Amanu: CNN-RNN Kapampangan Language Learning-Based System for Grade School Learners

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Abstract

This study examines the development and implementation of "Amanu", a deep learning-based computer system designed to enhance Kapampangan language acquisition among grade school learners. Utilizing a CNN-RNN architecture, the system addresses challenges in preserving and promoting the Kapampangan language. The research employed a quantitative descriptive approach, using ISO 25010-based surveys for data collection. Developed using Agile methodology, Amanu incorporates features such as a pronunciation checker, multimedia lessons, interactive games, and a comprehensive dictionary. Findings indicate that Amanu significantly aids both teachers and learners in Kapampangan language education, receiving high ratings across all ISO 25010 categories with an overall mean score of 3.80. The study concludes that integrating such systems into standard teaching methods can revolutionize language learning approaches, making Kapampangan acquisition more accessible and engaging. Recommendations include incorporating adaptive learning algorithms and expanding cultural content. This research contributes to the fields of educational technology and language preservation, demonstrating the potential of deep learning-based systems in supporting the education of endangered languages.

Keywords: Amanu, Kapampangan Language, Educational Technology, Pronunciation Checking, ISO 25010 Criteria.

1. Introduction

With the upcoming "Matatag" curriculum, the Department of Education (DepEd) removes Mother Tongue as a subject and instead continues to utilize it as a medium of instruction [1]. Local language preservation advocates, including those for the Kapampangan language, are already expressing concerns. With the removal of mother tongue as a subject, the availability of Kapampangan learning materials is likely to decrease, which could result in fewer opportunities for future generations to learn and appreciate their local language. Since the mother tongue is only used as a medium of instruction for Grades 1-3, the Department of Education (DepEd) has ceased producing specific learning materials for local languages [2]. This means that Kapampangan resources will be scarce, and teachers may struggle to source their own materials while fulfilling other duties. The lack of sufficient learning materials is likely to diminish pupils' ability to study Kapampangan and other local languages.

With this in mind, educators must embrace the digital era, where technology may be used to help preserve and teach indigenous languages, such as Kapampangan. As many as 280 interactive e-books in 14 Philippine languages, including an interactive Kapampangan primer, have been downloaded through DepEd's digital repository, which has been effective in enhancing engagement and literacy among young learners [3][4][5]. By leveraging these digital tools, educators can provide a more engaging, accessible, and culturally relevant experience, thereby helping to ensure the continued use and appreciation of Kapampangan as an integral part of our cultural heritage.

2. Literature Review

2.1. Kapampangan Language and Language Shift

Kapampangan is a regional language spoken in Central Luzon, Philippines, which is experiencing a gradual decline in usage due to sociocultural and linguistic shifts. Because younger generations, especially those from the middle and upper classes, prefer to be taught in English and Tagalog, there has been a decline in the use of Kapampangan vocabulary and language [6][7]. Contributing factors include globalization, intermarriage, increased exposure to modern media, and shifting educational policies.

The Mother Tongue-Based Multilingual Education (MTB-MLE) policy was designed to strengthen native language acquisition in early education. Studies show that while students exposed to MTB-MLE exhibit positive attitudes toward their mother tongue, a shift toward the national language (Filipino) remains, suggesting a decline in the long-term use of Kapampangan [8].

2.2. Language Learning and Artificial Intelligence

Write: The application of Artificial Intelligence (AI) in education enables the development of adaptive, responsive, and personalized learning systems. Using real-time feedback, predictive analysis, and automation, AI improves students' engagement and modernizes instructional design [9]. Machine learning algorithms help identify learning patterns and create learning instructions based on each individual's learner profile.

Deep learning, a subset of AI, is utilized for improving language-related functions such as pronunciation, translation, and comprehension. Techniques combining cognitive psychology with neural architectures have been proven effective in building intelligent language learning systems [10].

2.3. Deep Learning Architectures in Language Learning

Combining Convolutional Neural Networks (CNN) with Recurrent Neural Networks (RNN) has proven effective in handling both visual and sequential language data. CNNs extract features from visual inputs like spectrograms, while RNNs manage language sequences, enabling accurate pronunciation assessments. These architectures offer significant improvements in speech-based learning systems [11].

Language learning platforms equipped with automatic speech recognition have shown measurable benefits in vocabulary acquisition and speech production. Learners using such technologies have demonstrated improved retention and pronunciation accuracy compared to traditional methods [12].

2.4. Software Quality Assessment in Educational Systems

Evaluating educational systems requires standardized software quality metrics. ISO 25010 is an internationally recognized model that measures software across eight attributes. In the context of educational tools, focus is often placed on functional suitability, usability, reliability, performance efficiency, and portability. Studies confirm that applying ISO 25010 ensures structured and meaningful assessments of learning technologies [13][14].

2.5. Educational Technology and Language Retention

Trending technologies such as gamified applications, mobile platforms, online classes, and virtual environments have an impact in contributing to second and foreign language acquisition. However, research shows that learner engagement and system adaptability are critical to the success of these types of tools. Without learners' motivation and context-aware content, the effectiveness of these platforms may diminish [15].

3. Research Methods

3.1. Research Design

The research project used a quantitative developmental descriptive research design to collect and analyze numerical data using surveys, questionnaires, and measurement equipment. This study focused on the design, development, and assessment of the "Amanu" system, a computer-based Kapampangan language learning tool. The researchers followed an Agile methodology, which allows for incremental improvements based on user feedback and ISO 25010 quality standards. The system was tested for functional suitability, usability, reliability, performance efficiency, and portability, resulting in a structured assessment of its efficacy.

Data was gathered by the researchers based on the correctness, efficiency, and usability of the system as well as the competency, satisfaction, and overall learning experience of the learners. Quantitative methods such as surveys, data collection, and textual or visual material analysis were also employed to get more accurate and instructive data. This approach allowed for an evaluation of learners' motives, problems, and nuances, ultimately driving future improvements and developments to the computer-based learning system.

Quantitative research involves a systematic approach to collecting and making sense of numerical information from a limited sample or a larger group. It specifically focuses on the mathematical, statistical, or numerical analysis of data collected through surveys, polls, and questionnaires, as well as the modification of pre-existing statistical data through the use of computer tools and processes [16]. Analyzing the final results in connection to a particular demographic—in this case, grade school learners, instructors, and IT specialists evaluating the Amanu system—is the ultimate goal.

The researchers used the purposive sampling technique from non-probability sampling to select elementary learners from selected public schools in Sta. Ana. The approach enabled the researcher to gather specific and targeted insights from a relevant group of learners. The researchers considered specific criteria such as grade level, knowledge of Kapampangan, and previous exposure to technology in learning.

The researchers chose teachers and IT professionals as their respondents, each bringing unique insights to the project. Teachers offer valuable perspectives on the educational aspects, while IT professionals contribute their expertise in information technology. Computer experts bring a deep understanding of technical aspects. Together, their diverse backgrounds enriched the project, ensuring a comprehensive examination of the topic at hand.

3.2. System Framework

Input. The researchers require specific software and skills to execute the project successfully, particularly proficiency in HTML, CSS, JavaScript, Flask, and PHP for backend programming. These technologies will assist in developing a system that is both functional and aesthetically pleasing. The review of related literature, or RRL, will be utilized to collect data. This will enhance understanding of the existing state of the subject and identify any areas of knowledge that the project can tackle. Finally, they will need certain software prerequisites such as Visual Studio Code for coding, XAMPP to set up a local server, and a web browser to showcase the project. These technologies will assist in the efficient development, testing, and deployment of the project. For the project to succeed, all participants must possess a solid understanding of these technologies and tools.

Process. Agile methodology is a project management approach that breaks the project into multiple phases, each comprising distinct activities. It is the method used in the research. During the planning phase, the researchers focus on collecting requirements through interviews and surveys. The design phase includes the planning and creation of the system architecture. The development phase is when the system is constructed. The testing step, following development, verifies that the system functions as planned. The deployment phase encompasses the implementation and release of the system. Finally, during the review phase, input is collected, and ISO 25010 is em-

ployed for a systematic assessment to enhance the process. This iterative and adaptable approach facilitates modifications during the project lifespan.

Output. Upon completion of all the processes, the outcome of the study is "Amanu: Advancing Kapampangan Language Acquisition for Grade School Learners Through a Deep Learning-Based Computer System Using CNN-RNN Architecture." This innovative system aims to enhance the speaking and language acquisition skills of grade school learners in terms of the Kapampangan language. Amanu is developed to be engaging and supportive, leveraging cutting-edge technology to facilitate the learning process.
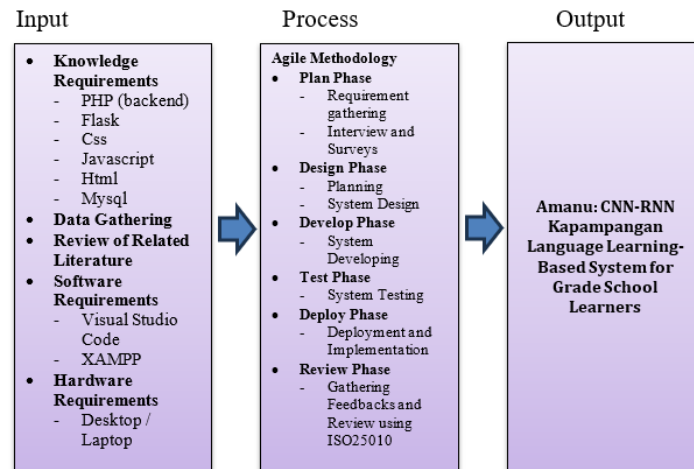

Fig 1. Research Framework: IPO Model

3.3. System Diagram

Upon launching the system, users will see the main menu interface offering three primary sections: Lessons, Dictionary, and Games. Each section is designed to be simple and structured, allowing young learners to familiarize themselves with the system easily.

Under the Lessons section, it has a submenu where users can choose their appropriate grade level from Grades 1, 2, and 3. Once the grade level is selected, the system displays all available Kapampangan lessons for that grade level, ensuring the lessons are age-appropriate and aligned with the students' comprehension level.

Choosing the Dictionary opens a dynamic and interactive interface. Users can search for Kapampangan words using the built-in search bar. Once a Kapampangan word is clicked, it will show the meaning of that word in both Tagalog and English and will also provide an example sentence on how the word is used. They can also listen to the correct pronunciation through audio playback and utilize the pronunciation checker to compare and improve their own pronunciation.

Lastly, the Games section offers users a list of educational games that can further enhance their knowledge of Kapampangan in a fun and engaging way. Users must first choose their grade level, after which they are presented with a variety of games that reinforce language concepts. Providing users with games that combine enjoyment and educational objectives will help students learn faster and be entertained at the same time.
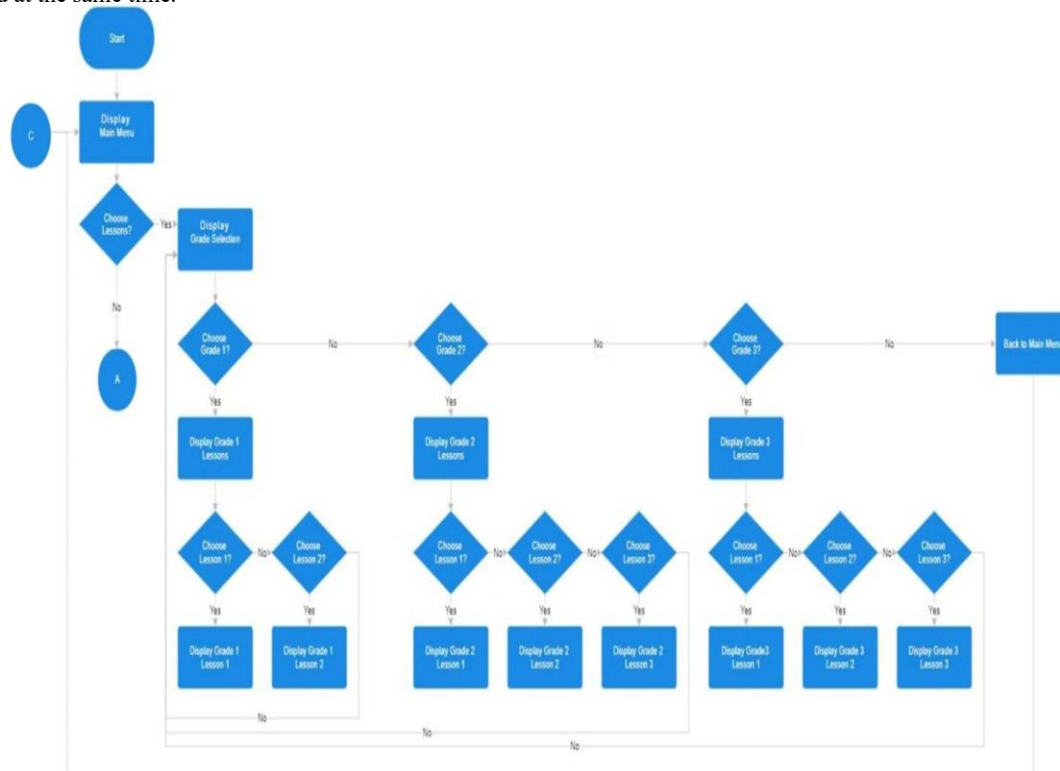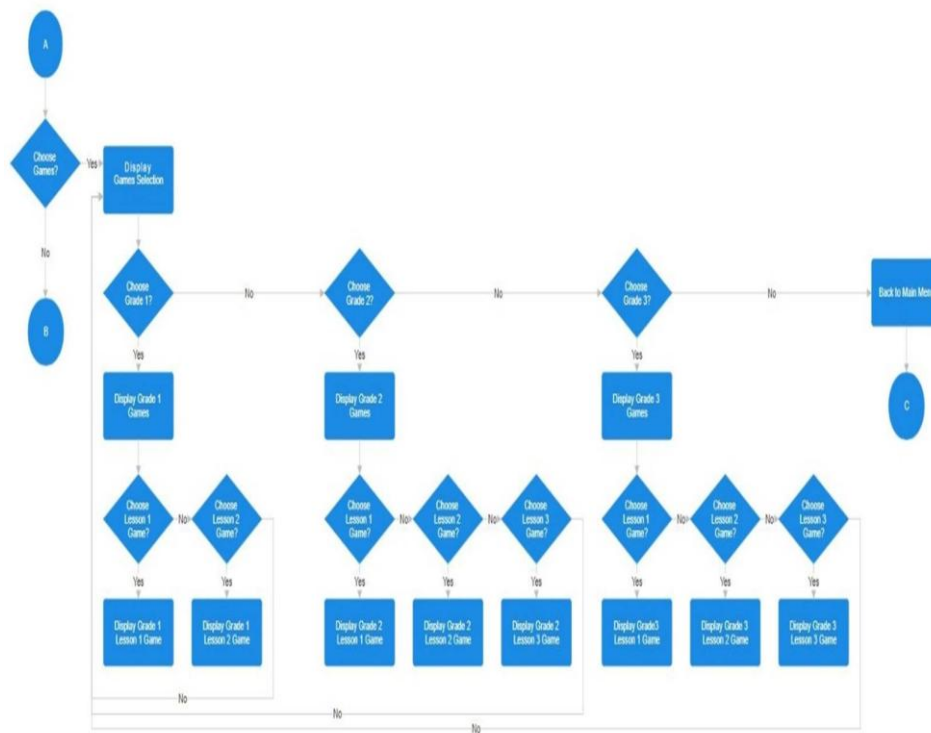

Fig 2. System Diagram
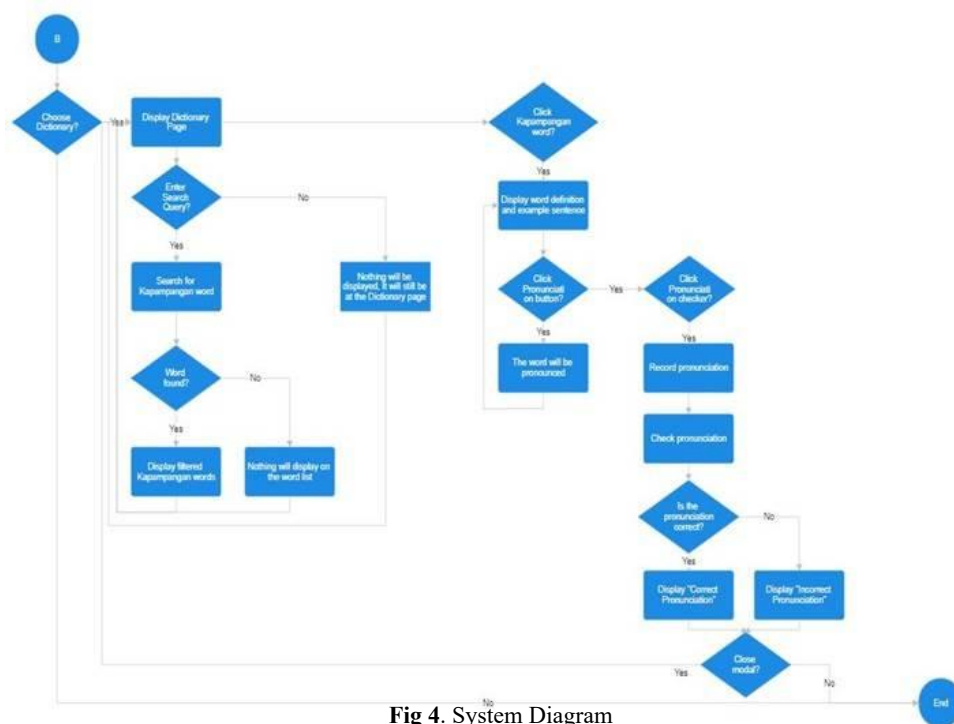
Fig 3. System Diagram

Fig 4. System Diagram

4. Results and Discussion

4.1. Algorithms used on Amanu

The project implemented a hybrid approach of Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN), that emphasizes on the spectrograms and Mel Frequency Cepstral Coefficients (MFCC) to improve the accuracy of pronunciation checks.

During the early stages of Amanu's development, the emphasis was placed on utilizing a singular algorithm to tackle the problem statement: "What are the suitable algorithms in deep learning that can be implemented in the creation of the system to assist teachers in teaching Kapampangan?" Initially, the Recurrent Neural Networks (RNN) algorithm was selected for its capability in managing sequential data, positioning it as a suitable option for language learning applications, especially in the comprehension and generation of linguistic patterns over time.
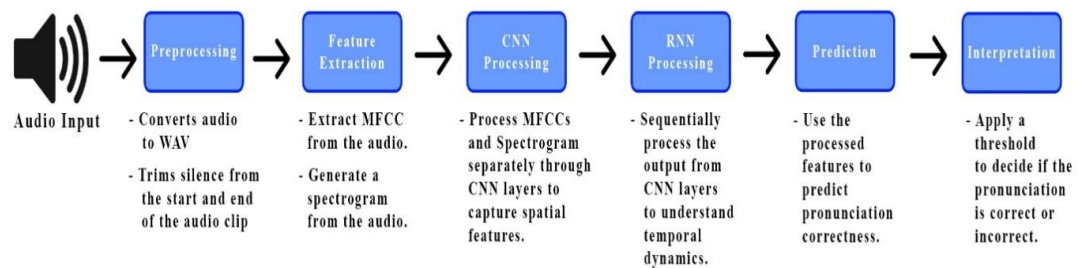
Fig 5. Pronunciation Checker Sequence

However, while RNNs provided a solid foundation for addressing the temporal aspects of language, it became evident that integrating an extra layer of analysis could further improve the system's effectiveness. This resulted in the combination of convolutional neural networks (CNNs) with RNNs, forming a hybrid model that utilizes the advantages of both algorithms. The system successfully analyzed spectrograms, illustrating the temporal changes in the frequency spectrum of a sound stream, facilitated by the application of CNNs, renowned for their exceptional ability to interpret visual data. The integration of Mel Frequency Cepstral Coefficients (MFCC) results in a comprehensive dataset that is crucial for the precise assessment and improvement of pronunciation.

The hybrid neural network provided better results than the first approach which only used RNNs. Combining the two neural networks made the system more accurate and better at giving detailed feedback on pronunciation, which improved the Kapampangan language learning experience for grade school children.

Recent findings highlights the efficacy of CNN and RNN models in language learning applications, indicating that these models can outperform single-algorithm approaches in tasks requiring both visual and sequential data processing [17]. This results in findings that are more accurate and relevant to the situation. These results are consistent with our findings from the development of Amanu, demonstrating the efficacy of integrating CNN and RNN to enhance language acquisition tools.

4.2. Features and functionalities of Amanu

To create an engaging and motivating environment for the grade school learners that are just starting their Kapampangan language learning journey, a computer-based learning system should include features and functionalities that address their specific needs. The pronunciation checker is a pivotal component of this system, designed specifically for the Kapampangan language. This tool assists individuals in achieving accurate word pronunciation while offering instant feedback that tells whether the pronunciation is right or wrong, enabling them to self-correct and enhance their skills over time. This type of interactive feedback plays a vital role in fostering both confidence and competence when learning a new language.
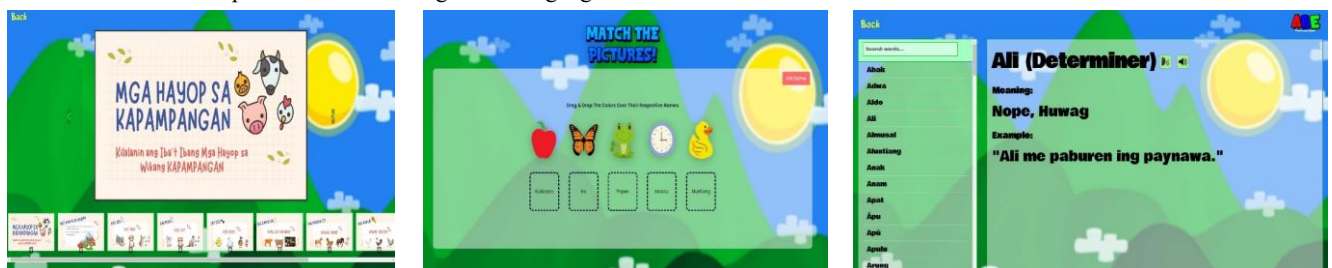

Fig 6. Features of Amanu

The system should provide not only pronunciation assistance but also a comprehensive collection of visual images and videos that are carefully selected for each lesson and grade level. This makes studying more fun by making abstract linguistic ideas more real and easier for kids to understand. The approach can also assist students connect words with their meanings by using visual aids in language lessons. Moreover, the integration of captivating games designed for each lesson and grade level adds a layer of enjoyment to the educational experience. These games are meant to do more than just help students remember what they learned in class, but also provide a chance to use what they've learned in a fun and competitive way. This gamification of learning keeps students interested and motivated by making the hard work of learning a language fun.

Finally, the incorporation of a comprehensive dictionary function, comprising over 100 Kapampangan words with audio pronunciation previews, is crucial for assisting grade school pupils in expanding their vocabulary and improving their pronunciation. The audio previews serve as an essential tool for auditory learners, enabling them to discern precise word pronunciations and engage in imitation practice, so enhancing their linguistic skills.Collectively, these attributes foster a comprehensive and engaging educational atmosphere that captivates and inspires young learners while aiding them in their pursuit of fluency in the Kapampangan language. By considering the various learning styles and preferences of young learners, the system promotes a balanced and inclusive approach to language acquisition, fostering a generation of confident and skilled Kapampangan speakers.

4.3. How can the system be an aid in teaching and learning Kapampangan language?

To Teachers. The computer-based learning system developed for Kapampangan language acquisition serves as a crucial resource for teachers because it enables teachers to ensure that every student is exposed to accurate pronunciation of words. This system may be effortlessly incorporated into daily sessions, allowing teachers to clearly illustrate the accurate pronunciation of difficult words and phrases. This kind of resource is very helpful for keeping language education at a high level for everyone, making sure that every student gets the chance to learn the right way to pronounce words from the beginning.

Furthermore, the system has a huge collection of videos and pictures that are suited to each class and grade level. This gives teachers a lot of multimedia materials to work with. This lets teachers use a wider range of resources, which makes lessons more interesting and lively. Teachers may make studying more dynamic and immersive by adding the visual aids provided by the system that will help the learners connect with the language better. Adding interactive games that help students remember language topics and vocabulary is also a new technique for teachers to get students interested. You can use these games in class or give them as homework. They are a fun and instructive way to learn outside of the classroom.

To the learners: The system's pronunciation checker is a big help for learners because it lets them practice and improve their pronunciation on their own. Amanu gives learners fast feedback, so they may quickly find and fix their faults. Giving students this much freedom in their learning makes them feel accomplished and encourages them to keep getting better. This technique makes it easier for students to practice pronunciation outside of class and at their own pace, which is an important part of learning a language.

The system's visual and video content, together with pronunciation exercises, is tailored to accommodate various learning styles, enhancing the language acquisition process and increasing enjoyment for diverse preferences. The addition of multimedia elements allows learners to visualize language concepts, enhancing retention and making the learning experience more engaging and efficient. Moreover, the interactive activities designed for each class and grade level offer language acquisition an enjoyable and competitive endeavor. Amanu's games facilitate the application of acquired knowledge in real-world contexts, rendering the learning experience more enjoyable and engaging while simultaneously improving language proficiency. Lastly, the full dictionary feature, which includes audio previews, is a great resource for students. It helps students learn new words and refine their pronunciation, making it a useful tool for language learners at any stage of their journey.

4.4. Impact and effectiveness of Amanu to standard teaching methods and curriculum

The implementation of a computer-based learning system into conventional teaching methods and curriculums for Kapampangan language acquisition could greatly improve the efficacy of traditional educational strategies. The inclusion of features like the pronunciation checker, multimedia content, interactive games, and a comprehensive dictionary adds a dynamic and engaging aspect to language learning, enhancing and complementing traditional teaching methods.

Firstly, the pronunciation checker acts as a valuable tool for guaranteeing accurate pronunciation, which is a vital component of language acquisition that can often be difficult to achieve in an educational environment. This feature facilitates personalized feedback, empowering learners to practice and enhance their skills at their own pace, thus assisting educators in upholding high pronunciation standards for every student. Research that studied at how automatic voice recognition affects pronunciation accuracy has shown that this kind of technology works. Findings indicate that learners who utilized ASR-based tools for pronunciation practice showed measurable improvements compared to those who did not [18]. This evidence indicates the necessity of incorporating automatic speech recognition technology, like a pronunciation checker, into language learning platforms to enhance pronunciation skills, providing a solid foundation for integrating this feature into the computer-based learning system for Kapampangan language acquisition.

Second, adding visuals, videos, and interactive tasks to the lessons motivates learners. The incorporation of multimedia and interactive elements addresses various learning styles, enhancing the inclusivity and effectiveness of the learning experience. Investigations indicate that multimedia learning improves knowledge retention by delivering content via various sensory modalities, effectively catering to diverse learner requirements [19]. This method is in sync with the integration of multimedia tools in Amanu, enriching the curriculum by creating a diverse and engaging learning atmosphere that promotes active involvement and supports a more profound comprehension of the language. Furthermore, Amanu enhances the educational experience through lessons delivered in a format similar to PowerPoint slides, complemented by accompanying videos. This approach supports learners by simplifying intricate language concepts into manageable, visually engaging formats, while also providing an alternative avenue for interaction through educational videos. The multimedia lessons are designed to enhance the interactive elements, providing a well-organized yet adaptable language learning environment that can be tailored to various teaching methods and learner characteristics. The application of multimedia tools in this context illustrates their capability to enhance educational results and advocates for their incorporation into contemporary language learning frameworks [18].

Finally, the dictionary with audio previews assists both educators and young learners by providing a straightforward method for acquiring new vocabulary and refining their pronunciation. This tool allows teachers to enhance lesson plans and provide students with additional support beyond school hours, thereby increasing their opportunities for study outside the conventional classroom setting.

When the researchers gave out the survey questionnaires, they asked for feedback on the Amanu system. The respondents said that the system is helpful and has a big impact on teaching, making the process easier. This good response shows how useful it is to add Amanu to the curriculum. It shows how it may improve teaching methods and help both teachers and students learn a language. Specifically, respondents said that the Amanu system's educational slides cut down on the need to look for more teaching materials. The pronunciation checker feature was especially helpful because it means that grade school teachers don't have to look elsewhere to check the correct pronunciation of Kapampangan words during lessons. These features make it easier to prepare and present lessons, which is why many think the system is useful and effective in the classroom.

4.5. Implementation of Amanu using ISO 25010

For Amanu to be successful, it needs to be integrated with high standards of software quality as defined by ISO 25010. Amanu is meant to help grade school students learn the Kapampangan language. The system's design emphasizes functional suitability, ensuring it provides essential functions for language learning, making it a comprehensive tool for its intended young audience. A user-friendly interface that makes learning both effective and fun is the main objective. A strong architecture for smooth operation and error handling makes the system very reliable, which makes for a smooth learning experience. Optimizing performance efficiency lets Amanu respond quickly to user inputs, which is important for keeping learners interested. Portability is also very important since it makes it easy to adapt to different hardware and software environments, makes installation and replacement easier, and makes sure that language education needs continue to be met.

Studies evaluating learning tools based on ISO/IEC 25010 standards underscore the significance of these software quality attributes. The findings indicated exceptional performance in expert evaluations, achieving a grand mean of 3.87, which demonstrates a robust consensus regarding the system's overall efficacy [20]. This evidence highlights the essential function of ISO/IEC 25010 in steering the creation of educational systems that meet user expectations and educational objectives. As a result, the Amanu system's compliance with these standards guarantees a high-quality and effective learning experience for the Kapampangan language.

The efficacy of Amanu was evaluated using the ISO 25010 quality model, in which it achieved high scores in every category:

a. Functional Suitability (3.70)
b. Usability (3.87)
c. Reliability (3.72)
d. Performance (3.87)
e. Portability (3.82)
f. Overall Satisfaction (3.82)

With an overall mean score of 3.80 (Strongly Agree), Amanu demonstrated strong performance, usability, and reliability as a language learning tool for Kapampangan.

4.6. Discussion

The hybrid Convolutional Neural Network (CNN) and Recurrent Neural Network (RNN) model implemented in Amanu demonstrated significant improvements over the initial RNN-only approach. While RNN processed sequential language data, the addition of CNNs enabled spectrogram analysis, leading to enhanced pronunciation checking accuracy. Furthermore, the incorporation of Mel Frequency Cepstral Coefficients (MFCC) further refined the system's ability to provide detailed and precise pronunciation feedback, thereby increasing its effectiveness as a Kapampangan language learning tool.

Amanu's features and functionalities were specifically designed to cater to elementary school learners, incorporating a multimedia library, interactive games, a pronunciation checker, and a dictionary with audio samples. These components foster entertainment, motivation, and knowledge retention, ensuring an interactive and comprehensive learning experience that benefits both teachers and students.

In terms of traditional teaching methodologies, Amanu introduces a technology-based approach that enriches classroom learning. Existing research on speech recognition and multimedia learning supports the effectiveness of these tools in enhancing engagement and improving pronunciation accuracy. By integrating interactive elements and audiovisual content, Amanu offers a more inclusive and adaptive language learning environment.

The system was evaluated using ISO 25010 quality standards, where it received high ratings across multiple criteria, including functional suitability, usability, reliability, performance, and portability, with an overall mean rating of 3.80 (Strongly Agree). These findings confirm Amanu's efficacy as a computer-based language learning system that aligns with established quality benchmarks, reinforcing its role as a valuable tool for teaching and preserving the Kapampangan language.

5. Conclusion

Test results for the "Amanu" system, designed for learning Kapampangan, were positive, indicating the system's outstanding functionality. With mean scores of 3.70 for functional suitability, 3.87 for usability and performance efficiency, 3.72 for reliability, and 3.82 for portability. These ratings show that the system is not only user-friendly but also capable of meeting user needs, responding effectively, and operating consistently. In conclusion, Amanu offers an innovative, successful, and entertaining method for learning the Kapampangan language. It is a helpful tool to use for both teachers and learners due to its outstanding usability, performance, and functionality ratings. By supporting the preservation of the Kapampangan language and demonstrating how educational technology can enhance the learning process, its innovative design connects traditional teachings with modern digital tools, creating a more engaging, effective, and fun approach to teaching the Kapampangan Language.

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