

MAKULIT: A Gamified Mobile Application for Interactive Kapampangan Language and Kulitan Learning

Hennessy S. Almonia¹, Paolo P. Cabigting², Arian R. Salvador³, Rayben S. Santos⁴, Christian D. Velasquez⁵,

¹ College of Computing and Information Sciences, Systems Plus College Foundation, Angeles City, Pampanga, Philippines

*Corresponding Author Email: hens.almonia@gmail.com

ABSTRACT

In this study, MAKULIT: A Gamified Mobile Application for Interactive Kapampangan Language and Kulitan Learning is a mobile learning application for Kapampangan vocabulary and basic Kulitan writing skills. This study addresses the need for accessible and interactive digital teaching materials for Kapampangan language and traditional writing systems. MAKULIT is a dictionary containing two types of entries: Kapampangan and English words along with their definitions, pronunciation, and guidance on how to write the Kapampangan words, with some interactive activities, gamification elements (points, rewards, challenges, feedback, progress tracking), and a special section for tracing the Kulitan characters. The application is designed using the Agile Scrum methodology, and the evaluation is carried out with a descriptive-developmental research design using a quantitative method. A panel of selected IT professionals and students from the Systems Plus College Foundation evaluates the software quality, usability, functionality, efficiency, reliability, compatibility, and interactive learning experience of the application. The study is not concerned with advanced mastery of language or language conservation, but rather basic to intermediate acquisition of the Kapampangan language and basic to elementary literacy of Kulitan. MAKULIT is set to be a mobile, accessible, and interactive language learning tool that integrates language learning with traditional writing-system training and gamification in one place.

Keywords: *Kapampangan Language, Kulitan, Mobile-Assisted Language Learning, Gamification, Mobile Application, Language Learning*

SECTION I — INTRODUCTION (THE PROBLEM AND ITS SETTING)

1.1 Introduction

Language is an important part of a community's cultural identity, as it provides a means of expressing knowledge, traditions, values, and shared experiences. This is hugely important as society and technology continue to change, affecting language learning and use and the process of intergenerational transmission of local and Indigenous languages. Digital technology has increasingly been acknowledged as a way to preserve, revitalize, and promote Indigenous and minority languages in response to the concerns mentioned above. UNESCO (2023) emphasizes that digital tools can provide opportunities to conserve and promote languages while making language resources more accessible to contemporary users.

In Central Luzon, Philippines, a variety of languages and cultural traditions exist. One of these is the Kapampangan language that closely relates to the Kapampangan community's culture. For younger people, the importance of preserving and continuing the use of local languages is even more relevant, as the use of language may change when interacting with other widely used languages and various ways of communication. These changes and the ongoing significance of Kapampangan for its community have been explored in recent

Kapampangan studies.

The Philippines has more than 187 languages spoken by the scattered population. Tagalog, Cebuano, Ilokano, Hiligaynon, Bikol, Samar-Leyte, Kapampangan, Pangasinan, Marano, and Maguindanao are spoken by a million people each as significant languages. The primary language of Kapampangan is used primarily in the province of Pampanga. The speakers are from the southern part of Tarlac, northeastern Bataan, Bulacan, Nueva Ecija, and Zambales. In older times, Kapampangan is also referred to as Amánung Sísuan, meaning “language nurtured from the mother’s breast”, and in current times, as Indúng Kapampangan, meaning the “mother of all Kapampangans. In addition, Kapampangan is a unique language with its own writing system called Kulitan or ‘Súlat Kapampáŋan’. The script is a modern one for writing the Pampanga or Kapampangan language (ISO 639-3:pam) of the province of Pampanga. Although not the main script for the language, Kulitan is used by some Kapampangan speakers in addition to the regular Latin script of the language.

Concurrently, education is becoming significantly more mobile thanks to the fact that the learning environment is becoming flexible and mobile devices can deliver content and activities to the learner. Mobile games have recently been investigated as a means of language instruction. Liu et al. (2025) used a meta-analysis of 38 experimental and quasi-experimental studies, which included 4,102 students, to reach a conclusion that mobile games generally have a positive impact on language-learning outcomes, especially in vocabulary and pronunciation.

Adding game elements to learning can also give learners a more interactive learning. Gamification enables education to include aspects of games like challenges, rewards, feedback, and progression. If these elements are well designed, they can complement the learning activities and stimulate learners to actively take part in the learning process. The development of mobile game-based language learning research shows that language learning can be combined with interactive learning and mobile technology in language learning.

Given the cultural importance of Kapampangan and Kulitan, as well as the possibility of modern technology and mobile technologies in language learning, the need to create learning materials that integrate cultural education into modern technology is clear. This can serve as an alternative way for students to learn, experience and appreciate the Kapampangan language and writing system.

To address this, the present study introduces a gamified mobile application (MAKULIT) to assist interactive Kapampangan language learning and Kulitan learning. The proposed application will enable a mobile learning platform that includes a Kapampangan dictionary, pronunciation tools, tutorials for the learning of Kulitan writing system and gamified learning activities. These features aim to make Kapampangan language and Kulitan writing an accessible and engaging means for students. Students of SPCF will be the respondents of the study, and the use of mobile learning and a gamification approach in supporting the learning and engagement of Kapampangan and Kulitan will be explored.

1.2 Background of the Study

The Kapampangan language is valued as an integral component of the Central Luzon communities' culture and heritage. The ongoing use and transmission of the language, however, have been affected by social, cultural, and technological change. Gutierrez (2022) studied language use within Kapampangan-speaking families and concluded that there was evidence of language shift towards the Tagalog and English languages. The study found a variety of factors that contribute to this change, such as modernization, globalization, technology, and changes in language use in families. The results also showed some lack of knowledge by younger members of the community of some Kapampangan vocabulary.

Gutierrez (2024) also studied the changes of the Kapampangan language based on historical texts, historical dictionaries, interviews, and word lists with participants from different regions of the Kapampangan-speaking region. The study noted the impact of Tagalog on Kapampangan, with the assimilation of Tagalog elements by younger speakers. The factors associated with language change identified were also social media and technological innovations. These findings indicate that Kapampangan is still developing and it shows that it is

still important to provide opportunities for younger generations to remain familiar with the language.

The Kapampangan people also have a traditional writing system known as Kulitan. Promoting and sustaining Kulitan as a cultural heritage of Kapampangan can contribute to the language and cultural awareness of Kapampangan. Juarez et al. (2023) examined the potential of infographics to promote the Kulitan script, which they have found to be an effective means of raising awareness and interest in the script. Digital and social media were also identified as opportunities to reach the younger generation and foster an understanding and appreciation of Kulitan's culture.

While there has been some effort to promote Kapampangan and Kulitan, there is a need for learning materials that allow learners to interact with and practice the language and writing system, and that offer learning opportunities for the learner. Infographics and other informational resources can be used to introduce the learner to Kulitan, but this may not give the learner sufficient opportunities to practise vocabulary, pronunciation, and writing skills. This affords the opportunity to consider a more active digital learning model, which enables students to be actively engaged with the content and not just receive it.

Digital technology could provide a means of supporting this approach. UNESCO (2023) emphasized the role of online and digital tools in activities related to the conservation, revival, and promotion of Indigenous, minority, and marginalized languages. It provides recommendations on Indigenous languages, such as approaches for using languages in digital environments and creating digital technologies that can help preserve and promote Indigenous languages. This highlights the potential of digital technologies to enhance traditional language documentation and learning practices.

Previous studies have also discussed matters concerning the Kapampangan language in the context of Systems Plus College Foundation (SPCF) in Angeles City, Pampanga. Canlas et al. (2022) explored the factors contributing to Kapampangan language endangerment among the Kapampangan students in junior high school at SPCF. The present study builds upon this institutional context by approaching the issue from a technology and education perspective, focusing on the development of a mobile application that supports Kapampangan and Kulitan learning and engagement.

In view of these factors, there is a possibility of learning approaches that integrate language learning, cultural awareness, mobile technology and gamification. Studies have already focused on the promotion of Kapampangan and Kulitan, digital and game-based learning. However, research on gamified mobile learning applications that integrate Kapampangan vocabulary with interactive Kulitan writing exercises in a local educational context remains limited.

To address this, the study presents the prototype of an application which is called MAKULIT: A Gamified Mobile Application for Interactive Kapampangan Language and Kulitan Learning. The proposed application is a combination of a Kapampangan dictionary, support for pronunciation, Kulitan writing practice, and gamified learning activities in one mobile learning environment. MAKULIT is not only an informational tool, but also a tool that allows learners to interact with, practice, and reinforce selected Kapampangan vocabulary and basic Kulitan writing skills. The study will evaluate the application's functionality, usability, and user engagement among selected SPCF students.

1.3 Objectives of the Study

General Objective: The general objective of the study is to develop MAKULIT: A Gamified Mobile Application for Interactive Kapampangan Language and Kulitan Learning.

Specific Objectives:

1. Design the mobile application using the right technologies in mobile development including the Kulitan chart, classification of vowels and consonants, interactive tracing of characters, and a Kapampangan dictionary with English definition;
2. Gather and organize selected Kapampangan vocabulary with their definitions, pronunciation and

corresponding Kulitan representations to be included in the application;

3. Create interactive activities that could assist the user in mastering Kapampangan vocabulary and some basic skills in writing Kapampangan using Kulitan;
4. Add gamification elements like points, rewards, challenges, and progress tracking to incentivize users to engage in Kapampangan practices and use it more often;
5. Combine the language resources, learning activities and gamification into a single mobile learning application; and
6. Evaluate the created application using the functional suitability, usability, performance efficiency, reliability and compatibility of selected IT professionals and students of Systems Plus College Foundation (SPCF).

1.4 Scope and Limitation of the Study

Scope: The purpose of this research is to develop MAKULIT, a gamified mobile learning application to assist the Kapampangan vocabulary learning and basic Kulitan writing. The application is equipped with a Kulitan chart of vowels and consonants, interactive character tracing and a Kapampangan dictionary with English definitions, pronunciations, synonyms, antonyms and corresponding Kulitan symbols. It also offers points, the reward system and matching activities, writing exercises, and progress tracking to incentivize the practice and maintenance of the learning process. All these features are consolidated into one mobile platform that enables you to study vocabulary, improve your pronunciation and acquire basic Kulitan writing skills. Functional Suitability, Usability, Performance efficiency, Reliability and Compatibility are the factors by which the application will be evaluated by selected IT professionals and students of Systems Plus College Foundation (SPCF).

Limitation: The basic-to-intermediate Kapampangan vocabulary and basic-to-elementary Kulitan literacy are the focus of the study. It does not include advanced grammar, complex sentence structure, fluency of conversation, nor a complete account of all the variations in the Kapampangan language in the different communities. The application is not based on a typical digital font implementation as there is limited Unicode support for the traditional Kulitan script. Testing will also be done with a small number of selected users, and will concentrate on the use of the application, the level of engagement with the application by the users, and the functional aspects of the application, rather than on the application's role in language maintenance or formal use in academic curricula.

1.5 Significance of the Study

The significance of the proposed study is to make learning the Kapampangan language and Kulitan writing system more accessible and interactive using the use of gamified mobile applications. It utilizes a mobile learning and gamification platform to facilitate the learning and practice of Kapampangan vocabulary, pronunciation, and basic Kulitan writing, as well as to promote the appreciation of the language and its cultural heritage.

Kapampangan Learners. The study can benefit Kapampangan learners by providing an interactive platform where they can learn and practice vocabulary, pronunciation, and basic Kulitan writing. The addition of activities, challenges, rewards and progress tracking is designed to promote ongoing practice and help keep learning fun.

Non-Kapampangan Learners. The application can also be useful for individuals who are interested in learning the Kapampangan Language and Kulitan script. MAKULIT's structure of vocabulary, English definitions, pronunciation, and writing exercises can facilitate the exploration and understanding of the language and its

writing system.

Younger generation. The study can help motivate young Kapampangan users to be more interested in the Kapampangan language and culture. The mobile-based and gamified approach might offer a learning experience that is more familiar and engaging to technology-oriented learners, as the application uses this approach. **Kapampangan Community.** The proposed application can play a role in the further development and maintenance of the Kapampangan language and Kulitan writing system. The application will facilitate continued exposure and learning through selected Kapampangan vocabulary and Kulitan learning materials as digitized learning tools.

Teachers and Educators. The application can be used as an additional learning resource by teachers who teach and introduce Kapampangan language and Kulitan. The interactive activities might also offer another means of reinforcing classroom conversations and self-study.

Researchers and Developers of the Future. The study might be used by future researchers and developers, who will be interested in the language-learning applications, gamification, mobile-assisted language learning, indigenous language or regional language preservation, and digital representation of traditional writing systems. It might also serve as a foundation for developing further applications for the use of Philippine languages and cultural heritage.

In total, the study is expected to prove the effectiveness of mobile technology and gamification in making the study of language more interactive, including language preservation, promotion, and further learning of the Kapampangan Language and Kulitan writing system.

1.6 Definition of Terms

Makulit - This refers to the proposed Mobile Application for interactive Kulitan Learning with a Kapampangan Dictionary, the main output of this study that integrates a Kapampangan dictionary, pronunciation tools, Kulitan writing tutorials, and gamified learning activities.

Kapampangan - This is used by people who speak it as their native tongue in Pampanga and in parts of the Tarlac, Bataan, Bulacan, Nueva Ecija, and Zambales provinces. In this study, the word “local language” is used to indicate the local language in which the terms, pronunciation, and meaning of the dictionary feature of the application will be focused.

Kulitan (Sulat Kapampangan) - is the traditional, indigenous abugida writing system of the Kapampangan people in Pampanga, Philippines.

Amanung Sisuan - It is an old term used to refer to the Kapampangan language, literally “language cultivated from the breast of mother.

Indung Kapampangan - literally “the mother of all Kapampangans” is a term used to describe the Kapampangan language in present times.

Mobile Application - These are software programs that are made for running on the cell gadgets personified by handsets and tablets. For this study, it is the same as MAKULIT, which is developed and deployed for use by selected respondents.

Mobile-Assisted Language Learning (MALL) - These are the use of mobile devices and technology to support and enhance the language learning process. In this study, this means the overall methodology used in the design of MAKULIT for the delivery of Kapampangan and Kulitan lessons by a mobile platform.

Gamification - When game mechanics or structures, like points or rewards, challenges, and progress tracking, are introduced in contexts outside of gaming, such as education. In this study, it is the characteristics contained in MAKULIT designed to boost the interest and participation of users in learning.

Language Preservation - Activities in which a language (or languages) is preserved and maintained against a risk of decline or endangerment. For this study, it means the aforementioned overarching objective of MAKULIT,

which is to expose and expose to a greater extent, the younger population to the Kapampangan and Kulitan languages and encourage them to practice and use them.

Language Revitalization - is the process of reviving the use of a languishing language among a community, especially among young people. For this study, it means the goal or purpose of using the application to promote a renewed interest and usage of Kapampangan.

Language Shift - This is the progressive change of the preferred language of a community and, in Kapampangan's case, the transition from Kapampangan to Tagalog or English among the younger.

Intergenerational Transmission - the process in which a language continues to be transmitted from generation to generation. In this study, it can be said to be the continuity of Kapampangan and knowledge of Kulitan used by the younger users of the application.

Vocabulary Acquisition - The acquisition of new words and their meanings. For the purposes of this research, it means the learning outcome that is supported by the Kapampangan dictionary in the context of interactive exercises of MAKULIT.

Character Tracing - An interactive activity that involves tracing the strokes of written characters to help students practice writing the characters. In this study, it means the special feature of MAKULIT that enables users to practice Kulitan characters on the mobile device.

Pronunciation Assistant - A tool or feature that supports the user in terms of pronunciation assistance. It is a referent of the part of MAKULIT that provides word pronunciation for Kapampangan to users in this study.

Kapampangan Dictionary - This category is a reference that features Kapampangan words with appropriate English translation, synonyms, antonyms, pronunciation, and Kulitan script equivalents as integrated in MAKULIT

Digital technology/digital tools - used to create, store, process, or communicate information. In this study, it is short for mobile platforms and technologies adopted to develop and deliver MAKULIT.

Indigenous/Minority Language - A language indigenous to a particular community or region, and typically one spoken by fewer speakers than a more widely-used language. In this study, it means the Kapampangan language is used as a local language to focus on preservation and learning.

Functionality - ability to perform intended tasks and features correctly by a system or application. In this research, it is associated with one of the criteria that are employed to evaluate MAKULIT to determine whether it works as it was designed or not.

Usability - This is how easily users are able to learn, use, and understand a system or application. In this study, it means one of the factors that are measured to determine the usability of MAKULIT by the target users.

User Engagement - This is the degree of interest a user shows in an application, interest in participation, and the degree of continued interactions with the application. In this study, it means one of the factors for users' evaluation is whether they are motivated and involved when using MAKULIT, especially in the gamified elements of MAKULIT.

Respondents - refer to the students of Systems Plus College Foundation (SPCF) who were selected to participate in the testing and assessment of the MAKULIT mobile application. They provided responses and feedback based on their experience using the application during the study.

SECTION II — LITERATURE REVIEW

2.1 Introduction to the Review

This chapter summarizes the related literature and studies regarding the Kapampangan language learning, the preservation of the Kapampangan language and the Kulitan writing system, and digital technologies in language

learning. The literature review is organized under various themes: Kapampangan language and language preservation; Kulitan writing system; Mobile applications for language learning; Gamification in education; Digital dictionaries; Interactive methods in language learning about writing systems. Studies and research on indigenous and minority languages are also reviewed to determine approaches, technologies, and learning strategies that are relevant to the development of the proposed application. The review ends with a synthesis of the results and the research gap that the MAKULIT application wants to address.

2.2 Review of Related Literature and Studies

2.2.1 Kapampangan Language and Language Preservation

Language preservation is a crucial issue for Indigenous and minority communities, and the use and intergenerational transmission of many of their languages is decreasing. Meighan (2021) outlined that digital and online technologies can play a role in the revitalization of Indigenous languages, providing opportunities for language learning, community engagement, and use in various social domains, and that Indigenous languages remain under threat. The study also highlighted the need to design and implement technology within the context of the needs and selves of the communities whose languages are being preserved. Likewise, Meighan (2022) explored a version of CLC that integrates traditional ecological knowledge with technology for the acquisition and intergenerational transmission of Indigenous languages. The study showed that technology can be a complement to but not a substitute for, community-based language revitalization initiatives.

Social, institutional and linguistic aspects also play a role in language preservation in the Philippine context. In their review of language maintenance and revitalization of Indigenous languages in Bukidnon, Alejan et al. (2021) emphasized the importance of the strategies to face language endangerment and promote the use and transmission of Indigenous languages. Likewise, Mabuan (2021) studied the ethnolinguistic vitality of the Dumagat communities in Aurora, Bulacan, and Quezon, which revealed that social factors, institutional support, language contact, attitudes, and language usage patterns had an impact on language vitality. The results of this research show that, besides documentation, the use and transmission of the language within the community is also important for the preservation of the language.

Additionally, Canlas et al. 's (2022) study is more directly related to the educational sphere of the present study, in which they studied the factors associated with Kapampangan language endangerment among the Junior High School students of Systems Plus College Foundation. The researchers took into account intergenerational language transmission, availability of written materials for language education and literacy, reaction to new domains and media, institutional language attitudes and policies, community attitudes, and language documentation. The results of the study serve as a relevant basis in the local context for considering educational materials and modern media in learning and preservation of the Kapampangan language.

Overall, the reviewed literature indicates that language transmission, community attitudes, social changes, education, and access to modern technologies are among the factors that affect language preservation. The literature in the world demonstrates the possibilities for technology to assist with community-based revitalization, and studies in the Philippines and Kapampangan show the problems that can arise with the continued use of local languages. The results of these findings serve as the basis for studying an accessible digital learning resource to facilitate and aid the Kapampangan language in the learning and preservation of younger learners.

2.2.2 Gamified Application as Applied to Language Learning

The ubiquity of smartphones and game design has led to mobile-assisted language learning (MALL) being one of the most dynamic fields in educational technology internationally. Ishaq et al. (2021) conducted a systematic review of sixty primary studies, finding that researchers around the world have created a variety of simple and gamified mobile applications for language learning, based on different theories, frameworks, and development tools, and most of the work has been conducted in Asian contexts and focused on English as

the target language. They also use grammar, where the skill areas are most easily practiced in short, repeated, self-paced sessions on a handheld device. A parallel study by Shortt et al. (2023) reviewed 267 records and analyzed 25 studies that were published from 2012 to early 2020 specifically on the most gamified MALL application in use, Duolingo. They noted that the platform's appeal was largely based on gamification features like challenging tasks, reward incentives, levels, and user rankings based on achievements, but that most of the current research was design-oriented, quantitative, and used non-probability sampling. Importantly, Shortt et al. (2023) pointed out that the field has focused on the development of tools and not on the learning that occurs from using them, which is directly relevant to a capstone that develops an application and assesses its use.

In the Philippines, the research has shifted from testing game activities to developing and evaluating gamified mobile apps as teaching tools. Abenes et al. (2023) designed a Science-Inclusive gamified Mobile Application (SIGMA) for a Grade 8 mainstream class in a public school in Mandaluyong City based on a systematic literature search that calculated effect sizes for each gamification element. These results can be directly applied to application development: the effect size of storytelling ($g = 2.121$) was larger than that of its absence, as was the effect of responsive feedback ($g = 1.463$), timed activity ($g = 1.422$), badges ($g = 1.333$), competition ($g = 1.210$), advancement ($g = 1.180$), leaderboards ($g = 1.142$), and points ($g = 1.085$). Results of the post-implementation revealed a significant increase in learners' performance from a pre-test mean of 10.15 to a post-test mean of 26.73 out of 20. The authors also said that the respondents themselves wanted offline access, cross-device support, and availability on the app store, things that any app built by a Filipino needs to take into consideration. In line with this developmental approach, Toraja (2026) used a quasi-experimental and qualitative design with Grade 9 learners who were taught using Kahoot, Wordwall, and Quizizz on DepEd-procured tablets, and found that the achievement advantage was statistically significant for the gamified group. The learner interviews and focus group discussions are also informative, as students found the activity to be fun, innovative, and accessible. It also helped them to build their ICT skills, but it also highlighted technological issues, loss of focus, and less interaction with peers and the teacher. These national studies collectively validate the positive results of gamification in the Philippines' classrooms and highlight the various challenges of implementation, including connectivity, dependence on devices, and reduced social interaction.

When restricting literature to those that focus on the gamified application as language teaching tools, the evidence base is generally positive but with caveats. In their systematic review of empirical studies on gamification in EFL/ESL teaching, Zhang and Hasim (2023) reviewed the positive and negative impacts of gamified language activities and emphasized the need for teachers and researchers to have sufficient knowledge of the mechanisms that underlie gamification rather than assuming that game elements are always beneficial. In conjunction with this, Zolfaghari et al. (2025) performed a PRISMA-ScR scoping review of 33 studies from 2010 to 2024, which included 2,531 students in intervention studies. Their findings act as design specifications: quasi-experimental pretest-posttest designs were common, online delivery was the most common, and feedback was the most common gamification element, while challenge-based mechanics that keep learners engaged were also common. The review found that gamified applications work best to increase motivation and engagement, which is a key difference, as increased motivation does not necessarily lead to measurable proficiency gains.

Literature is less abundant within Central Luzon, but consistent. In the study conducted by Dela Cruz et al. (2025), with the participants being junior high school students from private schools in Bulacan, the researchers examined the relationship between AI-based gamified learning tools and language proficiency and student engagement, which were grounded on the theories of Constructivism, Self-Determination Theory, and Flow Theory. They found that the meaningful incorporation of gamified tools can positively impact language learning proficiency and engagement, and suggested that institutions invest in these technologies, develop teachers' digital pedagogical competence, and adopt language programs to incorporate them (Dela Cruz et al., 2025). Meanwhile, local evidence warns that mobile phones are not a neutral delivery vehicle. Fernandez et al. (2024) in a mixed-method sequential explanatory study of 643 senior high school learners from a public school in the Division of Pampanga, concluded that excessive screen use was linked to higher levels of stress, compulsive behavior, and reduced self-control, and suggested the need for intentional management of digital resources and a more balanced use of mobile

phones. In the context of a language-learning application like MAKULIT, the results indicate that gamification should be employed to facilitate rather than to keep users engaged in the app for longer durations. Learning activities need to be purposeful, manageable and pedagogically structured. This will be especially significant if creating a mobile application will be used to teach Kapampangan vocabulary and Kulitan writing; the game elements should not be the primary purpose of the application but rather help the learning of the Kapampangan words and the Kulitan writing.

2.2.3 Kulitan Writing System and Cultural Preservation

There is a growing trend of supporting indigenous languages and writing systems with digital tools that offer opportunities for documentation, access and cultural transmission. Sundani (2023) examined how digital technologies can help provide contemporary environments for documenting and sharing Indigenous language knowledge and facilitate Indigenous language access, promotion and preservation. The study also emphasized the potential of digital platforms to contribute to the visibility of Indigenous languages by providing access to language resources for language learners and communities. These are applicable to Kulitan, where digital learning resources can be used to reach and practise the traditional Kapampangan writing system in alternative ways. This is especially important when discussing Indigenous writing systems, as preservation must not only maintain historical documents, but there is a need for learners to experience and understand traditional Indigenous written forms. Digital technologies can thus offer a way of communicating linguistic knowledge, writing systems, and cultural resources in ways that can be understood by younger generations. In this respect, Digital Preservation can support awareness of indigenous languages and indigenous writing systems, as well as their adaptation in the context of new technological environments.

Mobile-assisted learning also offers opportunities for the enhancement of interactive and accessible language and literacy education. In this systematic review of collaborative mobile-assisted language learning (C-MALL), Guo et al. (2024) investigated the integration of mobile technologies in language-learning activities. The results show that mobile environments are able to offer learners flexible opportunities to access language materials outside the classroom. This is important when teaching writing systems, as students may need to be exposed to the system several times and then practice it over a period of time to become familiar with the system and the written forms they use. Mobile applications can offer activities where a user can identify symbols, work on writing, review vocabulary, and have the materials repeated. If mobile-assisted learning is used together with a learning support system like Kulitan, it can therefore be used as a complement to documentation so that linguistic information that has been recorded can be transformed into an activity that stimulates active participation and continued practice by the learners.

In the Philippines, digital language preservation has also been used in the preservation of indigenous languages, with issues regarding language transmission and the limited educational resources of indigenous groups. Abingosa et al. (2025) created a culturally responsive mobile app for the language Higaonon, which was enriched with multilingual search, phonetic transcriptions, example sentences, offline capability, and culturally relevant content. The researchers participated in the development process, involving Indigenous elders, educators, and younger community members in the process, highlighting the need for community knowledge in creating language preservation technology. The study also showcased the benefits of using a mobile application to both learn the language and to keep it easily accessible as a repository of Indigenous linguistic knowledge. It was not a traditional writing system but rather the Higaonon language was used, but the methodology can be relevant to Indigenous writing systems in the Philippines. A digital learning environment can present the vocabulary, pronunciation, written representations and instructional materials in a single place. This can serve as a helpful foundation for developing new learning technologies that link language learning to the maintenance and ongoing access to Indigenous cultural knowledge.

In the Kapampangan context, digital and visual materials have also been demonstrated to be effective tools in disseminating awareness on Kulitan. De Guzman et al. (2023) employed infographics in the presentation of information on the Kulitan script and its historical and cultural context. They found that visuals could help to make the information about the script more accessible and interesting, especially for younger people. It also highlighted the need for social media to share information and raise awareness about Kulitan. Based on these findings, it can be concluded that such materials, which are accessible and engaging to students, can help to increase students' exposure to the writing system and develop interest in learning it

Results from these research studies guide the integration of language instruction and technology/digital activities. Sundani (2023) explored the potential of digital technologies for the enhancement of Indigenous language materials, and Guo et al. (2024) examined the potential of mobile learning environments for flexible and interactive language-learning opportunities. Likewise, Abingosa et al. (2025) identified the promise of culturally responsive mobile apps to enhance access to and retention of Indigenous language skills. Moreover, in the Kapampangan context, De Guzman et al. (2023) also illustrated how visual communication can be utilized to introduce Kulitan and to disseminate its cultural meaning. Collectively, these studies provide justification for using accessible digital resources, interactive activities and visual materials in language learning and cultural education.

The findings of this study will be useful in the development of MAKULIT: A Gamified Mobile Application for Interactive Kapampangan Language and Kulitan Learning in the Philippines. The application that is being proposed constitutes an implementation of the concepts applied in a mobile platform that incorporates Kapampangan vocabulary, meanings of the words, pronunciation support, representations of Kulitan, and interactive learning activities. The application is not only about preserving the language, it is also about the learners getting accustomed with Kapampangan words and their representation in the Kulitan writing system. Through this, the study becomes related to language learning and exposure to the important aspect of Kapampangan cultural heritage.

2.2.4 Digital Dictionaries and Language Learning Resources

The digital dictionary is still an important tool in language learning because it gives learners instant access to the meanings of words and other lexical information. A meta-analysis by Zhang, Xu, and Zhang (2021) with 44 studies and a total of 3,475 participants showed that the use of a dictionary could significantly impact second-language vocabulary acquisition. The results they found suggest that dictionaries may assist in vocabulary development in a variety of learning situations but with varying degrees of effectiveness depending on the type of learning situation, the type of dictionary used, and the learner's characteristics. The results justify the importance of dictionary-based resources as a basis for learning vocabulary and offer some of the grounds for using dictionary functions in technology-based language learning applications.

Advancements in digital learning technologies have increased the ways in which learners engage with vocabulary resources. In their 2022 study on 34 studies with 2,511 participants, Yu and Trainin discovered the general impact of technology-assisted second-language vocabulary learning to be moderate and positive. They also found that in the studies examined, the outcome of mobile-assisted vocabulary learning was better than computer-assisted vocabulary learning. The researchers highlighted that technology can offer opportunities for practice and meaning-making via various media such as audio, images, and access to the learners' first language. Based on this, it can be concluded that a mobile dictionary is more than a reference book of words by adding multimedia and interactive learning elements to it.

Online dictionaries can also facilitate learning when incorporated into a structured language activity. Ebadi et al. (2022) studied the application of flipped vocabulary learning with the help of an online dictionary on 60 ELL learners. They conducted their research on the use of an online dictionary in the teaching of vocabulary and its correlation with learners' achievement. The study shows that the use of dictionary resources can be integrated into a wider learning process and not only in the process of finding the meaning of unknown words. This is also applicable to mobile language-learning apps, as entries in the dictionary may be linked to pronunciation, listening, and other interactive exercises.

Digital lexicography has also been used in the Philippines with local and Indigenous languages. In a paper presented at the 2023 International Conference of the Asian Association for Lexicography (ASIALEX), Sadural (2023) spoke about Project Marayum, an initiative by the University of the Philippines Diliman led and funded by the Department of Science and Technology that aims to be an online dictionary platform built collaboratively using mobile technology for Philippine languages. The project aims to facilitate the development of bilingual dictionaries and to engage communities and language professionals in the content management and community review of dictionaries. Kapampangan was one of the Philippine languages that were being collected for the platform during the time of the study. This shows the possibility of developing digital dictionary resources that are oriented towards languages of the Philippines and community

participation.

Moreover, the importance of documenting Kapampangan vocabulary is further supported by the study of Gutierrez (2024), which examined the changes in Kapampangan vocabulary through historical texts, dictionaries, word lists, and interviews with 62 Kapampangan native informants from 31 towns in the Kapampangan-speaking area. The study revealed that Kapampangan vocabulary has undergone changes over time which were affected by technological advancement and the use of social media today. The results of these findings indicate that it is important to document and make Kapampangan dictionary easily available, especially with the younger generation who face changing norms in the use and acquisition of Kapampangan.

In summary, the literature reviewed confirms dictionaries' role in vocabulary learning and the potential of digital and mobile technologies to increase the accessibility and interactivity of language resources. Other examples of digital lexicography for local languages are found in Philippine projects, like Project Marayum, that show how this can be an effective tool for local languages and for documenting and maintaining the Kapampangan vocabulary, a study of the language's vocabulary. Most of the current literature and resources, however, focus on dictionary functions, vocabulary learning, or documentation of a dictionary in a digital environment. This is an opportunity for MAKULIT to develop an integrated Kapampangan dictionary with pronunciation, interactive vocabulary activities, gamification, and Kulitan writing activities in one mobile learning application. The integration can make a dictionary a more interactive tool for language learning than a reference tool.

2.2.5 Interactive Learning for Language and Writing System

Interactive learning is a significant approach used in language education due to the importance of enabling learners to be active in the process of the activities and not just passive of those who only listen to the teacher. In an effort to promote English writing-based task-based learning and gamification techniques, Pingmuang & Koraneekij (2022) created mobile language learning software. The participants of their research were lower secondary students, and their study was situated in a mobile space that utilized writing activities, feedback, revisions, and learner-centred activities. The results revealed that the application had a positive effect on the students' writing ability and that, generally speaking, the students felt it to be satisfactory. It indicates that mobile interactive activities could offer learners the opportunity to practice the target language by engaging them in structured tasks.

Likewise, Octaberkung and Rofiki (2021) studied the use of online games to learn vocabulary among EFL learners in Indonesia. Vocabulary activities were delivered using SpellingCity in the study, and students' feelings of usefulness in learning the words and practicing pronunciation were observed. The researchers also highlighted the simplicity of the interface, which enhanced interest and user-friendliness for the learners. The outcomes indicate the application of interactive digital exercises in language learning training, which is able to utilize the benefits of practice, interactive learning, and multimedia materials that are accessible to students. These methods are applications that are designed to build up vocabulary while keeping up students' interest.

Magnaye (2024) came up with the idea of designing a game-based instructional material, which he named Tumbang Salita, to aid in teaching vocabulary to select Grade 7 students in the Philippines. The study was based on employing a game-based teaching and learning method that enables learners to practice vocabulary in a fun way to develop them in the context of using the Filipino language. The game demonstration illustrates how the interactive learning strategy could be introduced in the language teaching and learning process as a means to motivate and give opportunity for learners to practice their language. This also applies to MAKULIT since similar activities involving interactivity and games are provided to help learners practice and reinforce Kapampangan vocabulary.

Tapales (2023) reviewed the application of gamification in L2 learning and outlined the potential of adopting game features for supporting learning and evaluation processes at the local level. The study pinpointed properties that could inspire learners to engage in language-learning tasks such as rewards, feedback, and progression. The results indicate that the gamification approach can create a student-friendly atmosphere for teaching language and simulate active learners' involvement. It is relevant to MAKULIT since the proposed application involves points, rewards, challenges, and progress tracking towards Kulitan learning and

Kapampangan language learning in an interactive scenario.

Based on the aforementioned studies, the present study introduces a gamified mobile application named MAKULIT: A Gamified Mobile Application for Interactive Kapampangan Language and Kulitan Learning. While it focuses mainly on dictionary content or on the digitization of cultural resources, MAKULIT combines the study of Kulitan and vocabulary that are interactive in nature in learning the language of Kapampangan. The application features a Kulitan character chart, character tracing and writing exercises, Kapampangan Dictionary, pronunciation assistance, matching activities, points and rewards, challenges, progress tracking, and more. These features were developed to allow learners to interact with the language as well as the traditional writing system and not just to see information.

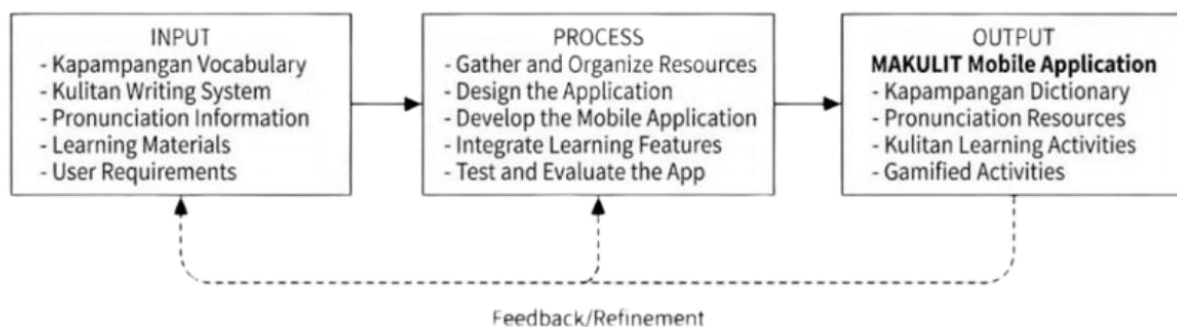
The literature reviewed overall shows that both IL and MAL offer opportunities to practice the language, expand vocabulary, engage in writing, and participate and interact with the language. The experience from the global studies indicates that mobile applications, games, task-based activities, and interactive exercises are useful tools, and those from Philippine and local studies show the value of using electronic tools to document and make indigenous and Kapampangan cultural and linguistic resources more accessible. However, the applications examined in this overview tend to be dictionary or reference applications or applications built on specific cultural content. This requires a more holistic learning platform that can include the ability to learn and practice Kapampangan vocabulary, pronunciation, interactive exercises, Kulitan writing practice, and gamification. MAKULIT aims to overcome this by integrating these learning elements in one mobile application that can be used for a learner-centred approach to Kapampangan language and Kulitan writing.

2.3 Conceptual Framework

The conceptual framework is presented as shown the relationship between the inputs, development process and the expected output of the study: “MAKULIT: A Gamified Mobile Application for Interactive Kapampangan Language and Kulitan Learning”. The study adopts the Input-Process-Output (IPO) model to demonstrate the utilization of the identified resources and requirements in various stages of the application development process in order to generate the proposed mobile learning application.

Figure 1

Input-Process-Output (IPO) Conceptual Framework of MAKULIT



This input includes the resources and requirements used for the development of MAKULIT. These include some Kapampangan vocabulary, information on the Kulitan writing system, pronunciation information, learning material and identified user requirements. The language resources are used for constructing the application's dictionary and some of its learning activities, while the Kulitan information is used for defining the content of the features related to writing. User requirements identified, in turn, inform the selection and development of features designed to support the learning needs of the target user.

The processes are the activities that are needed to take the identified inputs and convert them into the proposed

mobile application. This covers the collection and organisation of language resources; the design of the application; the development of functions; the incorporation of the learning features; testing and evaluation of the application. In developing the application, it included the Kapampangan dictionary, pronunciation resources, Kulitan learning activities, and gamified activities. The testing and evaluation were carried out to find out whether there are any problems in the application and to see whether the application works according to its needs.

The output is the developed MAKULIT mobile application that combines the Kapampangan dictionary, pronunciation resources, Kulitan learning activities, and gamified learning activities. This application aims to give students an interactive and accessible learning tool for the Kapampangan language and familiarize them with the Kapampangan writing system, Kulitan. By merging the above, MAKULIT is a mobile learning application that aids the learning of the Kapampangan language and maintenance of the Kulitan writing system.

2.4 Synthesis

The literature reviewed indicated that digital technology, mobile-assisted learning, gamification, digital dictionaries, and interactive activities can be used to assist language learning, vocabulary development, and language maintenance of Indigenous and local languages. The importance of accessible and culturally relevant digital resources to promote learner participation and practice also highlights the importance of previous research. What is lacking is research and applications that combine these elements into a single learning platform, however. Available studies and applications tend to focus on individual aspects (such as language documentation, digital dictionary, vocabulary learning, gamification, or cultural preservation). There is a need for an interactive resource that integrates Kapampangan words and pronunciation with basic Kulitan writing practice and gamified learning activities in particular. To fill this void, MAKULIT offers an integrated mobile application incorporating a Kapampangan dictionary, pronunciation guide, Kulitan character learning and tracing, interactive activities, and gamification to facilitate the learning of Kapampangan and basic Kulitan literacy.

SECTION III — METHODOLOGY

3.1 Research Design

This study uses a descriptive-developmental research design and quantitative approach to develop and evaluate the MAKULIT: A Gamified Mobile Application for Interactive Kapampangan Language and Kulitan Learning. The study also involves the development of MAKULIT as a mobile learning application. It is similar to the educational design research model, which involves the iterative design of an educational intervention and systematic investigation and evaluation in the process of fulfilling a specific educational need (Jacobsen & McKenney, 2024).

The developmental part of the study will be conducted by designing and developing the MAKULIT mobile application based on the learning needs and system requirements identified. The application will offer multiple learning features such as Kapampangan dictionary, pronunciation support, interactive Kulitan writing exercises, matching activities and gamification features including points and rewards and progress tracking. The features will allow the learner to see and learn Kapampangan vocabulary while learning basic Kulitan writing.

The descriptive part will be devoted to the description of respondents' evaluations of the created application. It will describe the software quality, usability, and interactive learning experience of the application as assessed by the selected IT professionals and students. After interacting with MAKULIT, the researchers will collect the respondents' evaluations.

The quantitative approach will be employed to collect numerical data from a structured questionnaire and a five-point Likert scale (Strongly Disagree - Strongly Agree). Five (5) IT or software-related experts and thirty (30) students selected using purposive sampling from Systems Plus College Foundation (SPCF) will participate in the evaluation. The IT professionals will evaluate the technical and software quality features of the application,

while the student evaluators will consider its functionality, usability, and interactive learning experience. Frequency, percentage, and weighted mean will be used to summarize the evaluators' assessment of the collected responses. The ISO/IEC 25010:2023 Product Quality Model will be used for the evaluation, with selected characteristics such as Functional Suitability, Usability, Performance Efficiency, Reliability, and Compatibility. The results will describe the evaluated quality of the application that is tested and areas for improvement. The study will focus on the application's software quality and user experience and will not aim to improve long-term language proficiency in Kapampangan or prove the language's long-term preservation.

3.2 System Development Methodology

The study will adopt the Agile Scrum approach in the development of MAKULIT: A Gamified Mobile Application for Interactive Kapampangan Language and Kulitan Learning. Agile is an iterative software development method that breaks down the task of the development process into smaller and manageable increments, allowing continuous improvements based on feedback from the software development process (Anifa et al., 2024). In the field of education, Scrum and user-centered development practices have also been used to develop mobile applications. (Castillo Lopez et al., 2023)

The development process will start with the requirements identification and organization required for the development of MAKULIT. These requirements will also be used as a foundation for designing the system structure and developing the initial interface design. The development process will then be followed through a series of sprints in which the researchers will focus on various parts of the application related to the development of the system, and then gradually integrate them into the system. The development will first concentrate on the basic language resources and Kulitan learning functions and then on the pronunciation, interactive learning, gamification and progress tracking functions. Rather than developing each feature as a complete finished product, each component will be individually developed and progressively integrated with the rest of the product, for testing as features are being integrated into the whole product.

Testing will be carried out while the various components are developed to determine errors, functional problems and the interaction between the features. Changes will be implemented in future development cycles where needed as a result of testing and review. This will continue until the necessary components are added and the application is complete to be tested and evaluated. The use of successive development cycles is especially applicable on MAKULIT as it is about a dictionary that is linked to Kulitan activities, pronunciation functions and gamification features in the development of a single learning application. Continually developing and evaluating such components enables the researchers to solve problems as they occur, rather than waiting until the whole system is finished and then encountering a problem.

3.3 Requirement Specification and Analysis

This section points out the functional and non-functional requirements of MAKULIT: A Gamified Mobile Application for Interactive Kapampangan Language and Kulitan Learning. The requirements were identified based on the objectives of the study and the functions of the application. Non-functional requirements are the properties and limitations of the system, and functional requirements are the operations and features that the system must perform. These requirements provide a guideline for the design and development of the system, making sure that the features and technical requirements of the application are consistent with its intended use.

3.3.1 Functional Requirement

Functional requirements describe the specific functions that the MAKULIT mobile application is expected to perform.

Table 1 Functional Requirement

No.	Requirement	Description
1	Kulitan Chart	The system shall display Kulitan characters according to their categories.
2	Character Information	The system shall display information about a selected Kulitan character, including its sound and related information.
3	Kulitan Writing Practice	The system shall provide an interactive area where users can practice writing or tracing Kulitan characters.
4	Kapampangan Dictionary	The system shall provide Kapampangan Vocabulary with corresponding English definitions.
5	Dictionary Search	The system shall allow users to search for available Kapampangan words.
6.	Pronunciation	The system shall provide pronunciation information or audio for available vocabulary.
7	Interactive Activities	The system shall provide learning activities such as matching, pronunciation, and writing activities.
8	Gamification	The system shall provide points, rewards, and challenges to encourage user participation.
9	Progress tracking	The system shall display the user's learning progress based on completed activities and earned points.

10	Activity Feedback	The system shall provide feedback after the user completes an activity.
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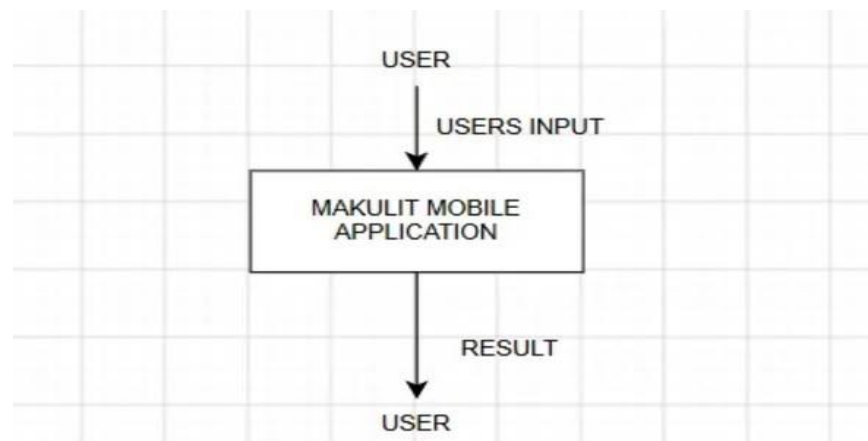
3.3.2 Non-Functional Requirement

Non-functional requirements are the attributes and performance of the MAKULIT mobile application.

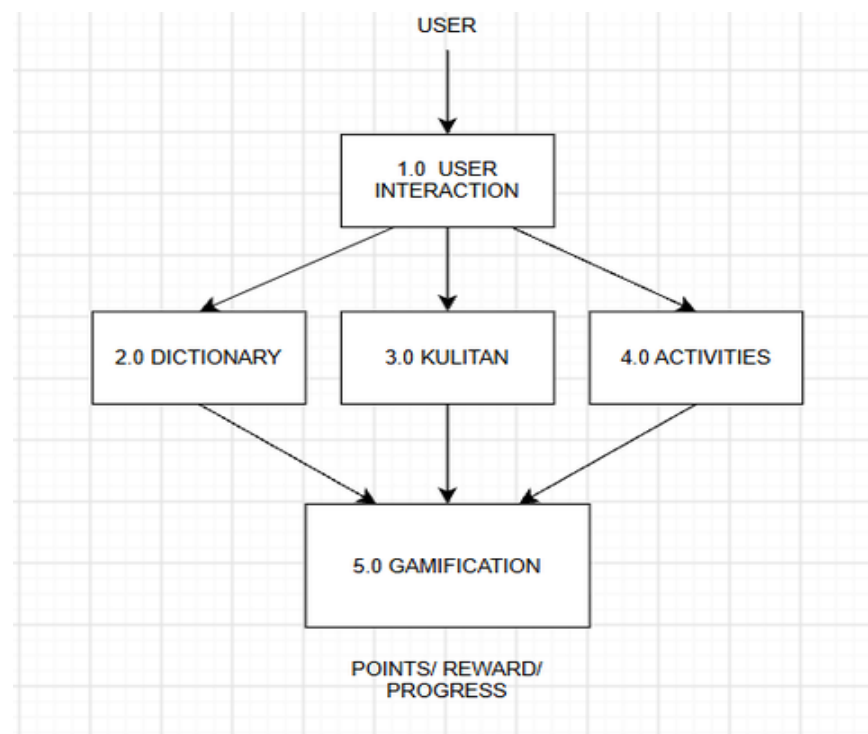
Table 2 Non-Functional Requirement

No.	Requirements	Description
1	Usability	The application should have an easy-to-use and easy-to-understand interface so that users can easily navigate through the learning features.
3	Performance Efficiency	The application shall react to user actions in a reasonable time.
4	Reliability	The application shall be reliable under normal use and ensure that there are no unnecessary application errors.
5	Compatibility	The application must run on supported Android and IOS mobile devices and function properly with the required software components.
6	Content Accuracy	Before being integrated into the application, the Kapampangan vocabulary, their pronunciation, English definitions, and Kulitan representation should be checked and validated.

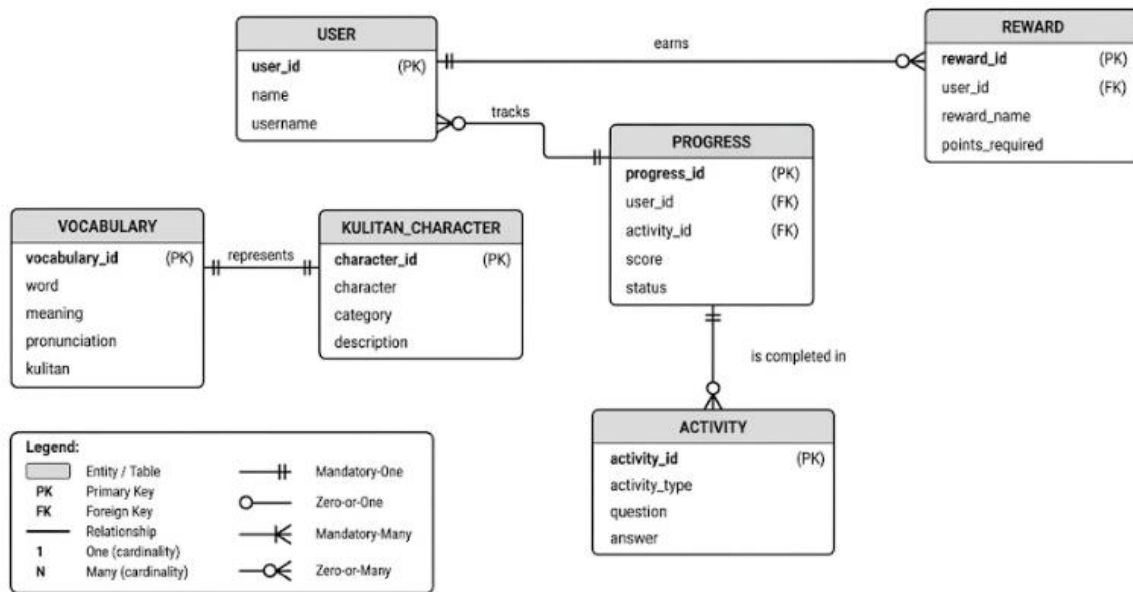
3.3.3 DFD Level 0



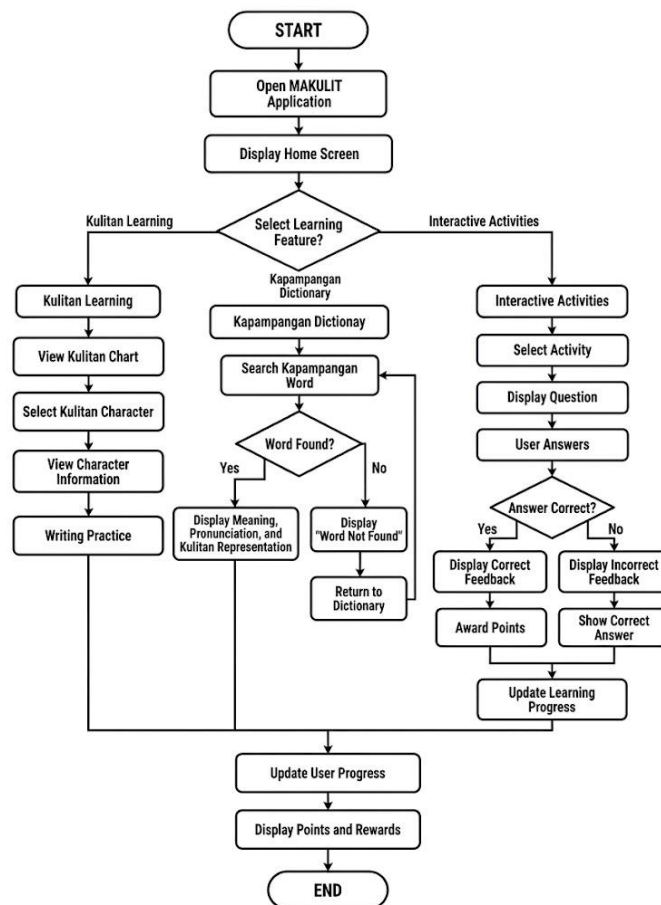
3.3.4 DFD Level 1



3.3.5 Entity-Relationship Diagrams (ERD)



3.3.6 System Flowchart



The system flowchart shows the overall process of the MAKULIT system. It starts from the time the user launches the application and logs on to the home screen, where the user can choose from Kulitan Learning, Kapampangan Dictionary, and Interactive Activities. The system offers the appropriate learning process depending on the feature selected: viewing of Kulitan characters, searching of Kapampangan words, or interactive activities. The system then updates the user's learning progress with the earned points, and the rewards are then displayed.

3.4 System Design Specification

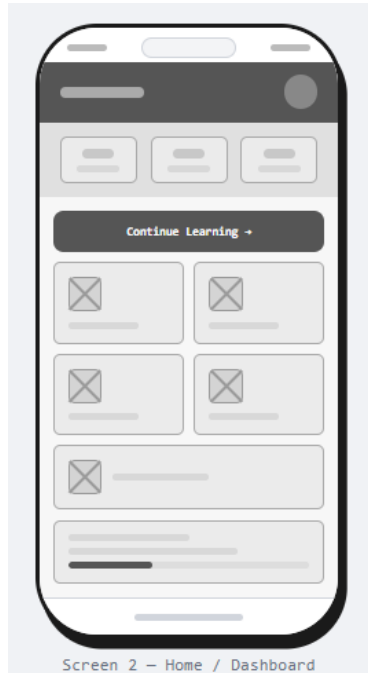
This section gives the design specifications for the MAKULIT mobile application, both logical and physical. The logical specification outlines the user interface, how the application is navigated, and what processes are in place for the main modules of the application. The physical specification describes the technologies, hardware, and software that have been developed and implemented to create the system.

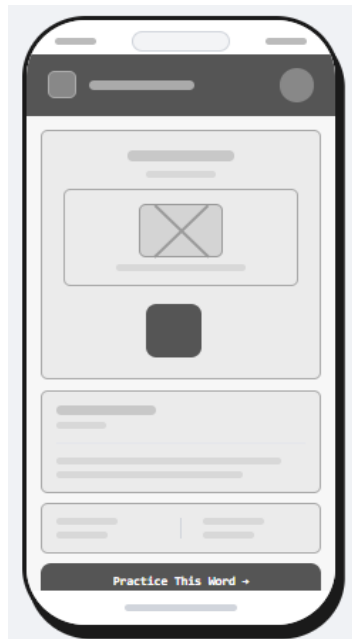
Logical Specification:

The logical specification details the navigation, interface and functional behavior of the MAKULIT mobile application as well as its structure. It emphasizes the use of the system and the function performed by each module. The logical design consists of various screens and learning modules that enable users to access Kulitan learning materials. Kapampangan dictionary, interactive activities, and progress-related features.

A. User Interface and UX Design

MAKULIT's user interface aims to offer an easy and accessible learning experience. The main interface provides access to the Kulitan learning module, Kapampangan dictionary, interactive activities, rewards, and progress features. Each screen has been structured according to its purpose, so that it is easy for users to access the learning materials and activities.

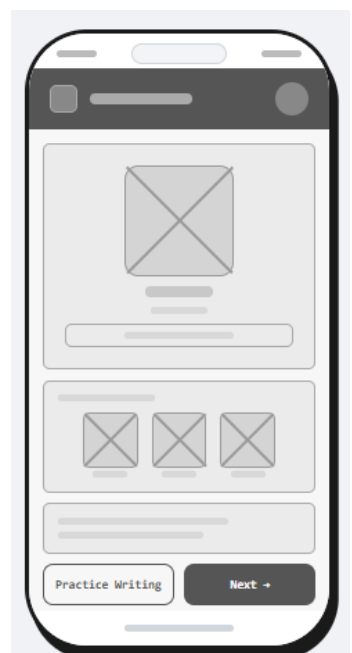




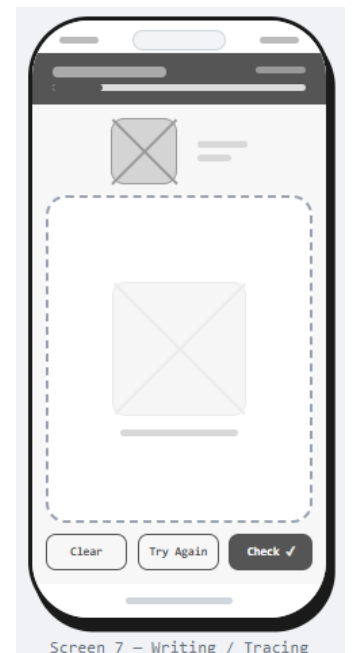
Screen 4 – Word Detail & Audio



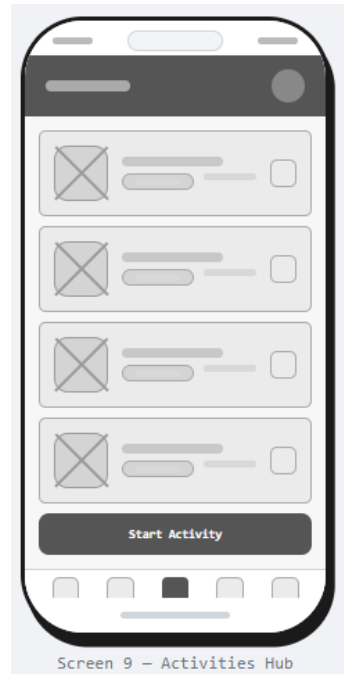
Screen 5 – Kulitan Categories



Screen 6 – Character Detail

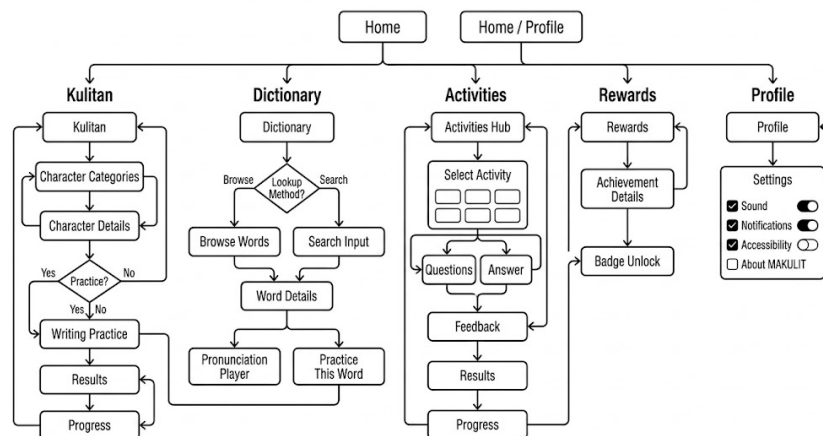


Screen 7 – Writing / Tracing Canvas



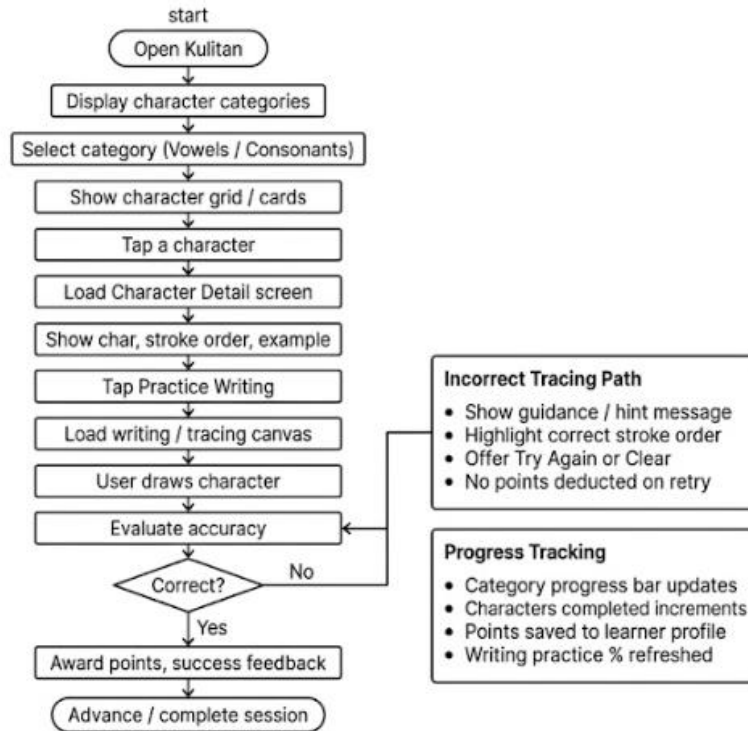


The navigation structure of MAKULIT starts at the Home Screen, from which the learners can choose the primary functions of learning. Users can view the characters and practice writing them in the Kulitan module; search for words and view the information about the words in the Kapampangan dictionary; and answer learning activities in the interactive activities. The navigation enables users to navigate between the features depending on their learning activity.



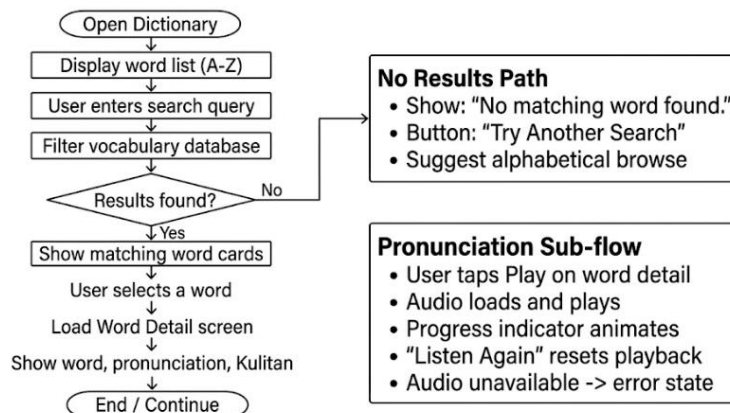
The navigation structure of MAKULIT begins at the Home Screen, where users can select the main learning features. Users can access the Kulitan module to view characters and practice writing, use the Kapampangan dictionary to search for words and view their information, or access interactive activities to answer learning exercises. The navigation allows users to move between the available features according to their selected learning activity.

B. Module Logic

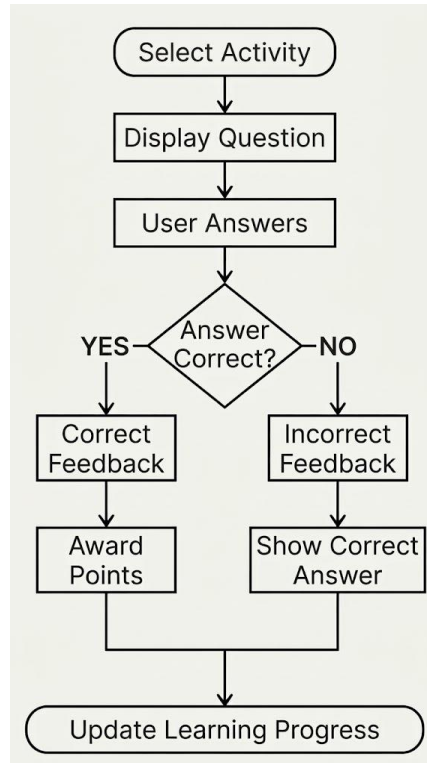


The Kulitan Learning Module enables the user to choose characters from the Kulitan chart and view a specific character. Once characters are selected, all the information of that character appears, and a practice function is available for the user to use the interface of the system to practice the character.

DICTIONARY MODULE FLOW



The Kapampangan Dictionary module enables the user to search for Kapampangan words. If the matching word is located, the system will show the information available to the word, such as its English meaning, pronunciation and kulitan representation. If the looked-for word is not in the dictionary, the system will indicate the message and let the user go back to the dictionary and search again.



The interactive Activities Module offers exercises for learning which will enable users to answer questions and practice their Kapampangan and Kulitan knowledge. The system verifies the user's response and gives the response accordingly. The correct answer and feedback for incorrect answers may be provided based on the correct answers. This learning progression is then updated according to the activity completed by the user.

Physical Specification:

A. Technology Stack

MAKULIT mobile app will be developed using a cross-platform technology stack to support deployment on Android and iOS platforms. The primary language would be TypeScript and for the mobile app framework, React native was chosen. It will be developed and built using Expo and the primary code editor will be Visual Studio Code. Furthermore, Firebase services will be included and application data (Cloud Firestore) and multimedia resources such as images and audio files (Cloud Storage) will be stored in a database.

Table 1. Technology Stack

Component	Technology	Purpose
Target Platforms	Android and iOS	Platforms supported by the MAKULIT mobile application
Programming	TypeScript	Primary language used for application development

Language		
Mobile Framework	React Native	Development of the cross-platform mobile application
Development Framework	Expo	Development, testing, and build tooling for the React Native application
Code Editor	Visual Studio Code	Writing, editing, and managing application source code
Backend Services	Firebase	Provides backend services and integration for the application
Database	Cloud Firestore	Stores and manages structured application data
Cloud Storage	Firebase Storage	Stores multimedia resources such as images and audio files

B. Hardware Specification

The hardware specifications is a description of all physical devices needed for development, testing and use of the MAKULIT mobile application. The development team will be provided with a laptop with enough processing power and memory for developing applications. Android smartphones and iPhones will be used to test the application's platforms. The two targets were considered to be: functionality, user interface and compatibility. Since MAKULIT includes dictionary entries, pronunciation video, pictures, interactive Kulitan tasks, gamed based activities and progress tracking, the recommended user devices provide sufficient these features have been provided with memory, storage and connectivity.

Table 2. Development Hardware

Hardware Component	Specification
Device	ASUS VivoBook M1605YA

Processor	AMD Ryzen 5 7530U
Installed RAM	16GB
Operating System	Windows 11
Primary Use	Mobile application development, testing, and system management

Testing Hardware

Device Type	Purpose
Android Smartphone	Testing application functionality, navigation, interface responsiveness, audio playback, interactive activities, and compatibility
iPhone	Testing application functionality, navigation, interface responsiveness, audio playback, interactive activities, and compatibility

Table 3. Recommended End-User Hardware Requirements

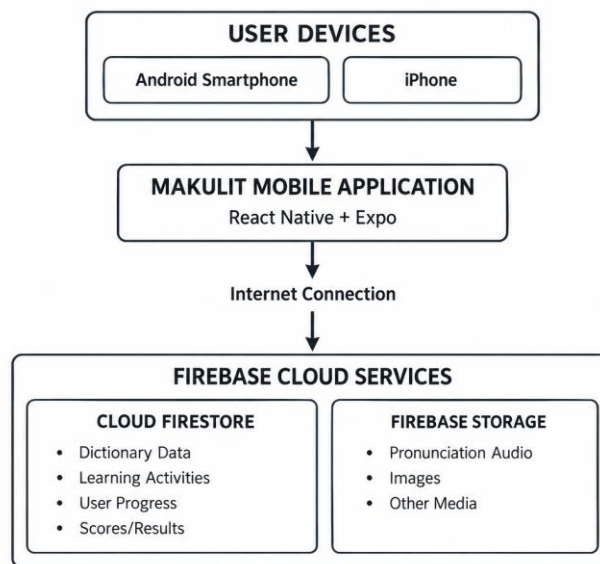
Hardware Component	Minimum/Recommended Specification
Device Type	Android smartphone or iPhone
Android Version	Android 10 or later
iOS Version	iOS 15.1 or later
RAM	3 GB or higher
Available Storage	At least 2 GB of free storage
Display	Touchscreen display

Internet Connectivity	Wi-Fi or mobile data connection
Audio Output	Built-in speaker or headphones/earphones

The suggested hardware requirements aim to secure enough resources for all basic MAKULIT features, such as: using the dictionary, pronunciation MP3, Kulitan learning for interaction, gamified activities, exercises and progress tracking. The application will be created for both Android and iOS platforms and the last supported version of operating systems will depend on the chosen React Native and version of the Expo.

C. Server/System Layout

MAKULIT application will be accomplished using a cloud-based system architecture that integrates the mobile application with the Firebase services via the Internet. The React Native & Expo will be used to develop and it will be connected to Firebase to manage the creation and publish application data and multimedia resources. Structured data such as entries in the dictionary, activities you undertake as a learner, and progress you make will be recorded in Cloud Firestore, while multimedia resources like pronunciation audio and images will be stored in Firebase Storage.



The system begins with the user's use of the MAKULIT mobile application installed in an Android cellphone or iPhone. When the internet is available, it makes requests to the internet to retrieve and manage information that is required. Cloud Firestore allows you to have the structured data from the application available, while Firebase Storage provides access to multimedia resources. This is a cloud-based architecture which allows access and management of learning resources from the supported mobile platforms.

3.5 Implementation

Following the design specification presented in Section 3.4, the MAKULIT mobile application was implemented using the react native platform, developed and built to Expo using TypeScript. Coding is structured based on features, and each module (denoted as Kulitan Learning, Kapampangan Dictionary, Interactive Activities, and

Gamification) consists of a set of service functions, each having its own corresponding feature to fetch and update data with Firebase following REST API standards, which makes clear separation of the user interface and the backend activities.

The database design is based on the previously mentioned Entity-Relationship Diagram (Section 3.3.5), and the entities (User, Vocabulary, Kulitan Character, Activity, Progress, Reward) are represented by the appropriate collection in Cloud Firestore. Audio for pronunciation is added to Firebase Cloud Storage with a reference URL and attached to the Firestore record for the respective character. Kulitan character images are also stored in Firebase Cloud Storage and referenced back to the Firestore record of the character.

The next level of the DFD, Level 1 (3.3.4), integrates the Dictionary, Kulitan, and Activities modules into the Gamification module, where the completion of the activities in one module also updates the user's points, progress, and reward from another.

Data migration is a process in which the validated Kapampangan vocabulary, pronunciations, and Kulitan character data are loaded into the Firestore database from pre-prepared CSV files, with proper structure and linking of dictionary and Kulitan data before it is available in the application.

3.6 Testing and Evaluation

The systematic testing and evaluation of the MAKULIT mobile application will be carried out to check the correctness of the functions, software quality, and usability of the application. The overall software quality will be assessed based on selected characteristics of the ISO/IEC 25010:2023 software product quality model through unit testing, integration testing, and user acceptance testing. The evaluation will be done with IT professionals and selected students from Systems Plus College Foundation (SPCF) who will be the intended users of the application.

3.6.1 System Testing Protocols

The development team will conduct different tests to detect their functional mistakes, integration issues, and problems that could impact the application's operation.

Unit Testing: Each application module/s component will be tested. Ensuring its working through an independent. Examples of testing will be Kapampangan. Search for the word in the dictionary, categorize and display the characters in the Kulitan series, trace the characters, the matching activities, points and rewards, and user features enable a more personalized learning approach. All components should achieve the desired outcome.

Integration Testing: The modules will be tested for interactions to ensure they will perform harmoniously in unison. This will encompass testing to make sure that user actions in learning activities and Kulitan writing activities are updated appropriately when users are engaged in them, trigger feedback as appropriate, record user points and rewards, and be consistent with the user database. The integration testing will also help ensure that the application's interface, application logic, and database services are working as intended.

User Acceptance Testing (UAT): The User Acceptance Testing will be done with a selected group of student evaluators from SPCF who are the target users of the application. The test will identify whether the application is able to do what the users want it to do. Students will be made to do representative activities like looking for Kapampangan words in the dictionary, listening to the pronunciation of the words, practicing the Kulitan characters, doing interactive activities, and seeing their progress and rewards. The outcomes will be utilized to recognize functionality or usability issues that need to be addressed before the final evaluation

3.6.2 Testing and Evaluation

The software quality evaluation will be based on the ISO/IEC 25010:2023 Product Quality Model, the purpose of which is to specify, measure, and evaluate the quality of software and other ICT products.

The standard lists nine product-quality characteristics, but the relevant characteristics for the objectives and functions of the MAKULIT mobile application will be evaluated.

The selected characteristics are Functional Suitability, Usability, Performance Efficiency, Reliability, and Compatibility.

Functional Suitability: Evaluate if the application meets the necessary functions properly and sufficiently. This will involve the production of a Kapampangan dictionary, pronunciation resources, and a Kapampangan dictionary that is useful for pronunciation. Kulitan writing exercises, interactive learning activities, points and rewards, progress-related functions.

Usability: Judges the ease of use, understanding and navigation of user's application. This will include user friendliness of the user interface, organization of content (information presented), navigation (how the information is organized), readability of information, and completion of learning activities.

Performance Efficiency: Measure and report on the responsiveness of the application performance regarding resources. This will address the transition time to respond between screens, dictionary searches, audio playback, character tracing, and more interactive activities.

Reliability: Determine whether the application will reliably carry out its functions or not as planned during normal operations. This will involve determining if significant are there any issues, crashes or loss of user progress to be aware that features run without running them in the test phase.

Compatibility: Test the application's ability to perform as expected on its supported mobile platforms, and ensure successful interaction between the software components needed to operate. The supported Android and iOS environments defined in the system specification will be taken into account for the evaluation.

The evaluator's assessment will be taken using a structured questionnaire with a five-point Likert scale. The responses will go from 1 – Strongly Disagree to 5 – Strongly Agree. Specific sections of the questionnaire will be developed for IT professionals and student evaluators to ensure that questions are relevant to their jobs and experience with the application.

The software quality assessment follows ISO/IEC 25010, and will be conducted separately for the accuracy of the content. Qualified persons having the right knowledge of the language and/or writing system will review the Kapampangan vocabulary, English definitions, pronunciation recordings and Kulitan representations prior to their final incorporation into the application. It is intended that this separate review shall ensure that the learning content is appropriate and accurate, and shall not be considered as an additional ISO/IEC 25010 product-quality characteristic.

3.6.3 Testing and Evaluation

The evaluation will involve two groups of evaluators: five (5) IT professionals or software-related experts and thirty (30) selected SPCF students. Purposive sampling will be used to select participants who meet the requirements of their respective evaluator groups.

Five IT professionals or software-related experts will be chosen due to the fact that the evaluation needs people who have knowledge and skill of software related systems analysis, software testing, information technology, or related fields. Obtaining multiple independent professional assessments of software quality and evaluation instruments is appropriate for a small expert panel. It is common to find in methodological discussions five to ten experts as a practical range to aim for when creating an expert panel, although there's no rule set for the number of experts that must be involved.

The IT specialists will assess the application's Functional Suitability, Usability, Performance Efficiency, Reliability, and Compatibility, mostly from the technical point of view of the system developed. Their assessment will give expert input on the software quality and technical performance of the application.

Thirty students from SPCF will be selected as the target group based on the setting of the institution. The number makes for a practical group of actual target users for quantitative evaluation and is still accessible to the researchers to administer and analyze. The number of participants used in

quantitative usability research generally ranges between about 20 and 40, with approximately 30 if there is some less-than-desirable precision.

The student evaluators will evaluate the Functional Suitability and Usability of the application and the user aspects of the interactive and gamified characteristics. The questionnaire will contain questions regarding ease of navigation, clarity of instructions, ease of doing learning activities, usefulness of feedback, interactivity, and perceived usefulness of the points and rewards for continuing participation. The evaluation will not be used to determine long-term improvement in the users' Kapampangan proficiency or long-term impact on language preservation; it will instead measure users' experience of the application.

The evaluation questionnaire will be checked by the researchers' adviser and/or qualified validators before administration to ensure that the items are clear, relevant, and in line with the chosen evaluation criteria. Once the application has been proven and tested, the questionnaires will be sent to the selected evaluators. Completed answers will be gathered, sorted, and ready to be statistically analyzed.

The data obtained from the 5-point Likert scale questionnaire will be summarized to express the evaluators' assessment of the assessment items using frequency, percentage, and weighted mean. The overall assessment for each selected ISO/IEC 25010 characteristic and for evaluation items will be determined using the weighted mean method. The results from the IT professionals and student evaluators will be reported separately to separate technical from target user results. The comments and observations from the evaluators will also be considered to suggest ways to enhance the application.

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