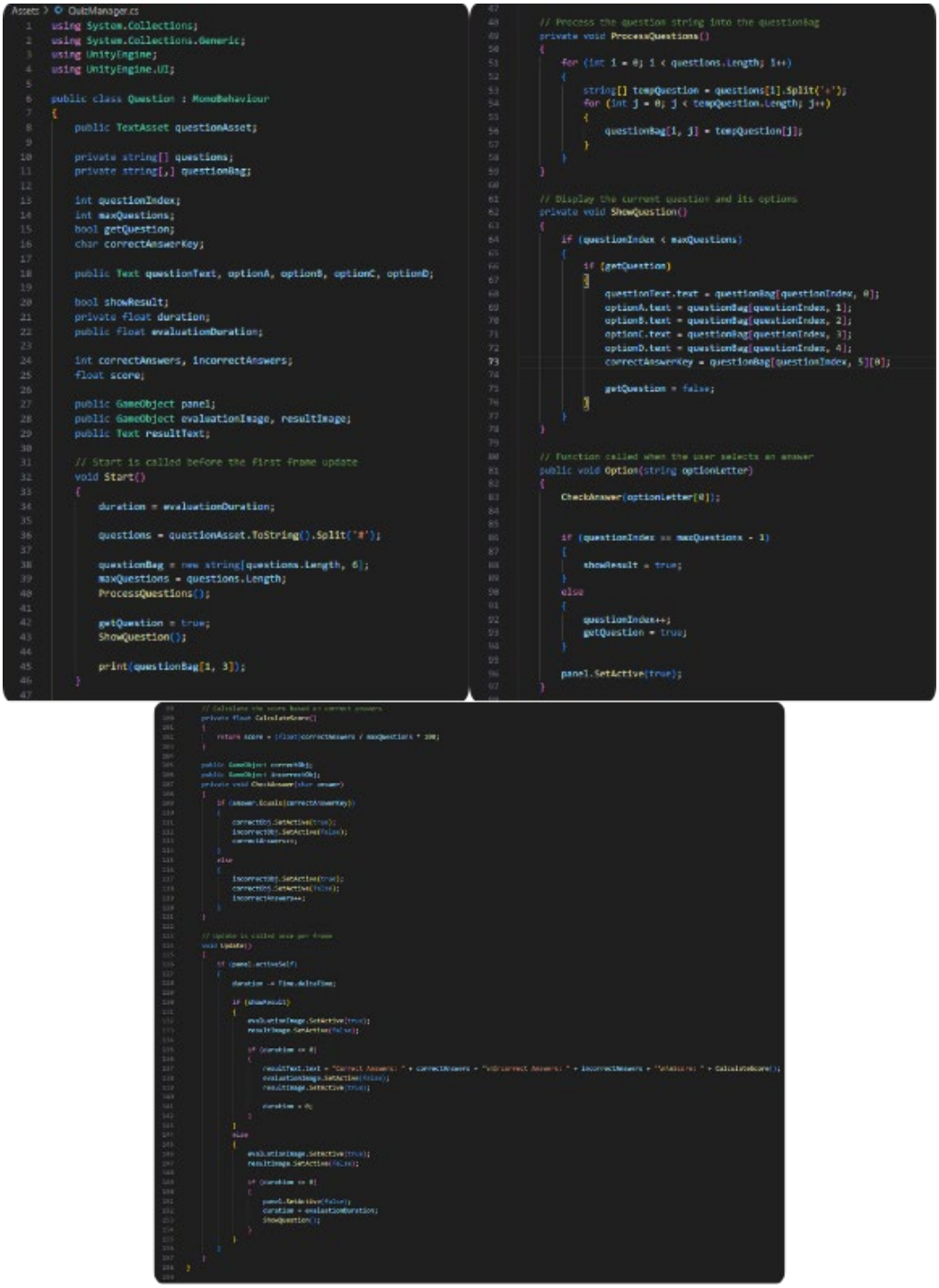
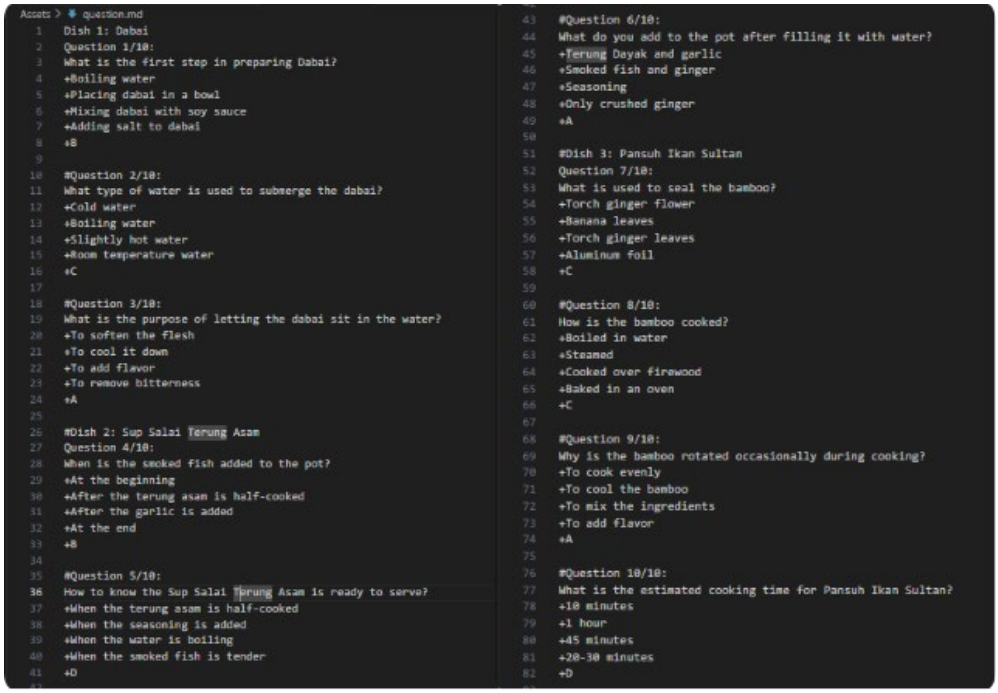


Figure 4.27 Script for Quiz Manager



```
Assets > question.md
Dish 1: Dabai
Question 1/10:
What is the first step in preparing Dabai?
+Boiling water
+Placing dabai in a bowl
+Mixing dabai with soy sauce
+Adding salt to dabai
+B

#Question 2/10:
What type of water is used to submerge the dabai?
+Cold water
+Boiling water
+Slightly hot water
+Room temperature water
+C

#Question 3/10:
What is the purpose of letting the dabai sit in the water?
+To soften the flesh
+To cool it down
+To add flavor
+To remove bitterness
+A

#Dish 2: Sup Salai Terung Asam
Question 4/10:
When is the smoked fish added to the pot?
+At the beginning
+After the terung asam is half-cooked
+After the garlic is added
+At the end
+B

#Question 5/10:
How to know the Sup Salai Terung Asam is ready to serve?
+When the terung asam is half-cooked
+When the seasoning is added
+When the water is boiling
+When the smoked fish is tender
+D

#Question 6/10:
What do you add to the pot after filling it with water?
+Terung Dayak and garlic
+Smoked fish and ginger
+Seasoning
+Only crushed ginger
+A

#Dish 3: Pansuh Ikan Sultan
Question 7/10:
What is used to seal the bamboo?
+Torch ginger flower
+Banana leaves
+Torch ginger leaves
+Aluminum foil
+C

#Question 8/10:
How is the bamboo cooked?
+Boiled in water
+Steamed
+Cooked over firewood
+Baked in an oven
+C

#Question 9/10:
Why is the bamboo rotated occasionally during cooking?
+To cook evenly
+To cool the bamboo
+To mix the ingredients
+To add flavor
+A

#Question 10/10:
What is the estimated cooking time for Pansuh Ikan Sultan?
+10 minutes
+1 hour
+45 minutes
+20-30 minutes
+D
```

Figure 4.28 List of 10 Questions for The Quiz

The QuizManager.cs script, as shown in Figure 4.27 above, handled the logic of the quiz section that follows the AR activities. It loads questions from an .md text file as shown in Figure 4.28 above and presents them to users one by one. Each question has multiple choice answers, and the script tracks user responses and calculates the final score.

Key logic includes:

- Displaying a new question after one is answered
- Verifying if the selected answer is correct or incorrect
- Displaying final scores after all 10 questions

The score then needs to be entered into the Google Form via QR code as part of the SUS evaluation.

4.5.5 VertexColorShader.shader

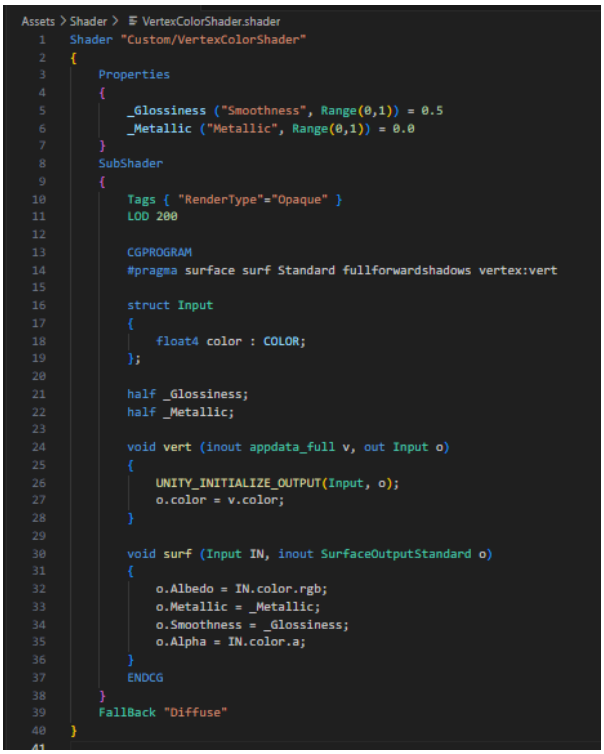


Figure 4.29 Vertex Colour Shader Script

Unity does not automatically preserve color data from sculpting apps like Nomad Sculpt. The VertexColorShader.shader script, as shown in Figure 4.29 above, was written to apply materials that correctly interpret vertex colors embedded in the FBX model. This allowed imported ingredients and dish models to retain their painted textures and colors, enhancing visual accuracy and realism in the AR environment.

Script Name	Purpose
ScreenSwitchers.cs	Navigates between scenes on button click
PanelOpeners.cs	Shows or hides hint/info panels during AR activities
ARPlacementManager.cs	Handles prefab selection and object placement
SetupInteractables.cs	Automatically assigns interaction components
QuizManager.cs	Loads and manages the quiz logic and scoring
VertexColorApplier.cs	Ensures painted vertex colors appear correctly in Unity

Table 4.1 Summary of the Scripts used

4.6 Summary of Implementation

In this chapter, the tools and techniques used for implementing NyamaiAR were discussed in detail. The app integrates Unity, AR Foundation, and various other tools to provide an interactive AR learning experience for Iban cuisine. The implementation ensures that users can engage with the app through intuitive interactions, 3D model placements, cooking videos, and immersive AR activities. This chapter provides a detailed breakdown of the development process, highlighting the key features and functionality that make the app both educational and user-friendly.

Chapter 5 Testing

5.1 Introduction

This chapter presents the testing and evaluation conducted on NyamaiAR to ensure the application functions according to its intended design and delivers a smooth, educational, and interactive experience. The objective of this phase was to verify that all core features—such as screen transitions, dish learning, video playback, augmented reality (AR) interactions, quiz functionality, and usability—performed as expected. Both functional and non-functional tests were carried out to validate the stability, responsiveness, and correctness of the application's behavior across different scenes. To further assess usability, a System Usability Scale (SUS) form was distributed to participants after completing all cooking AR activities and the quiz. The feedback collected through this method helped evaluate the user experience and identify areas for future improvement. The following sections detail the test cases and results obtained through this testing process.

5.2 Functional Testing

The purpose of functional testing is to ensure that each feature in NyamaiAR operates according to its intended functionality. Functional test cases were designed based on the expected user journey from the introduction screen to the final quiz and feedback form. These tests help identify navigation errors, feature failures, or UI mismatches, ensuring the app is usable and stable across all stages. Each major screen in the application is assigned a test plan with clear test objectives. Below are the detailed objectives for each test area:

Test Plan 1: Homepage Screen

Table 5.1 Functional Test Cases for Homepage Screen

Test Objective: To verify the homepage screen loads correctly and transitions to the Collection Screen when the user clicks the "Get Started" button.				
Test Case ID	**Input Data**	**Expected Result**	**Actual Result**	**Pass /Fail**
HP01	Launch the application	An introductory screen, "Get to know more about Iban Cuisine" and a "Get Started" button should appear	The screen appears correctly with text and a button	Pass
HP02	Click on the "Get Started" button	Navigates to Collection Screen	Navigates to Collection Screen	Pass

Test Plan 2: Collection Screen

Table 5.2 Functional Test Cases for Collection Screen

Test Objective: To evaluate the functionality of each dish selection button and ensure it navigates to the correct dish information screen.				
Test Case ID	**Input Data**	**Expected Result**	**Actual Result**	**Pass /Fail**
CS01	Click on "Buah Dabai"	Navigates to Buah Dabai Dish Information Screen	Users can navigate to the Buah Dabai Dish Information Screen	Pass
CS02	Click on "Sup Salai Terung Asam"	Navigates to Sup Salai Terung Asam Dish Information Screen	Users can navigate to the Sup Salai Terung Asam Dish Information Screen	Pass
CS03	Click on "Pansuh Ikan Sultan"	Navigates to Pansuh Ikan Sultan Dish Information Screen	Users can navigate to Pansuh Ikan Sultan Dish Information Screen	Pass

Test Plan 3: Dish Information Screen

Table 5.3 Functional Test Cases for Dish Information Screen

Test Objective: To confirm that the dish learning screen displays the correct content and buttons work properly.				
Test Case ID	**Input Data**	**Expected Result**	**Actual Result**	**Pass /Fail**
DI01	Click on "Did You Know?"	A pop-up panel with additional info appears	The pop-up panel shows successfully	Pass
DI02	Click on audio button	Audio pronunciation for the dish display	Audio plays correctly	Pass
DI03	Click on "Let's Cook!" button	Navigates to Cooking Video Scene	Scene loads and shows ingredient list and video player	Pass

Test Plan 4: Cooking Video Screen

Table 5.4 Functional Test Cases for Cooking Video Screen

Test Objective: To test that the cooking video scene loads correctly with video displayed on screen and supports video playback functionality (Play/Pause).				
Test Case ID	**Input Data**	**Expected Result**	**Actual Result**	**Pass /Fail**
CV01	Click "Play" button below the video	Video starts playing from the beginning	Video plays successfully	Pass
CV02	Click "Pause" button while video playing	Video playback pauses	Video pauses at the correct frame	Pass
CV03	Click on "AR Activity" button	Navigates to AR Activity Scene	Users can navigate to the AR Activity Scene	Pass

Test Plan 5: AR Activity Scene

Table 5.5 Functional Test Cases for AR Activity Scene

Test Objective: To test the AR activity scene's ability to detect flat surfaces, test the functional buttons, and allow the 3D models to interact using gestures.				
Test Case ID	**Input Data**	**Expected Result**	**Actual Result**	**Pass /Fail**
AR01	Open AR scene and scan a flat surface	Yellow planes appear on the ground surface	Plane is detected and appears on the ground surface	Pass
AR02	Tap the spawn button for an	Corresponding 3D object spawns on the yellow plane	3D model spawns at the correct position on the plane	Pass

	ingredient/kitchen tool			
AR03	Drag the spawned 3D model using one finger	3D model moves along the plane based on finger gestures	3D model moves smoothly with a finger	Pass
AR04	Rotate the 3D model using two fingers	3D model rotates based on finger gesture	3D model rotates correctly	Pass
AR05	Pinch to zoom using two fingers	3D model scales big or small depending on the gesture	3D model scales correctly	Pass
AR06	Tap on the Hint button	The instruction panel appears	Panel appears with instructions of "How to Get Started"	Pass
AR07	Tap the Recipe Book button	Cooking steps appear in a panel	The steps display as expected	Pass
AR08	Tap the Time button	Time alert panel shows with waiting instruction	Pop-up shows messages correctly	Pass
AR09	Tap "Next" or the "Well Done!" button	Navigates to the next AR Activity scene or the final dish scene	Correct scene loads	Pass

Test Plan 6: Final Dish Spawn

Table 5.6 Functional Test Cases for Final Dish Spawn

Test Objective: To ensure the final dish model can be spawned correctly and supports the same gesture-based interactions.				
Test Case ID	**Input Data**	**Expected Result**	**Actual Result**	**Pass /Fail**
FD01	Tap on the yellow plane to spawn the dish	Final 3D model of the dish appears on the yellow plane	3D model spawns correctly on the plane	Pass
FD02	Interact using drag/scale/rotate	Final dish can be dragged, rotated, and scaled	Interaction works as expected	Pass

Test Plan 7: Quiz Section

Table 5.7 Functional Test Cases for Quiz Section

Test Objective: To verify that the quiz screen loads correctly, displaying the quiz questions with a scoring function.				
Test Case ID	**Input Data**	**Expected Result**	**Actual Result**	**Pass /Fail**
QS01	Start the quiz	Questions appear one at a time with answer choices	Questions and answers display correctly	Pass
QS02	Select the correct/incorrect answer	Feedback appears, and the score is calculated correctly	Correct/incorrect indication works as expected	Pass
QS03	Complete all 10 questions	Score displayed at the end of the section	Result text appears correctly with the score summary	Pass
QS04	Scan the QR after the quiz	Redirects to the SUS form	QR works and opens the Google Form successfully	Pass

5.3 Non-Functional Testing

Non-functional testing focuses on evaluating aspects of the NyamaiAR application that do not relate directly to specific user functionalities but are crucial to ensure overall system performance, stability, and usability. These tests were conducted throughout the development process using both real-time device testing and iterative optimization within the Unity environment. The main areas of non-functional testing for NyamaiAR include:

5.3.1 Performance Testing

Performance testing was conducted to ensure the application runs smoothly across different components, especially during AR object rendering, gesture interaction, and video playback.

Device Used: Samsung A14 5G (1080x2408 resolution)

Table 5.8 Performance Testing of the Application

Component	Test Objective	Observed Outcome	Result
App Launch Speed	Ensure the app launches within 5 seconds	The application launched in approximately 2.8 seconds	Pass
Scene Transitions	Test the time it takes to load each scene	Scene transitions occurred within 2 seconds with no crashes	Pass
Video Playback	Check for lags/stutters in cooking video	Videos played smoothly, but sometimes a little delay occurred	Pass
AR Object Spawning	Test responsiveness when spawning 3D models	Model placement occurred within 1 second, placed on the yellow plane	Pass
AR Interaction Delay	Verify interaction (drag, rotate, scale) delay	Interactions occurred with minimal latency when properly select the model	Pass

5.3.2 Compatibility Testing

NyamaiAR was primarily tested on an Android platform, targeting ARCore-supported devices. Compatibility testing ensured the application could run without errors on the development and testing devices.

Table 5.9 Device Compatibility Testing

Device Model	OS Version	AR Support Status	Outcome	Result
Samsung A14 5G	Android 13	ARCore Supported	The application ran smoothly with full features	Pass

5.3.3 Usability Performance (App Responsiveness)

This involved assessing the application's response time to user input and ensuring that interactions such as button taps and UI feedback behaved intuitively.

Table 5.10 App Responsiveness Performance

Interaction Element	**Expected Behaviors**	**Outcome**	**Result**
Button Tap Response	Should respond within 1 second	Buttons navigated promptly upon tapping	Pass
Audio Playback Trigger	Audio should play immediately	Audio pronunciation played without delay	Pass
Recipe and Hint Pop-Up Display	Should appear within 1 second of tap	Recipe and Hint instructions appeared immediately	Pass

Overall, the non-functional testing confirmed that NyamaiAR meets expectations in terms of performance, responsiveness, and basic compatibility for its target platform. The application delivers a stable and smooth user experience under typical mobile usage conditions.

5.4 Quiz Score Analysis

After completing all AR cooking activities, users were directed to answer a 10-question quiz designed to test their memory and understanding of the ingredients and preparation steps for the three Iban dishes featured in NyamaiAR. The quiz served as a tool to evaluate the effectiveness of AR technology in helping users retain cultural knowledge, particularly through interactive learning.

Quiz Score Overview

Table 5.11 below summarizes the overall scores achieved by 30 non-Iban participants who completed the quiz:

Table 5.11 Summary of the Score Table for 30 participants

Score	**Number of Participants**
100	8
90	15
80	5
70	2

As shown in *Table 5.11,* many users scored between 90 and 100, indicating high levels of information retention. This reflects a strong understanding of the AR activities, suggesting

that the interactive features effectively supported learning. Only 2 participants scored 70, which may be due to confusion on specific details, such as ingredient types or cooking terminology.

Quiz Question Design

The quiz consisted of 10 multiple-choice questions:

- 3 questions on Buah Dabai
- 3 questions on Sup Salai Terung Asam
- 4 questions on Pansuh Ikan Sultan

Each question targeted a specific learning outcome such as identifying ingredients, recalling preparation steps, or understanding cooking tools. These questions were based directly on the interactive AR experiences and aimed to measure whether the user could remember what they had learned through gestures like spawning, dragging, and rotating objects.

Table 5.12 Quiz Questions Overview Based on AR Activities

Q#	Dish	Question Summary	Correct Answer	Notes
1	Dabai	First step in preparing Dabai	B (Placing dabai in bowl)	Simple procedural step; clearly demonstrated during AR activity
2	Dabai	Type of water used for soaking Dabai	C (Slightly hot water)	Some confusion noted between boiling and slightly hot water
3	Dabai	Purpose of letting Dabai sit in water	A (to soften the flesh)	Concept supported by the timer interaction in AR scene.
4	Sup Salai Terung Asam	When smoked fish is added	B (After terung asam is half-cooked)	Requires understanding of cooking order; visually represented. (confusion when user try to remember which steps)
5	Sup Salai Terung Asam	How to know when dish is ready	D (When the smoked fish is tender)	Judgement-based question; some users confused “tender” with “boiling.”

6	Sup Salai Terung Asam	What is added to pot after filling with water	A (Terung dayak and garlic)	Recipe clearly displayed during ingredient listing. (confusion when user try to remember which steps)
7	Pansuh Ikan Sultan	What is used to seal the bamboo	C (Torch ginger leaves)	Some user confuse banana leaf and ginger torch leaf, which one to use during AR activity.
8	Pansuh Ikan Sultan	How bamboo is cooked	C (cooked over firewood)	Straightforward; emphasized in the final AR scene with firewood.
9	Pansuh Ikan Sultan	Reason for rotating the bamboo	A (to cook evenly)	Logical reasoning from gesture suggestion.
10	Pansuh Ikan Sultan	Estimated cooking time	D (20-30 minutes)	Recall-based; might be guessed if not paid attention during the activity.

Observations and Insights

Based on the score breakdown, 8 participants scored 100, 15 scored 90, 5 scored 80, and only 2 scored 70. This can be observed that most users retained the cooking steps well after completing the AR activities. The questions were designed to reflect both the visual experience and logical understanding gained during interaction. For instance, straightforward actions such as placing Dabai in a bowl or cooking bamboo over firewood were answered correctly by nearly all high scorers, likely due to how directly these steps were reinforced through AR gestures like dragging and positioning objects.

On the other hand, the few lower scores (those who scored 70 or 80) may have struggled with more detail-specific questions like the correct water type for soaking Dabai or the exact leaf used to seal the bamboo in Pansuh Ikan Sultan. These questions required close attention to the recipe text and the visual cues in the 3D environment, which may have been missed if users rushed through the activity or skipped reading recipe.

Most users who scored 90 likely made one mistake, while the perfect scores suggest strong engagement and focus throughout all three dish activities. The quiz, in this case, served as a practical measure of short-term memory retention, showing that the AR interaction was not just entertaining but also educationally effective.

This supports the use of AR technology as a learning tool by actively engaging users in hands-on simulation, it encourages memory encoding that lasts even beyond the activity. Some users try to redo the activities again after they know how to handle the models. The detailed quiz design, based on real preparation logic, helped confirm that users could remember core steps, tool usage, and reasoning behind certain actions after completing the app's tasks.

5.5 Usability Testing

Usability testing was conducted with 30 non-Iban students to assess the user experience of NyamaiAR and gather feedback regarding the app's design, functionality, and overall performance. This usability test aimed to gauge user satisfaction, learnability, and the perceived ease of use of the application. The questionnaire consists of ten standardized statements rated on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree).

System Usability Scale (SUS) Results

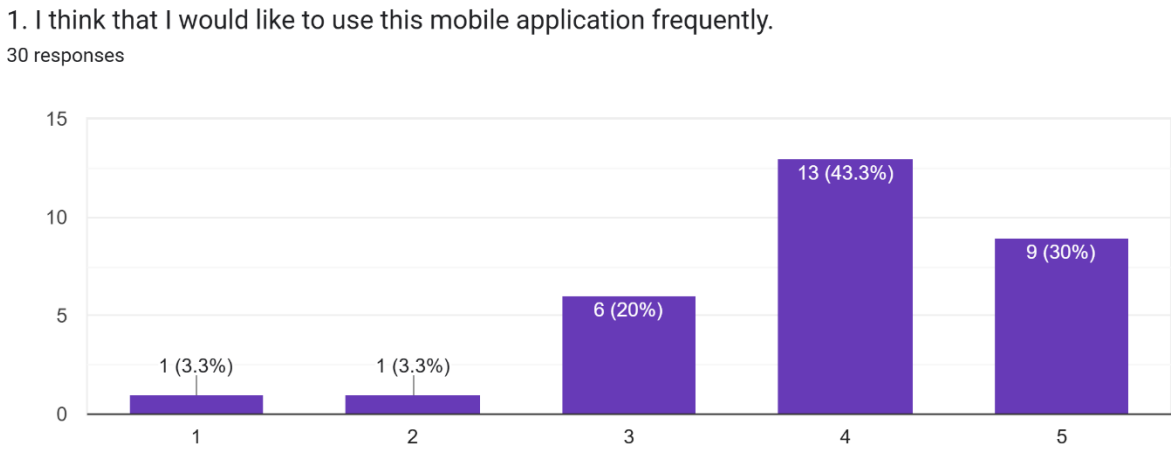


Figure 5.1 Frequency of Use

Based on Figure 5.1, the response was largely positive. A total of 13 users (43.3%) selected scale 4, and 9 users selected scale 5, indicating strong agreement. Only a small number of users gave lower ratings. This reflects an overall positive interest in continued usage, suggesting the app offers value and engagement worth revisiting.

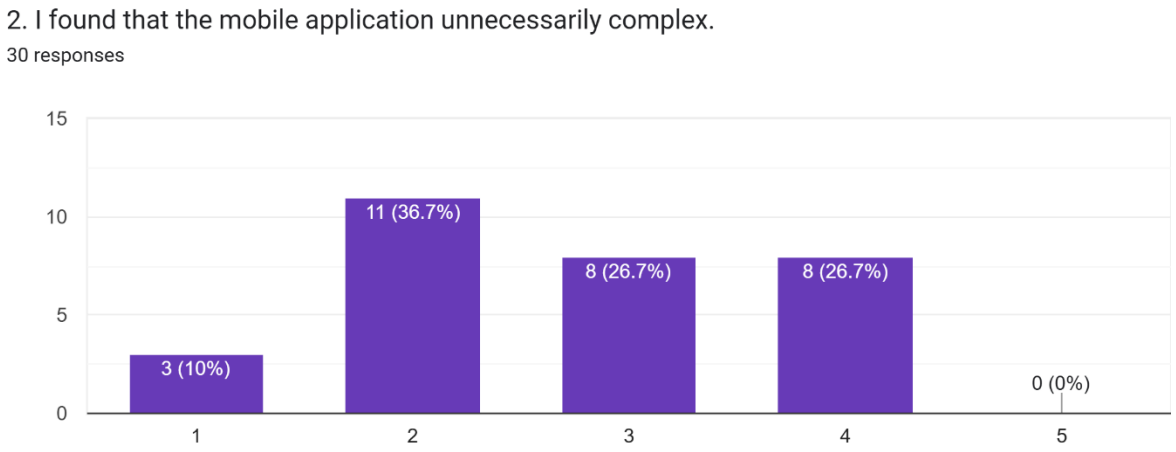


Figure 5.2 Complexity of the Application

According to Figure 5.2, 11 participants (36.7%) disagreed with this statement by selecting scale 2, while only a few chose higher levels of agreement. This suggests that while some users may have experienced minor complexity, the majority found the application straightforward and not overly complicated to navigate or use.

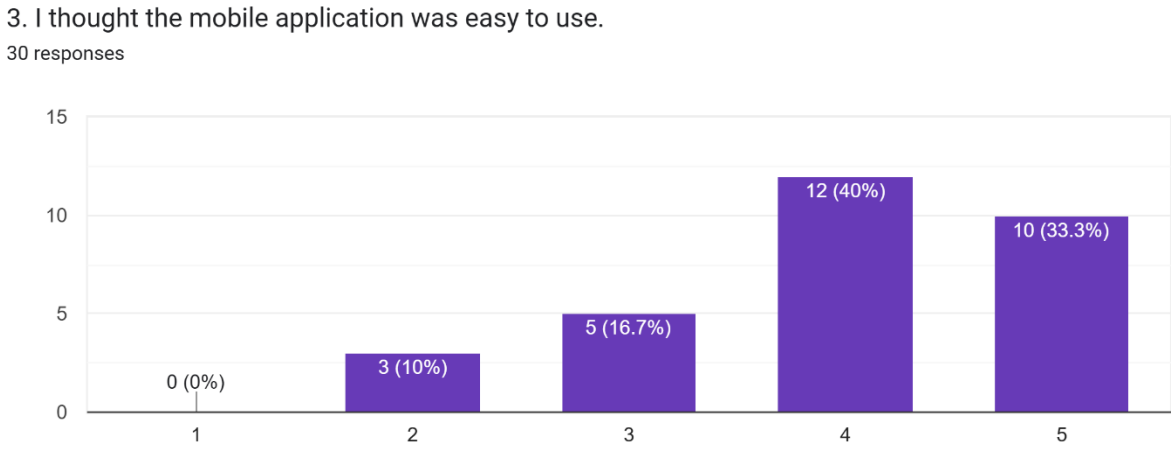


Figure 5.3 Ease of Use

As shown in Figure 5.3, 12 users (40%) selected scale 4, and 10 users selected scale 5. These responses indicate that most users felt confident using the application. While a few rated it slightly lower, this could be due to the learning curve associated with interacting with AR

elements for the first time. Overall, users found the interface and gesture controls easy to understand.

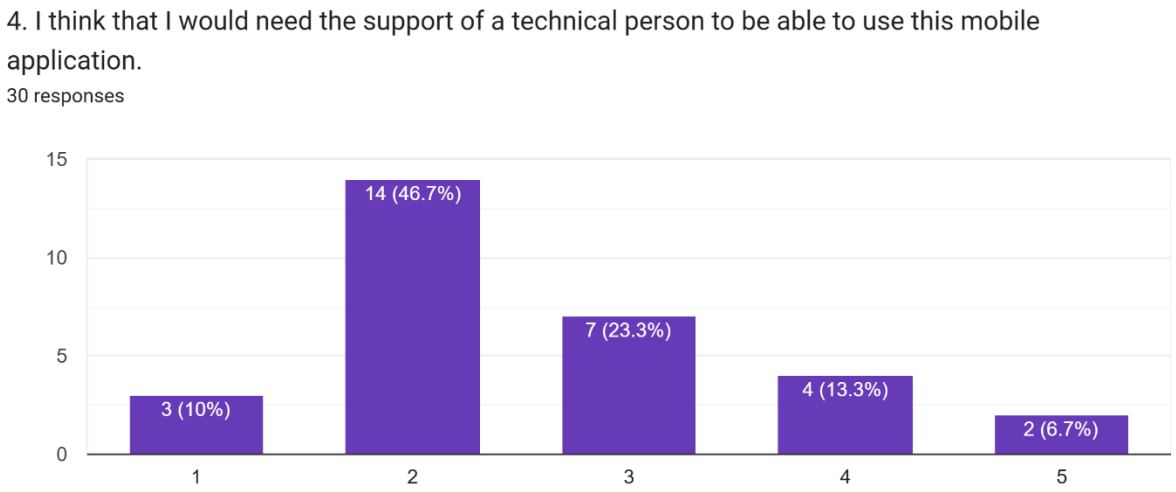


Figure 5.4 Need for Technical Support

Figure 5.4 shows that 14 users (46.7%) selected scale 2, suggesting that most users felt they could navigate the application without needing technical assistance. This reinforces that NyamaiAR is independently usable, especially after users become familiar with its core interaction patterns after the first AR scene.

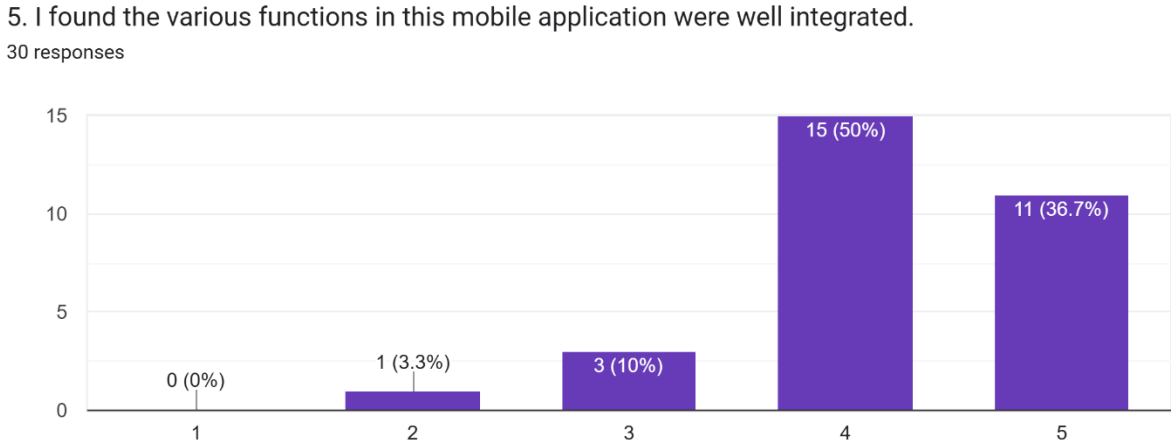


Figure 5.5 Integration of Functions

Half of the respondents (15 users) selected scale 4, and 11 users chose scale 5 in Figure 5.5. This reflects a high level of satisfaction with the integration of UI elements, scene transitions, and AR interactions. It shows that the flow from one scene to another (e.g., dish learning to AR activity to quiz) was logical and smooth.

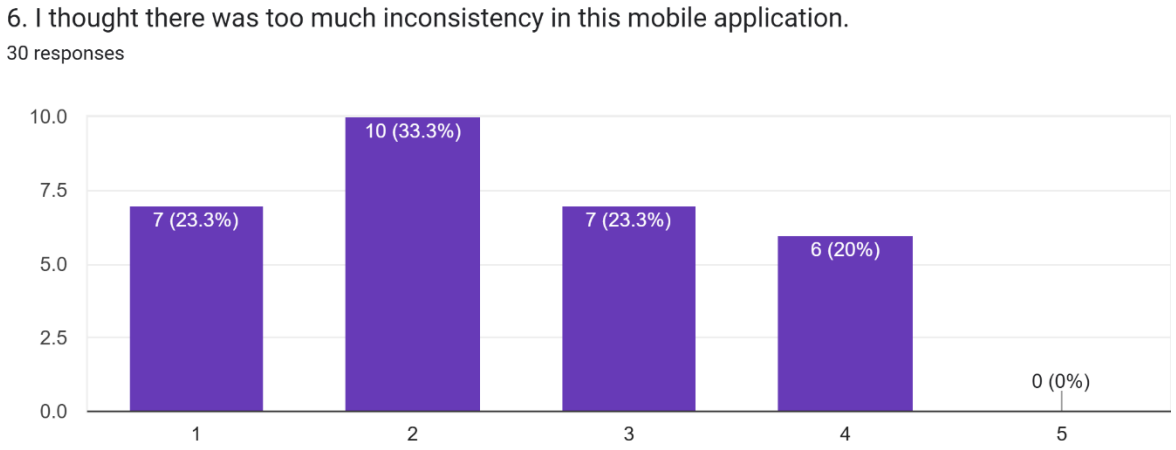


Figure 5.6 Inconsistency in Interface

From Figure 5.6, 7 users selected scale 1, and 10 users chose scale 2, indicating disagreement with the statement. This shows that users found NyamaiAR to be consistent in design, function, and interaction, without unexpected behavior or confusing features.

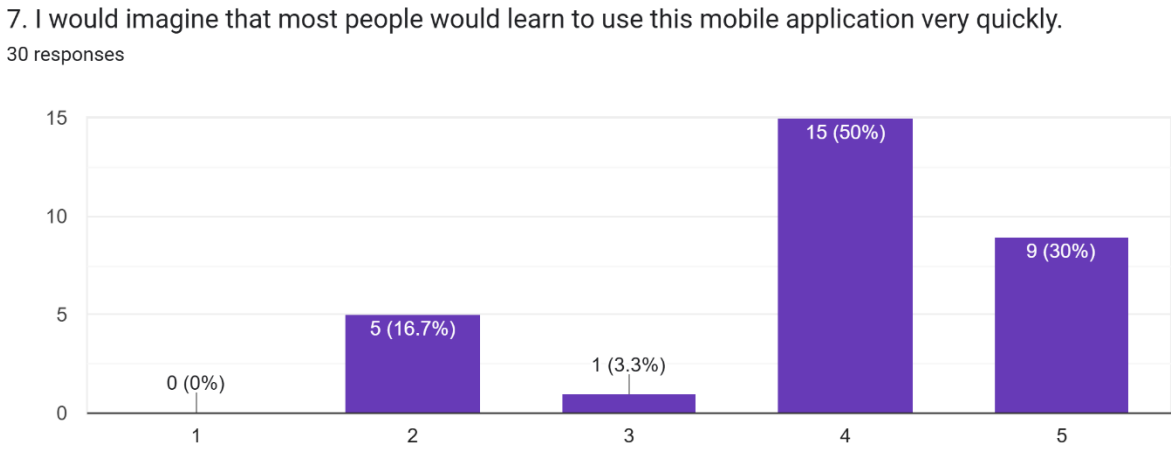


Figure 5.7 Ease of Learning

According to Figure 5.7, 15 users (50%) chose scale 4 and 9 users chose scale 5. These results show a strong belief that NyamaiAR is intuitive and easy to pick up, even for those without prior AR experience. With minimal guidance, users were able to engage confidently.

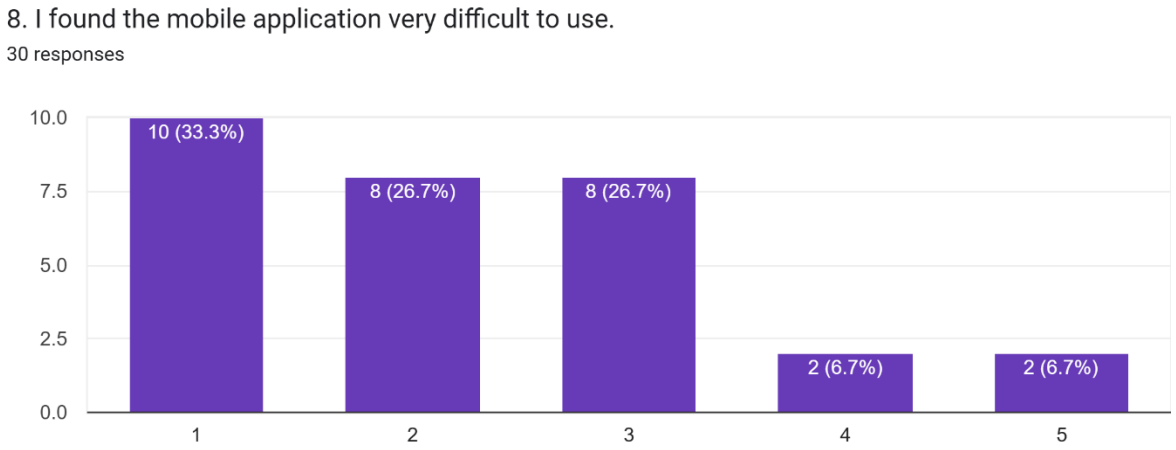


Figure 5.8 Difficulty of Use

In Figure 5.8, 10 participants (33.3%) strongly disagreed, and most responses were in the low difficulty range (scales 1 to 3). This confirms that most users did not experience major usability issues, though a few required some time to adapt to the AR environment and interactions.

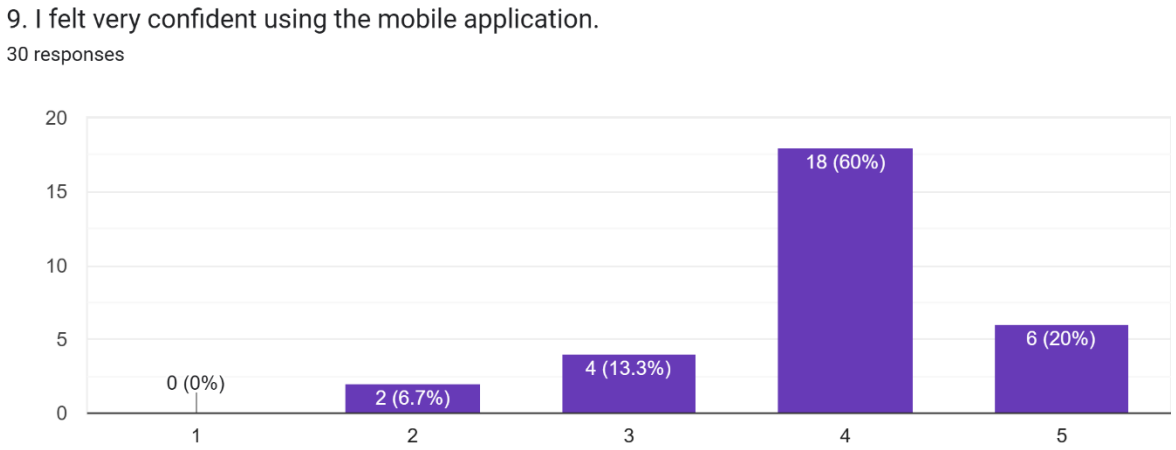


Figure 5.9 Users' Confidence Levels

Based on Figure 5.9, 60% of users chose scale 4, and 6 others selected scale 5. This high level of confidence shows that the app interface and interactions were well understood after minimal usage.

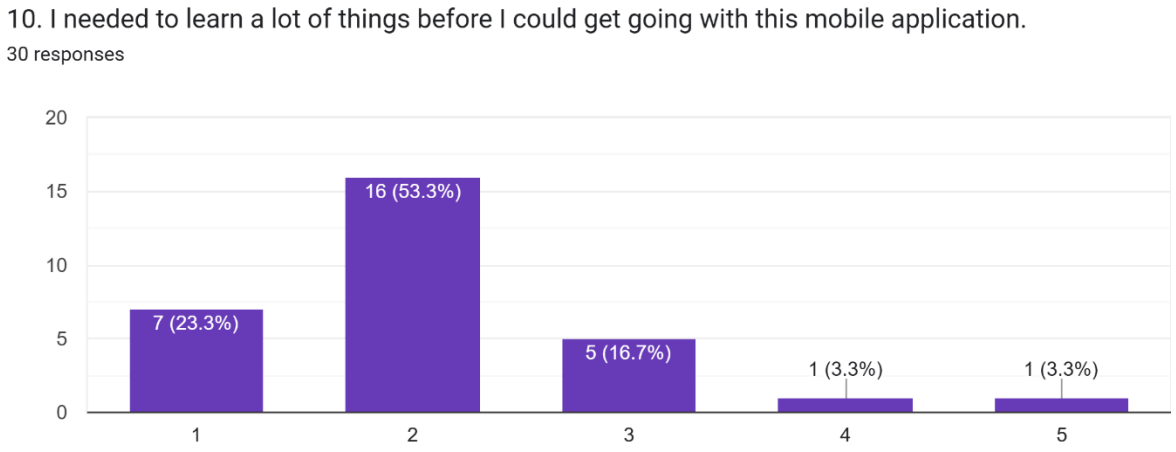


Figure 5.10 Learning Requirement

As illustrated in Figure 5.10, more than half (16 users or 53.3%) selected scale 2. This implies that the learning curve was minimal. While some users may have initially needed help understanding the AR gestures or sequence, most adapted quickly, especially after completing the first dish activity.

5.5 User Feedback Highlights

Throughout the usability testing phase, user feedback was gathered through direct observation and open-ended responses in the Google Form. The feedback provided valuable insights into how users perceived the usability, design, and overall experience of using NyamaiAR. Several users expressed enjoyment in exploring the AR activity scenes. They particularly appreciated the ability to spawn and interact with 3D ingredients and tools, which made the cooking process feel more immersive and engaging. Many commented on how the app felt like a fun, game-like experience, especially when trying to imitate cooking steps like stirring soup with the ladle or arranging ingredients in the pot. Besides, a few users initially struggled with understanding how to use the app, especially during the first AR activity. However, once they became familiar with the instructions and completed one dish, their confidence improved significantly. The Hint and Recipe Book buttons were praised for

providing essential guidance, though some users admitted they often forgot to check them at the beginning.

Users also found the visual design attractive and culturally engaging. The use of real Iban dishes converted into 3D models was well-received, with several participants noting how they moved their phone camera closer to inspect the models out of curiosity and interest. This shows that the visual appeal successfully encouraged user interaction and exploration. Next, some users encountered issues with yellow plane detection in certain environments, especially on uneven or glossy surfaces such as tables and library carpet floors with different lighting. While most users could detect the plane eventually, a few had to restart the app to improve detection. In the quiz section, users generally performed well, with most scoring between 80 and 100. When incorrect answers occurred, it was often due to similar-sounding options or a misunderstanding of specific local ingredients. Nevertheless, users found the quiz helpful in reinforcing what they had learned through the AR experience. Finally, the System Usability Scale results revealed that most users had a positive impression of NyamaiAR. They felt confident using the app after minimal guidance and agreed that its functions were well-integrated and not overly complex. The testing session highlighted the app's effectiveness as an educational tool and its potential to promote cultural awareness engagingly and interactively.

5.6 Cultural Mapping and Evaluation

Cultural elements were identified and mapped to relevant app features to assess how NyamaiAR supports the preservation and transfer of Iban culinary heritage. This mapping demonstrates how the application integrates intangible cultural aspects (e.g., traditional knowledge, food preparation methods, community values) into its learning experience through AR interactions and multimedia.

Table 5.13 Cultural Element Mapping with App Features

Cultural Element	App Feature	Purpose/Contribution
Indigenous Dish Knowledge (Dabai, Pansuh, Sup Salai Terung Asam)	3D Models + Cooking Simulation in AR	Preserves the physical appearance, preparation process, and identity of Iban dishes
Traditional Cooking Methods (e.g., bamboo cooking, smoked fish)	Step-by-step AR cooking interaction + video tutorials	Stimulates traditional methods such as cooking in bamboo (Pansuh) or using smoked fish
Native Ingredients (e.g., terung asam, buah dabai, Ikan salai, torch ginger flower/leaves)	Visual + AR Ingredients in the Scene	Educate users about local produce and their uses in Iban cuisine cooking
Iban Language Pronunciation	Clickable Audio Pronunciation for Dish Names	Encourages language preservation through spoken dish names
Cultural Significance/Fun Facts	Dish insight section with text + images	Communicates how dishes are tied to Iban identity, festivals (e.g., Gawai), and daily life
Community and Ritual Values	Cooking simulation as hands-on interaction + quiz	Recreates communal food prep practices to build appreciation and understanding

5.7 Summary

In summary, the testing phase for NyamaiAR demonstrated that the app met its core functional and usability objectives. Functional testing confirmed that all key features—from the homepage navigation to AR activities and quiz scoring—operated as intended. Non-functional testing highlighted performance consistency across most scenarios, with minor lag observed during video playback. Usability testing and feedback from 30 non-Iban participants provided encouraging results. Most users found the app easy to use, engaging, and informative. The AR experience was generally smooth, although plane detection and first-time instruction clarity were areas identified for further improvement. User feedback was largely positive, with quiz performance and SUS scores supporting the app's overall usability and learning effectiveness. These findings validate the viability of using AR technology to enhance cultural education and culinary learning, particularly for audiences unfamiliar with Iban traditions.

Chapter 6 Future Works and Limitations

6.1 Introduction

This chapter concludes the development process of NyamaiAR, an interactive mobile application that leverages Augmented Reality (AR) to preserve and promote traditional Iban cuisine. It discusses the extent to which the project objectives were achieved, acknowledges limitations encountered during development and testing, and proposes future enhancements to improve the system. The insights gained from user feedback and testing serve as the foundation for ongoing refinement and potential commercialization.

6.2 Achievements

NyamaiAR successfully achieved the project's aim to promote Iban traditional cuisine through an interactive and educational AR experience. According to Table 6.1 below, the achievements are aligned with each of the predefined objectives as outlined in Chapter 1.

Table 6.1 Accomplished Objectives Achievements

Objective	**Achievement**
To identify gaps in digital preservation of Iban cuisine cooking.	A gap was identified in existing mobile applications and digital media that lack to incorporate of immersive, culturally specific cooking experiences. NyamaiAR addresses this by embedding Iban cooking knowledge into interactive AR scenes, making cultural learning more accessible and engaging.
To design and develop a mobile application that showcases Iban traditional cuisine cooking employing AR technology.	NyamaiAR was successfully developed using Unity and AR Foundation, offering features such as animated 3D ingredient interactions, real-dish scanning, cooking videos, and an interactive quiz. Three Iban dishes—Buah Dabai, Sup Salai Terung Asam, and Pansuh Ikan Sultan—are presented with cultural and educational content.

To evaluate the effectiveness of AR technology in preserving Iban cuisine cooking	The system was evaluated by 30 non-Iban students. The results showed high scores in the System Usability Scale (SUS) and quiz performance, suggesting the app is effective in engaging users and improving their memory and understanding of Iban cooking steps and ingredients.

6.3 Limitations

While NyamaiAR has successfully met its core objectives and demonstrated its potential as a cultural learning tool, there are still several limitations that need to be acknowledged:

i. Video Playback Performance

During testing, the cooking video sometimes experienced noticeable lag, especially after switching between scenes or engaging with AR features. This issue was primarily observed on the Samsung A14 5G test device. The lag may be due to memory strain or resource management limitations when handling both video rendering and active AR sessions. Although restarting the app or returning to the video screen typically resolved the lag, it slightly disrupted the overall learning flow. This could be more problematic for users with lower-end devices.

ii. AR Plane Detection Sensitivity

While the AR plane detection generally worked well, some users encountered difficulty when trying to detect surfaces in environments with uneven lighting or cluttered surroundings. In some cases, the yellow plane would appear in excessive layers, leading to user confusion or difficulty placing objects accurately. Despite the system being set to detect both horizontal and vertical surfaces, wall detection was largely ineffective. These detection inconsistencies can cause frustration, especially for first-time users.

iii. Static Experience Without Progress Tracking

NyamaiAR currently operates as a standalone session app, meaning user progress, quiz scores, or activity history are not saved or tracked. This limits the ability to personalize learning experiences, provide continuity between sessions, or collect long-term performance data. A lack of a persistent user profile or data tracking may hinder the app's future use in formal educational settings.

iv. Static Interactions with Limited Visual Feedback

The current version of NyamaiAR relies on static 3D models and gesture-based manipulation (drag, rotate, scale) to simulate the cooking process. While this provides a foundation for learning, the absence of animations significantly reduces realism. Users are unable to experience actions like pouring liquids, cutting ingredients, or lighting a stove. Without animated feedback or dynamic responses to user actions, the experience remains mostly visual and lacks the deeper interactivity that can make AR more immersive and effective.

v. Lack of Sound Effects

There are currently no sound effects or background audio integrated into the app during AR interactions. The silence during the AR scenes can make the experience feel flat or less engaging. Sound plays a vital role in enhancing realism and feedback; its absence means users miss auditory cues that could support learning and immersion, such as sizzling, boiling, chopping, or even ambient kitchen sounds.

vi. Limited Content Variety

The prototype version of NyamaiAR includes only three Iban dishes: Buah Dabai, Sup Salai Terung Asam, and Pansuh Ikan Sultan. While these offer a meaningful start, the limited number restricts the cultural depth and replay value of the application. Users looking to explore more of Iban culinary heritage or use the app repeatedly may find the content insufficient for long-term engagement.

By recognizing these limitations, future work can focus on enhancing the performance, interactivity, and adaptability of NyamaiAR to make it more robust and scalable for broader use cases.

6.4 Future Enhancements

Although NyamaiAR successfully met its objectives, several enhancements can be made to improve its performance and usability. Suggested future improvements include:

i. Enhance Interactivity with Cooking Animations

Currently, NyamaiAR uses static 3D models that users can manipulate using basic gestures (drag, rotate, scale). While functional, this limits the sense of realism. Future versions should include animated actions such as pouring water into pots, stirring ingredients, adding items into bamboo, steam rising during cooking, and chopping or slicing animations. These animations will better simulate real-life cooking processes and increase user engagement. This would transform the AR activity from a passive simulation into a more realistic and hands-on experience—strengthening the "learning by doing" concept and making the app more enjoyable and educational for all age groups.

ii. Integrate Cooking Sound Effects

Sound design is a critical component of immersive experiences. By incorporating audio feedback—such as the sound of frying, boiling, stirring, chopping, or sizzling, NyamaiAR can evoke a more lifelike cooking environment. These sounds would trigger when users interact with ingredients or tools, providing sensory feedback that complements visual interactions. This enhancement not only improves user immersion but also reinforces cultural elements, as unique cooking sounds are often tied to traditional food preparation methods.

iii. Improve AR Plane Detection

Although the current app can detect horizontal surfaces, users occasionally face challenges when the lighting is uneven or the surface lacks sufficient features. In future development, optimization should focus on refining AR plane detection to prevent multiple overlapping planes and improve recognition speed. Additionally, offering clearer visual guidance (such as scanning tips or real-time detection feedback) would reduce user confusion. Incorporating vertical plane detection (e.g., scanning walls) more reliably would also allow flexible AR experiences in tighter or more constrained environments.

iv. Expand Content with More Iban Dishes

NyamaiAR currently features three iconic Iban dishes. While this is effective for a prototype, the potential of the app can be greatly expanded by including more traditional Iban recipes. Adding dishes such as manok pansuh (bamboo chicken), kasam ikan, or kuih penyaram could deepen users' cultural understanding. A broader variety of dishes also encourages repeated usage and supports long-term educational goals. This would also enable the app to be used as a more comprehensive teaching tool in schools or tourism contexts.

v. Interactive Onboarding for AR Activities

During usability testing, it was observed that users initially struggled with following the instructions, even with a "Hint" button available. A future version could include an onboarding sequence or tutorial animation to guide users through AR interactions the first time they use it. For example, an animated hand or brief voiceover could demonstrate how to scan the plane, spawn objects, and perform gestures. This would significantly improve the first-time user experience and reduce confusion, especially for non-technical users.

vi. Broader Device Compatibility and Cross-Platform Testing

At this stage, NyamaiAR was only tested on a Samsung A14 5G device. To prepare the application for broader adoption, future testing should include a range of Android and iOS devices with various hardware capabilities. This will ensure consistent performance, AR tracking reliability, and UI responsiveness across different screen sizes, processors, and operating systems. Addressing this will help eliminate performance bottlenecks (such as the video playback lag) and make the application more inclusive and accessible to a wider user base.

6.5 Conclusion

NyamaiAR was developed as an interactive educational mobile application to preserve and promote traditional Iban cuisine using Augmented Reality. Through careful design and implementation, the application successfully showcased traditional recipes through gesture-based AR activities, immersive videos, and quizzes that test users' understanding. From identifying the lack of digital preservation tools for Iban cooking, to developing an engaging mobile application using Unity and AR Foundation and finally evaluating the usability through

SUS testing and functional tests, this project has achieved its primary goals. Despite some limitations in AR detection accuracy and device compatibility, NyamaiAR has proven to be an effective and enjoyable medium for cultural learning. Lastly, NyamaiAR holds great potential to be expanded as a cultural education tool for other ethnic cuisines and traditions across Malaysia and beyond with continuous improvements and broader deployment.

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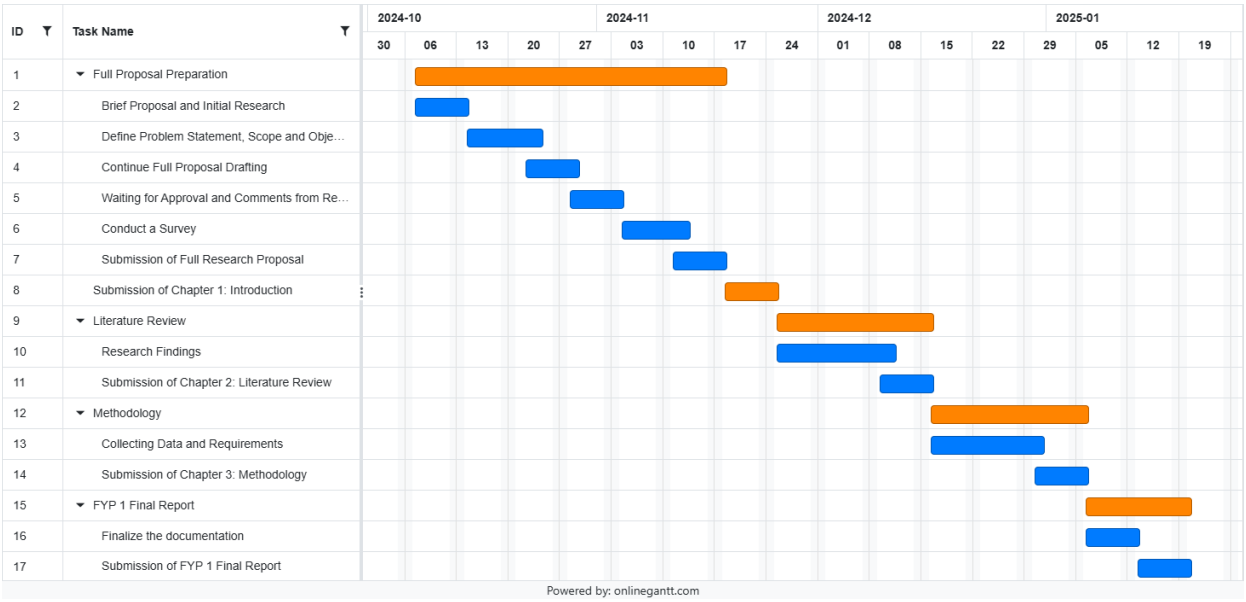
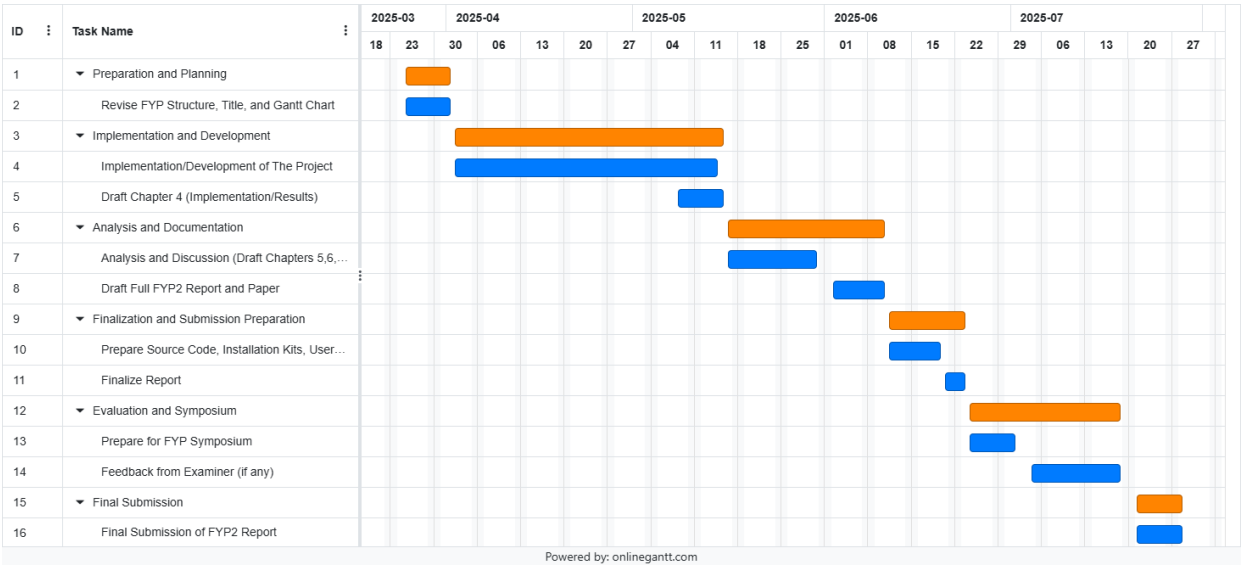
Appendix

Appendix A: Project Schedule and Gantt Chart

Week	Date	Tasks Plan
1	Oct 7 – Oct 13, 2024	Brief proposal preparation and Initial Research
2	Oct 14 – Oct 20, 2024	Refining brief proposal, defining problem statement, scope, aims and objectives
3	Oct 21 – Oct 27, 2024	Drafting the preparation for full research proposal, weekly discussion with supervisor in-charge
4	Oct 28 – Nov 3, 2024	Waiting for approval and Comments by reviewers
5	Nov 4 – Nov 10, 2024	Briefly explain methodology used for the project, prepare the project schedule and conduct a survey targeted to non-Iban young adults
6	Nov 11 – Nov 17, 2024	Submission of Full Research Proposal
7	Nov 18 – Nov 24, 2024	Submission of Chapter 1: Introduction
8	Nov 25 – Dec 1, 2024	More research findings for existing works and publications for literature review
9	Dec 2 – Dec 8, 2024	Defining the literature review for project related
10	Dec 9 – Dec 15, 2024	Submission of Chapter 2: Literature Review
11	Dec 16 – Dec 22, 2024	Collecting all the data and method uses for the project
12	Dec 23 – Dec 29, 2024	Plan well all the project needs for developing the app
13	Dec 30 – Jan 5, 2025	Submission of Chapter 3: Methodology/Requirement Analysis and Design
14	Jan 6 – Jan 12, 2025	Finalizing the documentation for FYP 1 Final Report
15	Jan 13 – Jan 19, 2025	Submission of FYP 1 Final Report for assessment

Week	Date	Tasks Plan
2	Mar 24 – Apr 1, 2025	Revise FYP structure, title, and Gantt chart
3-9	Apr 2 – May 14, 2025	Implementation/Development of the project
9	May 8 – May 15, 2025	Draft Chapter 4 (Implementation/Results)
9-11	May 16 – May 31, 2025	Analysis and Discussion (Draft Chapter 5,6, and Abstract)
11-13	Jun 1 – Jun 10, 2025	Draft the full FYP2 report and paper
13-15	Jun 11 – Jun 23, 2025	Prepare source code, installation kits, user manual, and finalize the report
15-16	Jun 24 – Jul 1, 2025	Prepare for FYP Symposium
16-18	Jul 5 – Jul 18, 2025	Incorporate feedback from examiners (if any)
18-20	Jul 19 – Jul 28, 2025	Final submissions of the FYP2 report




ID
Task Name
2025-03
2025-04
2025-05
2025-06
2025-07
18 23 30 06 13 20 27 04 11 18 25 01 08 15 22 29 06 13 20 27
1 Preparation and Planning
2 Revise FYP Structure, Title, and Gantt Chart
3 Implementation and Development
4 Implementation/Development of The Project
5 Draft Chapter 4 (Implementation/Results)
6 Analysis and Documentation
7 Analysis and Discussion (Draft Chapters 5,6,...
8 Draft Full FYP2 Report and Paper
9 Finalization and Submission Preparation
10 Prepare Source Code, Installation Kits, User...
11 Finalize Report
12 Evaluation and Symposium
13 Prepare for FYP Symposium
14 Feedback from Examiner (if any)
15 Final Submission
16 Final Submission of FYP2 Report
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Appendix B: Survey Collection

Fakulti Sains Komputer dan Teknologi Maklumat
Faculty of Computer Science and Information Technology

UNIMAS
UNIVERSITI MALAYSIA SARAWAK

UNIMAS/NC-19.03/04-32 Jld. 2 (57)

13 Januari 2025

Kepada Sesiapa Yang Berkenaan

Tuan/Puan

Kerja Lapangan Pelajar Tahun Akhir dari Universiti Malaysia Sarawak
- Addelia Shaina anak Augustine Lubon

Dengan segala hormatnya perkara di atas adalah dirujuk.

Sukacita dimaklumkan bahawa pelajar berikut akan mengumpul maklumat untuk projek beliau.

Berikut adalah butir-butir pelajar:

Nama Penuh	:	Addelia Shaina anak Augustine Lubon
No. Matrik	:	77733
No. Kad Pengenalan	:	020203-13-0226
Program	:	Pengkomputeran Multimedia
Tahun Pengajian	:	4
Tajuk Projek	:	*Enhancing Iban Cuisine Cooking using Augmented Reality Technology*
Penyelia	:	Ts. Dr Lim Phei Chin
Email	:	pclim@unimas.my
Telefon	:	0198680028

Sehubungan itu, sukacita kiranya pihak tuan/puan dapat memberikan kerjasama kepada pelajar berkenaan untuk menyalurkan maklumat yang diperlukan bagi memenuhi syarat kursus. Segala maklumat yang diperolehi akan hanya digunakan untuk tujuan akademik semata-mata dan akan dijamin kerahsiaannya.

Ini adalah sebagai makluman kepada pihak tuan dan sekiranya ada sebarang pertanyaan, sila hubungi penyelia pelajar tersebut.

Sekian, terima kasih.

Siti Lydiawati binti Sahmat
Penolong Pendaftar Kanan

s.k. - **Timbalan Dekan, Prasiswazah, FSKTM**

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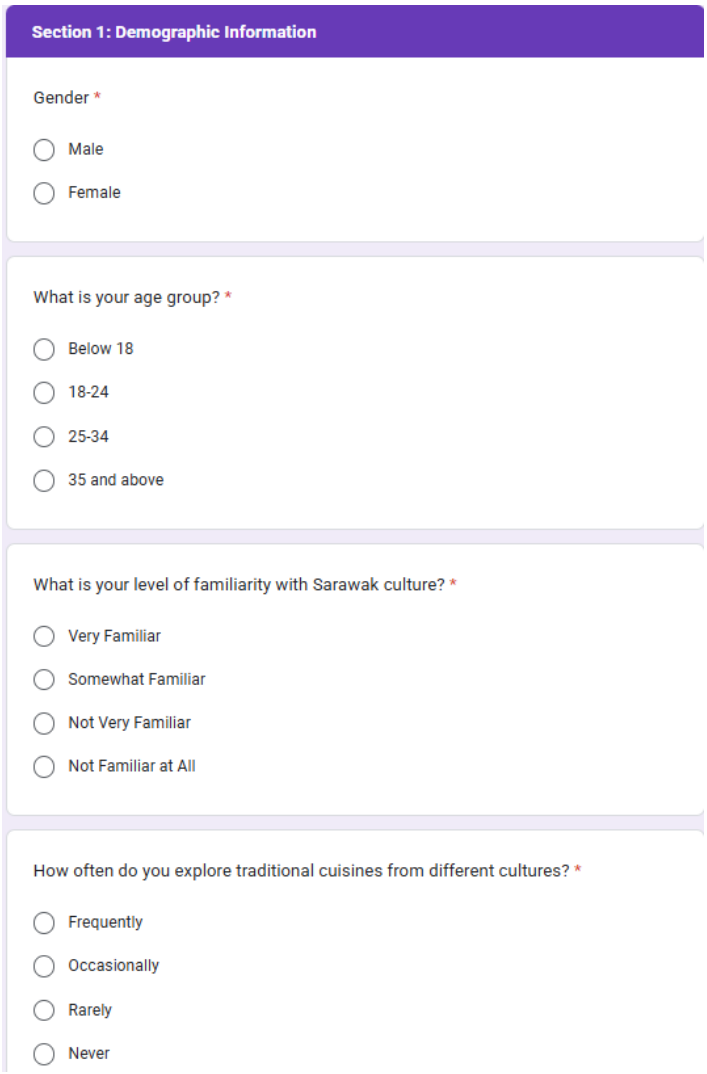
Appendix C: User Requirements Survey Form



Section 1: Demographic Information

Gender *

- Male
- Female

What is your age group? *

- Below 18
- 18-24
- 25-34
- 35 and above

What is your level of familiarity with Sarawak culture? *

- Very Familiar
- Somewhat Familiar
- Not Very Familiar
- Not Familiar at All

How often do you explore traditional cuisines from different cultures? *

- Frequently
- Occasionally
- Rarely
- Never

Section 2: Awareness of Iban Cuisine

Have you heard of Iban cuisine before? *

- ◯ Yes
- ◯ No

If yes, how did you come across Iban cuisine? (Select all that apply)

- ☐ Through friends or family
- ☐ Through social media
- ☐ Through travel to Sarawak
- ☐ Through cultural events or festivals
- ☐ Other (Please Specify)
- ☐ Other: _____

Which of the following Iban dishes are you familiar with? (Select all that apply) *

- ☐ Pansuh Ikan Sultan
- ☐ Sup Salai Terung Asam
- ☐ Buah Dabai
- ☐ None of the above

How would you rate your knowledge of Iban culinary traditions? *

- ◯ Very Knowledgeable
- ◯ Somewhat Knowledgeable
- ◯ Minimal Knowledge
- ◯ No Knowledge

Section 3: Interest and Engagement

Would you be interested in learning how to cook Iban dishes? *

- ◯ Very Interested
- ◯ Somewhat Interested
- ◯ Neutral
- ◯ Not Interested

Which aspect of Iban cuisine interests you the most? *

- ◯ Ingredients and cooking techniques
- ◯ Cultural significance of dishes
- ◯ Flavor profiles and taste
- ◯ Not particularly interested

How likely are you to use an AR-based application to learn about traditional cuisines? *

- ◯ Very Likely
- ◯ Somewhat Likely
- ◯ Neutral
- ◯ Not Likely

Section 4: Feedback on Learning Preferences

Which of the following features would you find most useful in an AR-based cooking application? (Select all that apply) *

- [ ] Step-by-step cooking instructions
- [ ] 3D models of dishes and ingredients
- [ ] Audio guides for pronunciation of dish names
- [ ] Videos demonstrating cooking techniques
- [ ] Interactive activities for virtual cooking

What challenges do you usually face when trying to cook traditional dishes from another culture? (Open-ended) *

Your answer

Would you prefer the application to provide cultural background information for each dish? *

- ◯ Yes, I find cultural context interesting and important
- ◯ Maybe, a brief summary would be sufficient
- ◯ No, I am more interested in the cooking process only

How important is it for you to know the correct pronunciation of Iban dish names? *

- ◯ Very Important
- ◯ Somewhat Important
- ◯ Not Important

Section 5: User Experience Expectations

What type of visual elements would make the learning experience more engaging for you? (Select all that apply) *

- [ ] Realistic 3D models
- [ ] Can interact with 3D models
- [ ] Bright and colorful animations
- [ ] Step-by-step easy cooking recipes
- [ ] Interesting cooking video tutorial

Would you be interested in participating in user testing of the AR application once it is developed? *

- ◯ Yes
- ◯ Maybe
- ◯ No

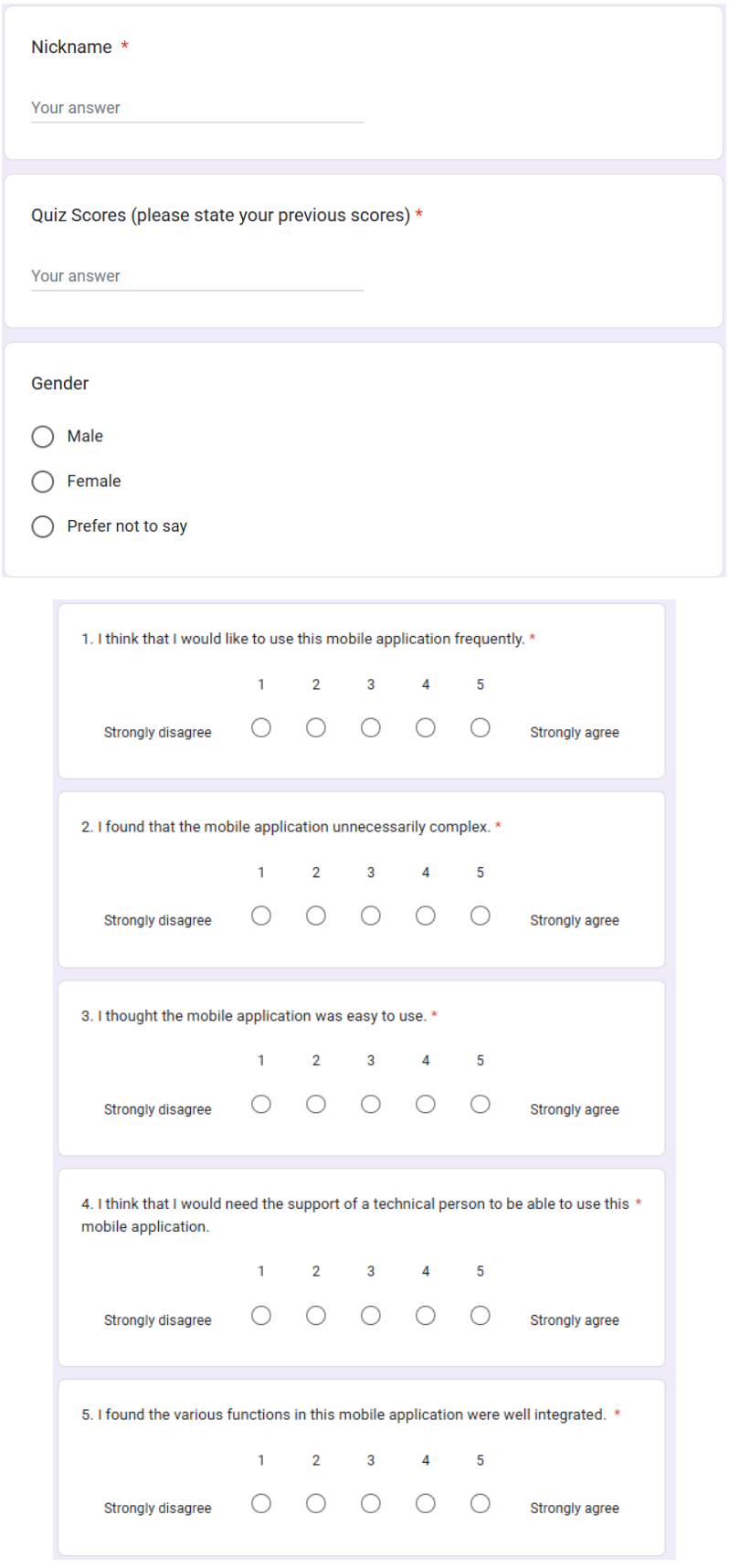
Would you be willing to share your experience of using this AR application to help others learn about Iban culture? *

- ◯ Yes
- ◯ Maybe
- ◯ No

Any other comments or suggestions regarding Iban cuisine or the idea of learning about it through an AR application? (Open-ended) *

Your answer

Appendix D: System Usability Score Survey Form



Nickname *

Your answer

Quiz Scores (please state your previous scores) *

Your answer

Gender

- Male
- Female
- Prefer not to say

1. I think that I would like to use this mobile application frequently. *

	1	2	3	4	5	
Strongly disagree						Strongly agree

2. I found that the mobile application unnecessarily complex. *

	1	2	3	4	5	
Strongly disagree						Strongly agree

3. I thought the mobile application was easy to use. *

	1	2	3	4	5	
Strongly disagree						Strongly agree

4. I think that I would need the support of a technical person to be able to use this mobile application. *

	1	2	3	4	5	
Strongly disagree						Strongly agree

5. I found the various functions in this mobile application were well integrated. *

	1	2	3	4	5	
Strongly disagree						Strongly agree

6. I thought there was too much inconsistency in this mobile application. *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

7. I would imagine that most people would learn to use this mobile application very quickly. *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

8. I found the mobile application very difficult to use. *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

9. I felt very confident using the mobile application. *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

10. I needed to learn a lot of things before I could get going with this mobile application. *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Appendix E: Evidence for User Testing, Targeting Non-Iban Users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