International Journal of Applied Mathematics

Volume 38 No. 1s , 2025

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

OPTIMIZATION AND ALGORITHMIC APPROACHES FOR IOT-DRIVEN LEARNING MODELS IN LOCAL LANGUAGE PRESERVATION

Kadaruddin [1§], Muh. Nurtanzis Sutoyo [2], Karimuddin [3]

[1] Faculty of Teacher Training and Education, Universitas Sembilanbelas November Kolaka, Jalan Pemuda No. 339, Kolaka Regency, Southeast Sulawesi – 93561, INDONESIA

e-mail: kadaruddin1234@gmail.com ([§]Correspondence author)

[2] Faculty of Information Technology, Universitas Sembilanbelas November Kolaka, Jalan Pemuda No. 339 Tahoa, Kolaka Regency, Southeast Sulawesi – 93561, INDONESIA

e-mail: iyes14831@gmail.com

[3] Faculty of Teacher Training and Education, Universitas Sembilanbelas November Kolaka, Jalan Pemuda No. 339, Kolaka Regency, Southeast Sulawesi – 93561, INDONESIA

e-mail: karimuddinusn@gmail.com

Abstract

The decline in the use of local languages in Indonesia has become a serious concern, including the Mekongga language in Kolaka Regency, Indonesia, which is currently threatened with extinction. This study aims to optimize and analyze algorithmic approaches within an IoT-driven interactive learning model to support the preservation and revitalization of the Mekongga language. The study employed a Research and Development approach using the Analysis, Design, Development, Implementation, Evaluation model to design, optimize, and evaluate the learning system. The population consisted of educators and students involved in Mekongga language learning, with a sample of 34 respondents selected through purposive sampling. Data were collected through pre-test and post-test, questionnaires, observations, interviews, and IoT system activity logs. The results of the descriptive statistical analysis showed that all indicators —algorithmic efficiency, material completeness, user interface, feedback, personalization, and engagement —achieved average scores above 4.20 and low standard deviations (≤ 0.66), indicating consistent positive perceptions among respondents. The highest score was recorded on the feedback and system performance indicator ($M = 4.50$). Furthermore, the pre-test and post-test results revealed a significant improvement in learning outcomes, with an increase from 65.12 to 82.35 ($p < 0.05$). Qualitative findings supported these results, with respondents highlighting increased motivation, engagement, and learning experiences driven by interactive features, quick feedback, and personalized learning. This study concludes that the optimized IoT-driven learning model with algorithmic enhancements is effective in improving learning outcomes and motivation in Mekongga language learning, while also contributing to the preservation of local languages in the digital era.

Math. Subject Classification: 68M11

Received: August 03 2025

Volume 38 No. 1s , 2025

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

Key Words and Phrases: Internet of Things (IoT), Local Language Preservation, Optimization Algorithms, Machine Learning, Smart Learning Models

1 Introduction

Local languages are one of the nation's assets that have high historical, cultural, and local wisdom values [1]. In Indonesia there are many local languages with their own characteristics, this is a representation of the cultural richness of the archipelago which is reflected in the motto *Bhineka Tunggal Ika*. However, in recent times, several local languages in Indonesia have experienced a decline in the number of speakers, one of which is the Mekongga language in Kolaka Regency, Southeast Sulawesi, Indonesia [2]. Some of the factors that cause this language to become endangered include modernization, the mixing of marriages, and the influence of Indonesian and foreign languages [3]. Revitalization efforts are important to preserve the language so that cultural and linguistic diversity can be maintained [4].

The development of digital technology, especially the Internet of Things (IoT), can be used as a new opportunity in the development of language learning models [5]. By using IoT, learning can take place interactively, adaptively, and contextually [6]. The device can be integrated to deliver more independent, fun, and real-time learning. As for local language learning, IoT can be used to present a learning atmosphere that is not only in accordance with the times but can also be adjusted to local wisdom through interactive media [7]. Thus, the use of IoT can be an innovative solution for more effective and sustainable learning in supporting efforts to revitalize local languages, especially the Mekongga language [8].

In line with recent advances in computational linguistics and artificial intelligence, IoT-based learning environments can be further enhanced through optimization and algorithmic approaches. These approaches enable adaptive learning systems capable of analyzing learner behavior, automating feedback mechanisms, and optimizing content delivery in real time [9]. Through algorithmic optimization, the IoT learning model can intelligently manage data flow between devices, sensors, and users, ensuring a more personalized and efficient language learning experience.

In addition to the use of technology in learning, efforts to revitalize local languages will be maximized if supported by the active participation of the community, especially the younger generation who are the main target of learning. Most of the younger generation is more familiar with using technology in social media activities and other activities than using it as a learning medium [10]. Therefore, there is a need for an innovation in technology-based local language learning models that consider the integration between pedagogical, technological, and cultural aspects that are balanced [11].

Observing several previous studies, departing from the research gap, it can be said that the use of IoT in learning can increase learning motivation, expand access to learning, and can increase interaction between educators and students [12], [13]. However, the application of IoT in learning local languages, including the Mekongga language, is still very limited [14].

Received: August 03 2025

Volume 38 No. 1s , 2025

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

Furthermore, studies that integrate algorithmic modeling, data analytics, and optimization techniques into IoT-driven language learning remain scarce, leaving a significant research gap in the intersection between computational technology and local language preservation [15]. This reality opens up a wide opportunity for a study to test the effectiveness of the use of IoT as an interactive learning model in the context of local language revitalization [15], [16]. Through this approach, it is hoped that a learning strategy can be found that can foster the awareness of the younger generation in preserving local languages while supporting their language mastery [17].

Theoretically, this research will contribute to the development of a multidisciplinary model that combines computer science, linguistics, and learning technology [18]. The use of IoT is not only a technological tool, but can also be used as a means to create a more inclusive learning atmosphere [19], [20], [21]. By combining smart devices such as smartphones, voice sensors, learning applications, and internet networks, students can experience learning local languages more deeply and in accordance with their environment and needs [22], [23]. The incorporation of optimization algorithms and data-driven analytics strengthens this integration, allowing IoT systems to automatically adjust learning pathways, detect performance patterns, and deliver contextually relevant materials to each learner [24]. This innovation is the answer to the need for an adaptive local language learning model in the industrial era 4.0 and society era 5.0.

In practical terms. This research presents an IoT-based interactive learning model that can be used by various parties such as educators, local and cultural communities, as well as government agencies, in this case the Education and Culture Office as an effort to preserve local languages, including the Mekongga language [24]. The use of this model is not limited to classrooms but can be used online both synchronous and asynchronous [25]. This makes learning the Mekongga language easier to access, learn, and use in daily life by all groups [26]. By optimizing the underlying algorithms and IoT architecture, the system ensures scalability, interoperability, and long-term sustainability in local language preservation initiatives.

The significance of this study is also strengthened by the fact that the Mekongga language is endangered. If these local languages are actively used and taught, then the extinction of these local languages in the next one or two generations is not an impossibility [27]. Therefore, this study not only focuses on the study of the effectiveness of IoT, but also on efforts to sustain the use of this language among its speakers [28]. Thus, this study has a strong relationship in a national and global context.

Based on this description, the main purpose of this study is to optimize and evaluate IoT-driven learning models using algorithmic approaches in supporting efforts to preserve the Mekongga language [29], [30]. In addition, this study will also make a real contribution to the study of applied linguistics, academic literature in the field of learning technology, and the preservation of local languages [31]. Finally, this article is expected to be the basis for the development of data-driven, algorithm-enhanced technology policies for local language learning and preservation in Indonesia.

Received: August 03 2025

Volume 38 No. 1s , 2025

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

2 Related Work

The use of technology in learning has been widely studied in recent years. The use of IoT has great potential to be used as a form of learning technology innovation that has succeeded in improving the quality of learning [32], [33]. Research conducted by Syakroni et al. [34] and Rajora et al. [35] shows that the use of IoT can create a more personalized, real-time, and learning atmosphere that suits the needs of students. The combination of smart devices, IoT, and multimedia can make learners learn more independently and interactive compared to conventional methods [36]. This explanation shows that IoT is not just a technological advancement but also an approach that is very suitable for the world of education.

A number of studies related to the use of technology in language learning have been conducted, although the focus is on foreign language learning. Alakrash et al. [9] said that the emergence of digital learning has reshaped English language learning. Thus, technology-based language learning has received widespread attention because of its benefits. Meanwhile, Grünewald [37] in his research, it was stated that technology-based language learning can improve students' communication skills [38]. In line with that, Shaikh et al. [39] show that the use of IoT-based mobile applications is able to expand students' access outside the classroom. However, most of the research related to the use of technology has not touched the realm of local language learning.

Meanwhile, efforts to revitalize local languages are still limited to documentation approaches, such as research conducted by Guo and Zhu [40], which describes the use of technology in vocabulary learning is still passive, not yet involving interaction between speakers and learners. It can be said that efforts to revitalize local languages that utilize technology, especially IoT, are still minimal.

A recent study conducted by Kadaruddin et al. [30] describes the use of the Learning Management System (LMS) in learning the Mekogga language. In the study, it was stated that the use of LMS in Mekongga language learning makes it easier for educators to manage the learning process from planning, implementation, to evaluation. This is also an effort to preserve the Mekongga language.

However, research related to the Mekongga language is still very limited. Some previous research still emphasizes the linguistic descriptive aspect, not thoroughly discussing the history of language and the cultural values contained in it. There is very little research on local languages that integrates the use of digital technology, especially related to the application of IoT. Meanwhile, Gökçearslan et al. [7] said that the acceptance of IoT technology in learning will affect the seriousness of educators to use this technology in the future. Bianco [41] in his article reminded us that the role of language in cultural preservation is very important.

3 Material and Methods

A. Research Approach and Design

Received: August 03 2025

Volume 38 No. 1s , 2025

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

The approach used in this study was the Research and Development (R&D) approach with the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model [42]. This approach was chosen based on the research objectives, namely developing, optimizing, and evaluating the performance of an IoT-driven learning model using algorithmic approaches to support efforts to preserve the Mekongga language [43]. This model was chosen because it was systematic, flexible, and the model had been widely used in research on learning technology development [44].

In the analysis stage, the researcher conducted a needs assessment through observation and interviews with native speakers, educators, and students [45]. The data obtained became the basis for the design and optimization of the IoT system architecture according to needs. The design stage involved the process of modeling the IoT learning architecture and defining algorithmic rules for adaptive content delivery and user feedback optimization [46]. The development stage focused on the development of prototypes. At this stage, limited tests were carried out to ensure that each component functioned as it should [46]. The implementation stage was the stage of applying the prototype both in the classroom and outside the classroom. The last stage was the evaluation stage, which includes formative tests [47]. Effectiveness was assessed based on increased motivation, learning outcomes, and student involvement in learning the Mekongga language.

Through this ADDIE model, an optimized IoT-driven learning model enhanced with algorithmic personalization mechanisms was produced as well as an empirical overview was found about the effectiveness of this learning model in an effort to support the preservation of the Mekongga language.

B. Population, Sample, and Sampling

The population in this study was all those involved in learning the Mekongga language in Kolaka Regency, Southeast Sulawesi, Indonesia. They are educators and students. This population was chosen because it saw its huge role in efforts to revitalize the Mekongga language. Educators as facilitators who delivered learning materials, while students were expected to be the next generation who actively used the Mekongga language.

The number of samples in this study was 34 people. The sample was determined using the purposive sampling technique, which was the selection of subjects based on the criteria and objectives of the research. The criteria for students to be selected were those who taught the Mekongga language in formal institutions, while students who selected were those who learned Mekongga language in formal institutions.

This sample selection model provided more comprehensive results in providing an overview of how effective this interactive learning model was in efforts to revitalize the Mekongga Language. The data obtained from the students provided a pedagogical overview, ease of use, and relevance of the learning materials. Meanwhile, the data obtained from students provided an overview of the effectiveness of this learning model, seen in terms of learning experience, motivation, and improvement of Mekongga's language skills.

Received: August 03 2025

Volume 38 No. 1s , 2025

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

C. Study Variable(s)

In this study, there were two variables, namely independent variables and dependent variables. These variables were designed to measure the effectiveness and optimization efficiency of IoT-based interactive learning models in the context of Mekongga-based language defence.

The independent variable in this study was the IoT-driven learning model integrated with algorithmic personalization features, including IoT technology, interactive learning design, and system accessibility. Meanwhile, the dependent variable was the effectiveness and optimization outcome, of Mekongga language learning which was measured through several indicators, namely learning outcomes, learning motivation, engagement, and user perception.

D. Measuring Technique and Instrument

Each variable in this study was measured using appropriate techniques and instruments to ensure its validity and realism. To provide a complete overview of the effectiveness of this learning model, measurements were carried out qualitatively and quantitatively.

1) Independent variable measurement

The independent variables in this study were measured through a user evaluation technique involving educators and students. The closed questionnaire was used as an instrument with a Likert scale of 1-5, which included: ease of access to IoT applications and devices, multimedia quality, interface display, ease of navigation, and system consistency. This questionnaire was designed to find out the extent of user perception regarding the reliability of the design and application of IoT in the learning of the Mekongga language.

2) Dependent variable measurements

The dependent variable indicator can be described as follows:

a. Learning Outcomes

(1) Learning outcomes were measured using pre-test and post-test. The tests included four basic skills of the Mekongga language and vocabulary, simple grammar, pronunciation, and oral communication.
(2) The test took the form of multiple-choice, short-filled, and oral practice assignments.
(3) The improvement in learning outcomes was analysed by comparing the pre-test and post-test scores of respondents.

b. Learning Motivation

(1) Learning motivation was measured using a learning motivation questionnaire on a Likert scale of 1–5, which included indicators: interest, enthusiasm, participation in activities, and effort in completing tasks.

Received: August 03 2025

Volume 38 No. 1s , 2025

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

(2) This instrument was adapted from the ARCS (Attention, Relevance, Confidence, Satisfaction) model to assess motivational aspects in technology-based learning.

c. Imvolvement

(1) Involvement was measured through structured observation during the learning process.
(2) Aspects observed included: frequency of interaction with IoT applications, activeness in discussions, and completion of learning activities.
(3) Engagement data were also obtained automatically through IoT system activity logs, such as the number of logins, the duration of application usage, and the amount of material accessed.

d. User Perception

(1) User perception was measured through a user satisfaction questionnaire that contained questions about the usefulness, convenience, and sustainability of using IoT applications.
(2) In addition, semi-structured interviews were conducted with educators and several students to explore the experience of use in more depth.

3) Instrument Analysis Techniques

Before use, all instruments were tested for validity and reliability. The validity of the content was tested through expert judgment (learning technology experts and Mekongga language experts). The validity of the construct was tested by exploratory factor analysis. The reliability of the questionnaire was tested using Cronbach's Alpha to ensure internal consistency.

4) Data Triangulation

To measure the effectiveness of the model more objectively and comprehensively, and to increase the validity of the research results, triangulation methods were used, namely comparing test results, questionnaires, observations, interviews, and IoT system activity log data.

E. Data Collection

The data collection of this research used several techniques adapted to the research objectives. Data were collected from the main respondents by quantitative and qualitative methods, through the following stages.

1) Preparation stage

In the preparation stage, the researcher designed the instruments to be used in the form of learning outcome tests, questionnaires, observation sheets, and interview guidelines, and then tested for validity. After being declared eligible, socialization was carried out with prospective respondents.

Received: August 03 2025

Volume 38 No. 1s , 2025

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

2) Stage of data collection

Quantitative data were collected using three main instruments, namely the pre-test and post-test, the questionnaire, and the activity log. Meanwhile, qualitative data were obtained from the results of observations and interviews.

3) Stages of data validity and reliability

To ensure that the data collected was completely accurate, a triangulation method was carried out by comparing test results, questionnaires, observations, interviews, and log system data. In addition, the reliability of quantitative instruments was assessed using Cronbach's Alpha, while qualitative data were assessed using inter-rater reliability.

4 Result

A. Respondent Description

The respondents in this study were 34 people, consisting of educators and students who participated in Mekongga language learning. By involving these two elements, the data were said to reflect the perceptions of both parties directly involved in this learning.

B. Qualitative Descriptive Analysis

In accordance with the research method, the questionnaire used a Likert scale of 1-5 (1= strongly disagree, 5= strongly agree), included five indicators, namely material completeness, visual interface and navigation, feedback and assessment, learning personalization, and personal engagement. In addition, system-level algorithmic performance data such as response time, feedback accuracy, and adaptive content distribution were analyzed to support the optimization aspect of the model.

Table 1. Results of Descriptive Statistical Analysis.

Indicator	Average (Mean)	Standard Deviation (SD)	Response Trends
Material Completeness	4.47	0.58	Agree – Strongly Agree
Visual Interface & Navigation	4.35	0.63	Agree – Strongly Agree
Feedback and Assessment	4.50	0.52	Strongly Agree dominant
Learning Personalization	4.29	0.66	Agree – Strongly Agree
Personal Engagement	4.41	0.60	Agree – Strongly Agree

Based on Table 1, the interpretation is obtained as follows.

Volume 38 No. 1s , 2025

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

1) An average score above 4.20 indicated that respondents rated this learning as effective and relevant.
2) A relatively small standard deviation (SD) (≤0.66) illustrated the consistency of responses between respondents.
3) The highest indicators were on feedback and assessment (mean = 4.50), which showed that the evaluation feature—supported by the optimized feedback algorithm—was considered very helpful in increasing students' motivation to understand the learning material.
4) System log data also showed stable algorithmic performance, with an average response latency below 1.2 seconds per feedback interaction, indicating efficient optimization in the IoT-driven learning environment.

C. Qualitative Data

The main findings obtained from the questionnaire and interviews can be described as follows.

1) Educators considered that this model facilitated the preparation of teaching materials and allowed for measurable monitoring of learning activities through automated IoT tracking and algorithmic feedback loops.
2) Students stated that they were more motivated to participate in this learning because of the quick and interactive feedback.
3) Some respondents said that the automated quiz feature helped strengthen their understanding of the Mekongga language learning.
4) Some respondents experienced unstable connectivity, which affected the synchronization of IoT devices and algorithmic response times.

This data strengthened the quantitative results, where this learning model was not only well-received but also increased the motivation and learning experience of students.

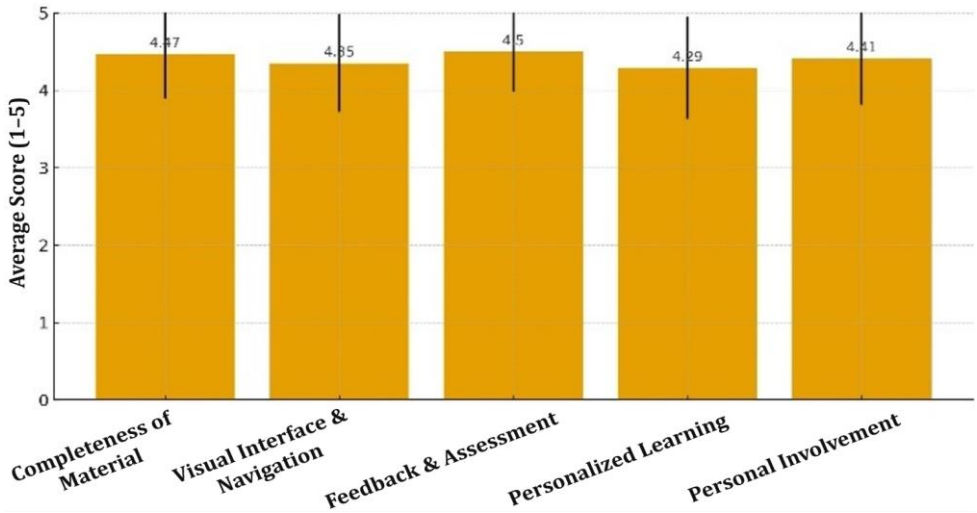

Figure 1. Average Questionnaire Score on the Effectiveness of the IoT Learning Model.

Received: August 03 2025

Volume 38 No. 1s , 2025

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

D. Pre-test and Post-test Results

The pre-test and post-test were carried out to measure the improvement of students' Mekongga language learning outcomes. The results can be seen in the following Table 2.

Table 2. Pre-test and Post-test Results.

Test Stage	Average Score	Standard Deviation
Pre-test	65.12	6.84
Post-test	82.35	5.97

The paired sample test showed a significant difference between the pre-test and the post-test. This indicated that the IoT-driven and algorithmically optimized learning model was also able to increase students' learning achievement in learning the Mekongga language.

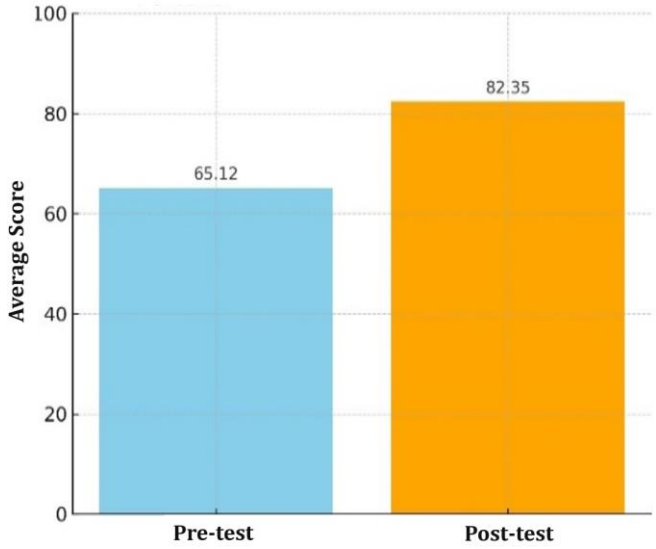

Figure 2. Comparison of Pre-test and Post-test Scores.

E. Key Findings

1) In terms of perception (questionnaire) and improvement of learning outcomes (pre-test and post-test), IoT-based interactive learning models—with algorithmic optimization features for feedback and personalization—were categorized as "good".
2) The completeness of the material, visual interface, and automated adaptive feedback algorithms were the dominant factors that respondents appreciated.
3) Qualitative data confirmed that learning motivation increases due to the personalization of learning and a rapid evaluation system.
4) Algorithmic optimization supported efficiency and consistency in learning analytics, although technical challenges such as limited internet access affected full performance.

F. Implication

Received: August 03 2025

Volume 38 No. 1s , 2025

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

The results of this study strengthened the opinion that through the R&D approach with the ADDIE model, it can succeed in producing effective learning products, in accordance with the research objectives, namely:

1) Revitalized the Mekongga language through algorithmically enhanced IoT learning models.
2) Provided a model that could be replicated for learning other local languages in Indonesia through optimized technology-based learning approaches.
3) Proved that the combination of quantitative data (descriptive statistics, t-test) and qualitative data (interviews, open-ended responses) provided a comprehensive overview of the effectiveness and optimization efficiency of the learning model.

5 Discussion

A. Interpretation of Quantitative Results

Based on the description of the research results, it can be explained that the optimized IoT-driven interactive learning model integrating algorithmic approaches in an effort to preserve the Mekongga language received a positive response from respondents. It can be seen that the average score of the questionnaire based on five indicators consisting of material completeness, interface display, feedback, personalization, and individual involvement is in the range between 4.29 to 4.50 with a low standard deviation of ≤0.66. This shows that respondents consistently say that this learning model is effective in supporting the learning of the Mekongga language.

The findings were strengthened by the results of the pre-test and post-test which showed a significant increase, namely from 65.12 to 82.35 or $p < 0.05$. This means that this system can be positively accepted in terms of perception while also having a real impact on improving the ability to learn the Mekongga language. The integration of algorithmic optimization in IoT data flow and feedback mechanisms ensures more adaptive content delivery, resulting in improved learning performance and engagement. Thus, it can be said that the use of IoT in learning the Mekongga language can be a solution for learning local wisdom in modern technology.

B. Interpretation of Qualitative Results

Qualitative data analysis strengthens the findings of quantitative results. Tracking learning outcomes is very helpful for educators to see the learning progress of students. Likewise with the automatic system, this system greatly eases the task of educators. In line with that, students feel highly motivated because learning is interactive and receives feedback quickly. This is in accordance with the Technology-Enhanced Language Learning theory, which emphasizes the importance of interactivity and personalization in language learning.

Received: August 03 2025

Volume 38 No. 1s , 2025

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

The addition of algorithmic monitoring and real-time analytics enables the system to automatically identify students' learning patterns and adjust learning materials accordingly, increasing personalization and instructional relevance. This learning model is also enriched by audio, visual, and interactive quizzes so that it presents a fun learning atmosphere. This reinforces previous findings that interactive multimedia increases engagement and retention in language learning.

C. Theoretical and Practical Implications

Theoretically, the results of this study strengthen the framework of Computer-Assisted Language Learning and extend it into the realm of Algorithm-Optimized IoT-Based Language Learning. The use of IoT devices enables local language learning to be not only text-based but also interactive, adaptive, and contextual. By embedding optimization algorithms, the model allows intelligent adaptation of content delivery, network efficiency, and learner analytics—creating a data-driven environment that aligns with the principles of artificial intelligence in education.

In practical terms, these findings provide an opportunity for local governments, educational institutions, and local communities to adopt similar models in efforts to revitalize other local languages in Indonesia. This IoT- and algorithm-driven learning framework also supports scalable deployment across different regions, enabling real-time monitoring and performance evaluation for local language programs. If developed more widely, this model can contribute to the preservation of endangered local languages in a way that is relevant to the younger generation.

D. Research Limitations

Although the results of this study show the effectiveness of the model, there are some shortcomings that were found. First, the number of respondents is still limited so that the results of the study cannot be generalized. Second, limited internet access is a separate obstacle that affects the smooth learning of students. Third, the algorithmic modules developed in this study are still in the early stages of optimization, and further refinement using larger datasets and machine learning techniques is needed to enhance system intelligence and adaptability. Future studies should also compare various optimization algorithms to determine the most efficient approach for local language learning contexts.

6 Conclusion

The results of this study show that the optimized IoT-driven learning model integrating algorithmic approaches has a significant impact on the learning outcomes of the Mekongga language. The questionnaire analysis shows an average score above 4.20 on all indicators with

Received: August 03 2025

Volume 38 No. 1s , 2025

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

low standard deviations. This indicates that there is consistency in respondents' assessments. In addition, there was an increase in Mekongga language competence from an average score of 65.12 to 82.35.

In terms of qualitativeness, respondents assess that this learning is able to increase motivation, engagement, learning experience with interactive features, real-time feedback, and algorithmically driven personalization of learning content. Thus, it can be said that this research makes a real contribution to the integration between intelligent technology, algorithmic optimization, and local language preservation efforts.

In addition, from the practical side, this learning model can be used as one of the scalable and adaptive models for revitalizing local languages that are adaptive to technological developments and the needs of the younger generation. Overall, it can be emphasized that the algorithm-optimized IoT-based interactive learning model is effective in learning the Mekongga language and is relevant in supporting efforts to revitalize the Mekongga language. Thus, it can be said that this approach can also be used for other local languages in Indonesia that are experiencing similar conditions in their preservation.

However, this study certainly has some limitations, such as the relatively small number of respondents and technical obstacles in the form of uneven internet access. Therefore, it is suggested that further research can expand the number of respondents, explore various optimization algorithms and machine learning techniques, and integrate longitudinal evaluation approaches to enhance the model’s accuracy, adaptability, and overall effectiveness in improving local language learning quality.

7 Acknowledgment

The authors express their gratitude to *Lembaga Penelitian dan Pengabdian Masyarakat* Universitas Sembilanbelas November Kolaka for the support of research facilities, as well as to educators and students who have participated in the implementation of the IoT-based learning model for the Mekongga language.

This research was funded by *Direktorat Penelitian dan Pengabdian kepada Masyarakat, Direktorat Jenderal Riset dan Pengembangan, Kementerian Pendidikan Tinggi, Sains, dan Teknologi* in the 2025 fiscal year through a research contract with the: 106/C3/DT.05.00.PL/2025.

References

[1] D. Hidayat, G. Rahmasari, and D. Wibawa, The Inhibition and Communication Approaches of Local Languages Learning Among Millennials, *Ijole*., **5**(3) (2021), 165–179.

Volume 38 No. 1s , 2025

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

[2] N. Nurjanah, Y.T. Herlambang, B. Hendrawan, and G. Gandana, Regional Language Education in the Era of the Industrial Revolution Era 4.0: An Idea About Education in the Techno-pedagogy Perspective, *J. Phys.: Conf. Ser.,* **1477**(4) (2020), 042068.

[3] B. Arafah, K. Kaharuddin, T. Takwa, A.N.B. Arafah, K. Kadaruddin, and S.M.R. Leba, Promoting the Building Up of Character Education Based on Literature, Culture, and Local Wisdom, *Elem. Educ. Onl*., **20**(4) (2023), 206–216.

[4] E. Benmamoun, S. Montrul, and M. Polinsky, Heritage Languages and Their Speakers: Opportunities and Challenges for Linguistics, *Theor. Ling*., **39**(3–4) (2013), 129-181.

[5] A. Kukulska-Hulme, R.A. Giri, S. Dawadi, K.R. Devkota, and M. Gaved, Languages and Technologies in Education at School and Outside of School: Perspectives from Young People in Low-Resource Countries in Africa and Asia, *Front. Commun.,* **8** (2023), 1-16.

[6] W. Dong, D. Pan, and S. Kim, Exploring the Integration of IoT and Generative AI in English Language Education: Smart Tools for Personalized Learning Experiences, *Jour. of Comput. Sci.,* **82** (2024), 102397.

[7] Ş. Gökçearslan, H.Y. Durak, and N.A. Uslu, Acceptance of Educational Use of the Internet of Things (IoT) in the Context of Individual Innovativeness and ICT Competency of Pre-Service Teachers, I*nterac. Learb. Envir.,* **32**(2) (2024), 557–571.

[8] H. Outakoski, C. Cocq, and P. Steggo, Strengthening Indigenous Languages in the Digital Age: Social Media–Supported Learning in Sápmi, *Med. Inter. Australia.,* **169**(1) (2018), 21–31.

[9] H.M. Alakrash, N.A. Razak, and P. Krish, The Application of Digital Platforms in Learning English Language, *IJIET*., **12**(9) (2022), 899–904.

[10] S.-G. Lee, S. Trimi, and C. Kim, The Impact of Cultural Differences on Technology Adoption, *Jour. of World Busi*., **48**(1), (2013), 20–29.

[11] J. Voogt, P. Fisser, N. P. Roblin, J. Tondeur, and J. V. Braak, Technological Pedagogical Content Knowledge – A Review of the Literature, *Comp. Ass. Learn*., **29**(2) (2013), 109–121.

[12] S. Tzima, G. Styliaras, A. Bassounas, and M. Tzima, Harnessing the Potential of Storytelling and Mobile Technology in Intangible Cultural Heritage: A Case Study in Early Childhood Education in Sustainability, *Sustai*., **12**(22) (2020), 9416.

[13] Y. Yusman, B. Bakhtiar, and U. Sari, Rancang Bangun Sistem Smart Home dengan Arduino Uno R3 Berbasis Internet of Things (IoT), *Jur. Lit. Jurn. List. Teleko. Elektro*., **16**(1) (2019), 25–29.

Received: August 03 2025

Volume 38 No. 1s , 2025

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

[14] J.E. Casal and M. Kessler, Can Linguists Distinguish Between ChatGPT/AI and Human Writing?: A Study of Research Ethics and Academic Publishing, *Res. Meth. in Appl. Ling.* **2**(3) (2023), 100068.

[15] M. Merkt, S. Weigand, A. Heier, and S. Schwan, Learning with Videos Vs. Learning with Print: The Role of Interactive Features, *Learn. and Instr*., **21**(6) (2011), 687–704.

[16] S.S. Sinaga, Children's Trilingual Songs (Indonesian, English, and Javanese) as Media for Strengthening the Diversity Character of Elementary School Students, *Huma. Journ. of Arts Rese and Educ*., **22**(2), 392–404 (2022).

[17] H. Hetilaniar, I. Zulaeha, H.B. Mardikantoro, T. Yuniawan, and N. Lachlan, Phonological Variation Technology Integration for Indonesia Cultural Preservation and Edupreneurship, *ATT*., **7**(1) (2026), 158–168.

[18] F. García-Pinillos, M.A. Martínez-Marín, D. Jaén-Carrillo, I. Fernández-Navarrete, S.A. Ruiz-Alias, and V.M. Soto-Hermoso, "Bridging Sports and Academics: User Perception of an E-Learning Platform in the Edusport Project, *Retos*., **68** (2025), 359–365.

[19] S. Hopkins and H. Farley, eLearning Incarcerated: Digital Humanities in Australian Prisons, *The Intern. Jour. of Hum. Educ*., **13**(2) (2025), 37–45.

[20] P. Kale, H. Singh, and H. Perlmutter, Learning and Protection of Proprietary Assets in Strategic Alliances: Building Relational Capital, *Strat. Mgmt. Jour*., **21**(3) (2000), 217–237.

[21] D. Prihatmoko, The Application of the Internet of Things (IoT) in Learning at Unisnu Jepara, *Simet*., **7**(2) (2016), 567 (2016), 567–574.

[22] B.A. Kumar, and M.S. Goundar, Developing Mobile Language Learning Applications: A Systematic Literature Review, *Educ. Inf. Tech.,* **28**(5) (2023), 5651–5671.

[23] B. Guo, and L. Niu, A Novel Internet of Things and Cloud Computing-Driven Deep Learning Framework for Disease Prediction and Monitoring, *IJACSA.*, **16**(1), (2025), 733–740.

[24] I. Inayatulloh, Preserving Regional Languages with Blockchain Technology to Increase Transparency of Regional Language Preservation Activities, in *2025 7th Intern. Conf. on Intel. Sust. Syst.*, (IEEE, India, 2025), 491–495.

[25] N.D.K. Salwa, *Education Transformation Through Advanced Technology and IoT*, Cloud Computing Indonesia (2024).

[26] R. Nasrullah, Revitalization of Regional Languages in Indonesia: Integration of AI Technology and Community-Based Approaches, Badan Pengembangan dan Pembinaan Desa (2024).

Received: August 03 2025

Volume 38 No. 1s , 2025

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

[27] K. A. Kadir, Contrastive Analysis of Between Mekongga and English Syntax, *IJLL*, **3**(3) (2015), 110–115.

[28] J. Guo, W. Chen, and X. Zhang, GOA-WO-ML: Enhancing Internet of Things Security with Gannet Optimization and Walrus Optimizer-Based Machine Learning, *Ijacsa*., **16**(5) (2025), 558–567.

[29] M.S. Astriani, B.P. Dirgantoro, J.J.L. Martinez, and L.H. Yi, A Smartphone-Based Solution for Enhancing Interactive Learning Experiences in Early Childhood Education Using Near Field Communication and Holographic Modules, in *Optim. and Dat. Sciec. in Indus. Engin.*, edited by A. Mirzazadeh, Z. Molamohamadi, E. Babaee Tirkolaee, G.-W. Weber, and K.E. Stecke, (Springer Nature Switzerland, Cham, 2026), 437–448.

[30] Kadaruddin, Y.S. Baso, G. Gusnawaty, M. Hasjim, and M. Hasyim, The Effectiveness of a Learning Management System (LMS) in the Learning Process of Mekongga Regional Language, *Jour. of Comp. Anal. and Applic*., **33**(5) (2024), 47–59.

[31] A.T. Nguyen, T.T. Nguyen, T.T. Le, H.Y. Phuong, T.T. Pham, T.A.T. Huynh, and H.T. Nguyen, Effects of Memrise on Vietnamese EFL Students' Vocabulary: A Case Study at a College in a Rural Area, *EJEL*., **21**(5) (2024), 450–460.

[32] A. Hamdan, M. Tahboush, M. Adawy, T. Alwada'n, and S. Ghwanmeh, Feature Reduction and Anomaly Detection in IoT Using Machine Learning Algorithms, *IJACSA*., **16**(1) (2025), 463–470.

[33] L.W. Yen, R. Thinakaran, and J. Somasekar, Machine Learning-Based Denoising Techniques for Monte Carlo Rendering: A Literature Review, *IJACSA*., **16**(2) (2025), 581–588.

[34] A. Syakroni, Zamroni, C. Muali, H. Baharun, M.Z. Sunarto, B. Musthofa, and M. Wijaya, Motivation and Learning Outcomes Through the Internet of Things; Learning in Pesantren *J. Phys.: Conf. Ser.*, **1363**(1) (2019), 012084.

[35] R. Rajora, A. Rajora, B. Sharma, P. Aggarwal, and S. Thapliyal, The Integration of IoT in Learning Environments: Assessing the Impact of Educational Empowerment and Addressing its Challenges, in *2024 4th Inter. Conf. on Innov. Prac. in Tech. and Manag.*, (IEEE, Noida, India, 2024), 1–5.

[36] E. Spaho, B. Çiço, and I. Shabani, IoT Integration Approaches into Personalized Online Learning: Systematic Review, *Comp.*, **14**(2) (2025), 63.

[37] A. Grünewald, Language Learning and Technologies, in *Man. of App. Rom. Ling.*, edited by V. Mathieu, J. Montemayor Gracia, and C. Polzin-Haumann, (De Gruyter, 2025), 445–466.

[38] A.H. Farhan, T.H. Tahseen, B.M. Shihab, M.A. Jabar, N.A.Z. Aldulimey, S.Q.S. Al-Mousawi, and N.Y. Farhood, The Effect of the Cube Model on Visual-Spatial

Volume 38 No. 1s , 2025

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

Intelligence and Learning the Skill of Spiking in Volleyball for Female Students, *Retos.,* **68** (2025), 513–524.

[39] H. Shaikh, M.S. Khan, Z.A. Mahar, M. Anwar, A. Raza, and A. Shah, A Conceptual Framework for Determining Acceptance of Internet of Things (IoT) in Higher Education Institutions of Pakistan, in *2019 Inter. Conf. on Inf. Scie. and Com. Tech.*, (IEEE, Karachi, Pakistan, 2019), 1–5.

[40] M.H. Guo, and W.I. Zhu, Application of New Media Technology in Vocabulary Learning of College English Curriculum, Educ. *Sci-Theor. Pract.,* **18**(6) (2018), 3376–3383.

[41] J.L Bianco, The Importance of Language Policies and Multilingualism for Cultural Diversity, *Int. Soc. Sci. Jour.,* **61**(199) (2010), 37–67.

[42] R. Suratnu, The Adoption of the ADDIE Model in Designing an Instructional Module: The Case of Malay Language Remove Students, *IJIET*., **7**(2) (2023), 262–270.

[43] D.R. Martatiayan, H. Usman, and H.D. Lestari, Application of the ADDIE Model in Designing Digital Teaching Materials, *Jour. Pend. Peng. Gur. Sek. Das.,* **6**(1) (2023), 105–109.

[44] S. Sunarti, ADDIE Method for Implementation Virtual Reality in Online Course Using Model Project Based Learning, *JDR.,* **6**(1) (2022), 61–65.

[45] M. Rusdi, H. Sirajuddin, and R. Alfah, Implementation of the ADDIE Model (Analysis, Design, Development, Implementation, Evaluation) in PHP-Based E-Learning in the Era of Pandemic, *JTekInfULM*., **7**(1) (2022), 49–56.

[46] É.W.J. Soto and F.M. Eliche, Designing an English learning website by using the ADDIE model, *Ap.,* **14**(1) (2022), 148–163.

[47] T. Dousay and R. Logan, Analyzing and Evaluating the Phases of ADDIE, in *Conf.: Des. & Dev. Res. Conf.*, (IEEE, Cape Town, India, 2011), 32–45.

Received: August 03 2025