Journal of Science and Social Research ISSN 2615 – 4307 (Print)
Oct 2026, IX (5): 8800 – 8813 ISSN 2615 – 3262 (Online)
Available online at http://jurnal.goretanpena.com/index.php/JSSR

ADOBE FLASH CS3-BASED ENGLISH LEARNING MEDIA

Ridwan Yusuf [1], Haanii Pradini [2], Ada Udi Firmansyah[3], Untoro Apsiswanto[4], Nova Alvian Ramadhan[5], Zidan Danida Aprianto[6]
[1,2,4]Sistem Informasi, Universitas Dharma Wacana
[3,6]Bisnis Digital, Universitas Dharma Wacana
[5]Teknik Informatika, Universitas Dharma Wacana
Email: [2]pradinihaanii@gmail.com

Abstract: *This study addresses the pedagogical limitations of conventional English language teaching in elementary school education, which often relies heavily on static worksheets and whiteboard instruction, leading to low student engagement and rapid boredom among young learners. To resolve this problem within the educational technology domain, this research aims to design, develop, and test an integrated interactive multimedia learning application specifically tailored for elementary school students. The proposed application was built using a Research and Development (R&D) methodology utilizing Adobe Flash CS3 and ActionScript 2.0. The development seamlessly integrates alphabet recognition, number recognition, animal and fruit vocabulary, correct audio pronunciation models, and interactive multiple-choice evaluation exercises within a single software ecosystem. Software testing and functional validation confirm that the application operates stably across target operating systems, delivering responsive non-linear navigation and real-time audio-visual feedback. The results demonstrate that the combination of systematic digital assets and interactive triggers successfully creates an engaging, self-paced learning environment, providing a viable multimedia alternative for elementary school educators and establishing a comprehensive development blueprint that can inform content migration to modern educational platform standards.*

Keywords: *Adobe Flash CS3; Elementary School Education; English; Interactive Multimedia; Learning Media.*

Abstrak: Penelitian ini membahas keterbatasan pedagogis dalam pembelajaran bahasa Inggris konvensional di sekolah dasar yang masih banyak mengandalkan lembar kerja statis dan pembelajaran melalui papan tulis. Kondisi tersebut menyebabkan rendahnya keterlibatan siswa dan munculnya rasa bosan dengan cepat pada peserta didik usia dini. Untuk mengatasi permasalahan tersebut dalam bidang teknologi pendidikan, penelitian ini bertujuan untuk merancang, mengembangkan, dan menguji aplikasi pembelajaran multimedia interaktif terpadu yang dirancang khusus bagi siswa sekolah dasar. Aplikasi ini dikembangkan menggunakan metode Research and Development (R&D) dengan memanfaatkan perangkat lunak Adobe Flash CS3 dan bahasa pemrograman ActionScript 2.0. Pengembangan aplikasi ini mengintegrasikan pengenalan huruf alfabet, pengenalan angka, kosakata nama-nama hewan dan buah-buahan, contoh pelafalan yang benar melalui audio, serta latihan evaluasi berbentuk pilihan ganda dalam satu perangkat lunak terpadu. Pengujian perangkat lunak dan validasi fungsional menunjukkan bahwa aplikasi dapat beroperasi secara stabil pada sistem operasi yang menjadi sasaran pengembangan, serta menyediakan navigasi nonlinier yang responsif dan umpan balik audio-visual secara langsung. Hasil penelitian menunjukkan bahwa kombinasi aset digital yang tersusun secara sistematis dan pemicu interaksi berhasil menciptakan lingkungan pembelajaran yang menarik, memungkinkan siswa belajar sesuai dengan kecepatan masing-masing. Dengan demikian, aplikasi ini dapat menjadi alternatif media pembelajaran multimedia yang layak digunakan oleh guru sekolah dasar serta menjadi acuan pengembangan yang

komprehensif untuk mendukung adaptasi konten ke dalam standar platform pendidikan modern.

Kata kunci: Adobe Flash CS3; Pendidikan Sekolah Dasar; Bahasa Inggris; Multimedia Interaktif; Media Pembelajaran.

INTRODUCTION

English has become one of the most important international languages for communication, education, science, and technology (Shin, 2017). As globalization continues to increase the demand for English proficiency (Angelica, 2023), introducing English at an early school level has become a common practice in many educational institutions (Pransiska, 2020). The elementary school period is considered a critical stage for language acquisition because children at this age are highly receptive to expanding their vocabulary, refining pronunciation, and developing basic communication skills (Fauzi & Basikin, 2020; Ilham et al., 2023). Consequently, elementary schools are encouraged to adopt learning approaches that stimulate students' curiosity while creating enjoyable and meaningful learning experiences (Nuraeni, 2019).

Despite the growing emphasis on elementary English education, many schools continue to rely on conventional teaching methods, such as verbal explanations, whiteboard instruction, printed worksheets, and picture cards (Elisa & Tuti, 2020). Although these approaches provide basic language exposure, they often fail to sustain elementary students' attention for extended periods because young learners generally prefer visual, interactive, and game-based learning environments (Oranç & Küntay, 2019). As a result, students may experience boredom, reduced learning motivation, and limited vocabulary retention (Firdaus & Muryanti, 2020). The integration of multimedia technology into classroom instruction therefore presents an opportunity to create more engaging learning experiences by combining text, images, audio, animation, and interactive activities (Dhivya et al., 2023; Susantini & Kristiantari, 2021).

Previous studies have demonstrated that multimedia-based learning significantly enhances primary students' motivation, engagement, and language development Chen & Chan, 2019; Tazkiyatunnupus, S. A., Gunawan & Suhendar, (2025). Interactive multimedia provides attractive visual and audio stimuli that encourage active participation during learning activities while improving vocabulary acquisition and pronunciation skills (Utami et al., 2021). Recent needs analysis research also indicates that elementary school teachers require multimedia applications that incorporate interactive games, attractive animations, and grade-appropriate English materials to facilitate classroom instruction and independent learning (Sanusi et al., 2020).

Several researchers have developed multimedia learning applications for elementary English education using Adobe Flash or Macromedia Flash technology. Jayanti & Norhayati (2019) designed an English learning application introducing environmental themes for lower-grade elementary children using Macromedia Flash and demonstrated that multimedia-based instructional design could support more systematic learning activities. Similarly, Anisma et al., (2021) developed an interactive English learning application for elementary education that replaced conventional classroom instruction with animation, sound, and interactive exercises to increase students' learning interest. Other studies have shown that Adobe Flash-based multimedia effectively improves learning outcomes, reading ability, and student

motivation in various primary educational settings (Silalahi, 2016).

Although these studies confirm the educational value of multimedia learning, several limitations remain. Most existing research has focused on general multimedia implementation or on subjects other than basic English literacy. Some studies emphasize interface design without comprehensive learning content, while others primarily evaluate usability instead of supporting the simultaneous development of alphabet recognition, number recognition, vocabulary acquisition, pronunciation, and interactive practice for elementary school students (Chai et al., 2021). Furthermore, many applications focus on a single learning component rather than integrating multiple learning activities into one educational application (Ikhwati et al., 2017).

Based on the identified research gap, this study develops an Adobe Flash CS3-based English language learning media specifically designed for elementary school students. The application integrates alphabet recognition, number recognition, vocabulary learning, pronunciation support, animations, images, and interactive exercises within a single multimedia environment. Although Adobe Flash CS3 is no longer widely adopted as a modern development platform, this research contributes by documenting a complete multimedia development process and evaluating how integrated multimedia features can improve learning engagement among primary school learners (Wahyono et al., 2020). The study also provides practical insights that may inform the migration of similar educational content to contemporary multimedia platforms (Wanja et al., 2026).

The objectives of this study are threefold. First, the study aims to develop an interactive English language learning media that assists elementary school students in learning English letters, numbers, and basic vocabulary through multimedia elements (Darsana, 2025). Second, it seeks to evaluate the effectiveness of the developed application in supporting student engagement and teachers' instructional activities (Agustin, 2020). Third, the study demonstrates the application of Adobe Flash CS3 as a multimedia development tool for producing educational software that integrates text, graphics, audio, animation, and user interaction (Lusianah, 2025).

The study employs a research and development approach involving data collection through observation, interviews, and literature review to identify user requirements. The application is developed using Adobe Flash CS3 and ActionScript 2.0, followed by interface design, implementation, and software testing to ensure functional correctness. Compared with previous studies that primarily focused on interface design or isolated multimedia features, the proposed approach emphasizes the integration of multiple instructional components within a single application, thereby providing a more comprehensive learning experience for elementary school English education (Suryadi, 2025).

This study contributes to educational technology by providing an interactive multimedia application that supports English language instruction for primary students. The proposed learning media offers teachers an alternative instructional tool capable of increasing students' motivation, participation, and vocabulary acquisition through enjoyable learning activities (Rosiyanah et al., 2020). In addition, the results contribute to the growing body of research on multimedia-assisted language learning and may serve as a reference for future researchers interested in developing interactive educational applications for young learners (Rabbiyanti, 2021).

METHOD

Journal of Science and Social Research ISSN 2615 – 4307 (Print)
Oct 2026, IX (5): 8800 – 8013 ISSN 2615 – 3262 (Online)
Available online at http://jurnal.goretanpena.com/index.php/JSSR

This study employed a structured multimedia application development methodology to design and develop an interactive multimedia application for English-language learning at the elementary school level. The development process consisted of requirements analysis, application design, interface design, program logic design, implementation, and functional testing. This systematic approach was adopted to ensure that the application met the intended learning objectives and provided an accessible, interactive, and child-friendly learning environment (Shneiderman, 2016).

1. Requirements analysis

The requirements analysis identified the application's learning content and interactive features, including alphabet and number recognition, animal and fruit vocabulary, multimedia elements, and multiple-choice exercises. Navigation was designed to provide easy access to the main menu, learning materials, exercises, and profile page.

The technical requirements included an Intel Pentium IV processor, 512 MB RAM, a 1,366 × 768 pixel display, sufficient storage, and standard peripherals. The application was designed for Windows XP, Windows Vista, and Windows 7.

2. Application design

The application navigation was designed using a combination of hierarchical and non-linear structures to facilitate access to learning materials (Shneiderman, 2016). The main components included an introductory screen, main menu, learning content, exercises, developer profile, and exit function.

The learning content covered alphabet and number recognition, animal and fruit vocabulary, supported by text, images, audio, and animation. Multiple-choice exercises were provided to assess understanding, while navigation buttons allowed users to move between sections. The navigation structure is illustrated in Fig. 1.

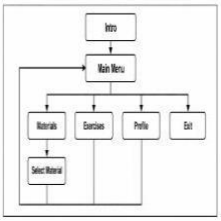


Fig. 1. Navigation structure of the learning application

3. Interface design

The user interface was designed with a consistent visual layout to facilitate navigation and provide an accessible learning experience for elementary school students. The interface design process began with the preparation of page layouts and wireframes, which were subsequently implemented in Adobe Flash CS3 Professional.

The introductory page served as the opening screen and displayed the application title and institutional information. An Enter button allowed users to proceed to the main menu.

The main menu functioned as the central navigation interface and provided buttons for accessing the learning content, developer profile, and exit function. A Home button was also incorporated into the relevant subpages to allow users to return to the main menu.

The learning content interface provided access to the four subject areas: alphabet recognition, number recognition, animal vocabulary, and fruit vocabulary. The content detail pages presented the learning materials using text, illustrations, audio pronunciation, and animation. These elements were arranged to support the recognition of English vocabulary and make the learning process more engaging.

The profile page displayed information about the application developer and included a navigation option for returning to the main menu. The navigation buttons were designed consistently across the application to

Journal of Science and Social Research ISSN 2615 – 4307 (Print)
Oct 2026, IX (5): 8800 – 8013 ISSN 2615 – 3262 (Online)
Available online at http://jurnal.goretanpena.com/index.php/JSSR

maintain interface uniformity and simplify user interaction.

The interface designs are illustrated in Fig. 2–10.

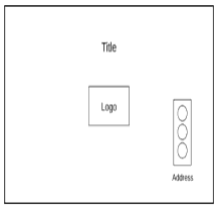


Fig. 2. Intro page design

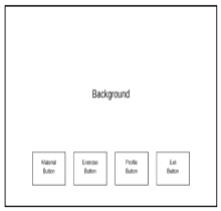


Fig. 3. Main Menu page design

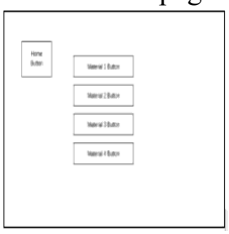


Fig. 4. Content page design



Fig. 5. Content detail page design

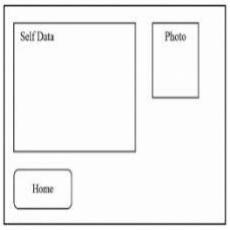


Fig. 6. Profile page design



Fig. 7. Home button design

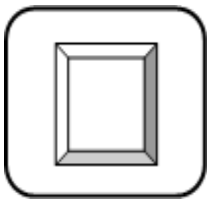


Fig. 8. Content button design



Fig. 9. Profile button design

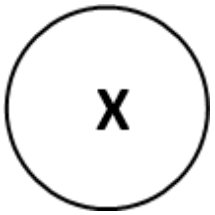


Fig. 10. Exit button design

4. Program logic design (flowchart)

The program logic was designed using a flowchart before the implementation stage. The flowchart represented the sequence of operations, beginning with application launch and continuing through menu navigation, learning content selection, exercise completion, and application termination.

The flowchart also defined the relationships between the interface components and the actions performed when users selected navigation buttons or answered exercise questions. This design served as a reference for implementing the application's interactive functions using ActionScript 2.0 in Adobe Flash CS3 Professional. The program flowchart is presented in Fig. 11.

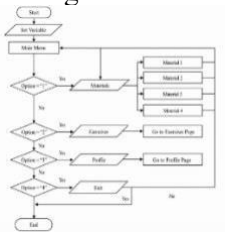


Fig. 11. Program flowchart

5. Application Implementation

The application was implemented using Adobe Flash CS3 Professional with ActionScript 2.0. Adobe Photoshop CS3 was used to prepare and edit the visual assets incorporated into the application. The development process consisted of asset preparation, interface construction, animation development, programming, and application publishing.

First, visual assets were prepared and edited using Adobe Photoshop CS3 before being imported into the Adobe Flash CS3 library. Audio files containing English vocabulary pronunciations were also imported for integration into the learning content.

Second, the application interfaces were constructed on the Flash stage. Text elements, images, buttons, and other visual components were arranged according to the previously developed interface designs. The timeline was used to organize scenes, frames, and animation sequences.

Third, animations and interactive elements were implemented using the Flash timeline and ActionScript 2.0. The programming process focused on three principal functions: navigation control, exercise evaluation, and audio playback. Navigation control enabled users to access different application sections through button interactions. Exercise evaluation processed multiple-choice responses, while audio playback provided pronunciation models for the English vocabulary presented in the learning materials.

Finally, the completed application was published in Shockwave Flash (.swf) format for use in compatible Windows environments. The published application was intended to operate independently of the Adobe Flash development environment, provided that a compatible Flash runtime or player was available.

2.6. Functional Testing

Functional testing was conducted to verify whether the application components operated according to the specified requirements. The testing focused on navigation functionality, learning content accessibility, audio playback, animation behavior, multiple-choice exercise responses, and application termination.

Each navigation button was checked to ensure that it directed users to the intended page. The learning content was examined to verify that the relevant text, images, animations, and audio elements were displayed or played as intended. The exercise module was tested to determine whether users' answer selections were processed correctly, and the exit function was checked to confirm that the application could be terminated properly.

The application was also examined for navigation consistency and the correct interaction between its main components. The results of these tests were used to identify functional errors and determine whether the application operated in accordance with its design specifications.

RESULT AND DISCUSSION

1. Application Production

The development of the multimedia-based English learning application comprises two fundamental phases: asset acquisition and multimedia editing through specialized software.

1.1. Material and Object Collection

The primary assets acquired for this application encompass four core thematic categories: alphabets, numbers, fruits, and animals. We recorded corresponding audio files to provide precise English pronunciation and textual translations. Additionally, we integrated complementary graphical assets to optimize the visual interface and layout aesthetics.

1.2. Editing Process

We executed the multimedia integration using Adobe Flash CS3 to

compile the prepared assets into a unified interactive framework. The application structure relies on a single executable file, "program.swf", and a designated "sound" directory for audio and background music management. We systematically developed the program through the following sequence:

a. We initiated a new project file via File – New, selected Flash File (ActionScript 2.0), and archived the project as program.fla within the primary asset directory.
b. We adjusted the stage dimensions in the properties panel to a width of 1,000 px and a height of 500 px.
c. We imported the background assets using File – Import – Import to Stage to establish the user interface foundation, as illustrated in Fig. 12.

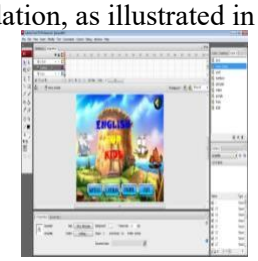


Fig. 12. Background creation process.

d. We constructed the content layout by executing Import to Library, positioning the graphical assets onto the Stage, and implementing the Text Tool to embed required textual data, as shown in Fig. 13.



Fig. 13. Main content menu design.

e. We synchronized the audio recordings within the timeline to deliver real-time voice guidance across the learning modules.
f. We generated the instructional content, including English text, phonetic pronunciation models, and semantic translations.
g. We developed the Alphabet module interface, embedding a primary navigation anchor to return to the landing page and a secondary control to access the module selection window, as depicted in Fig. 14.



Fig. 14. Alphabet module layout creation.

h. We established the Numbers module interface, applying a standard navigation matrix to maintain consistent user interaction, as presented in Fig. 15.

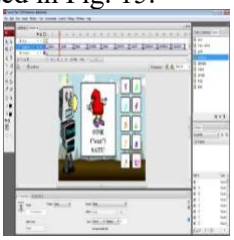


Fig. 15. Numbers module layout creation.

i. We designed the Fruits module interface to arrange visual illustrations with corresponding software interactive triggers, as shown in Fig. 16.



Fig. 16. Fruits module layout creation.

j. We built the Animals module interface, replicating identical structural buttons to ensure intuitive user navigation, as illustrated in Fig. 17.



Fig. 17. Animals module layout creation.

Journal of Science and Social Research ISSN 2615 – 4307 (Print)
Oct 2026, IX (5): 8800 – 8013 ISSN 2615 – 3262 (Online)
Available online at http://jurnal.goretanpena.com/index.php/JSSR

k. We constructed the Exercise module interface, which integrates multiple-choice assessment panels and a programmatic link back to the main dashboard, as displayed in Fig. 18.

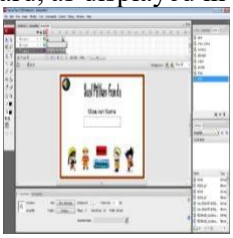


Fig. 18. Exercise module layout creation.

l. We deployed an Exit confirmation module featuring a Yes control to close the application and a No control to maintain the active state on the main dashboard, as depicted in Fig. 19.

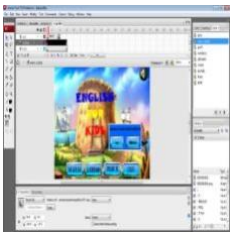


Fig. 19. Exit confirmation layout creation.

2. Program Testing

To validate software integrity and ensure execution stability, we subjected the multimedia application to comprehensive functional testing. The runtime environment was initiated via the Ctrl + Enter compilation shortcut within the authoring tool. The individual system components operate as follows:

a. Intro Menu Interface: This module functions as the application splash screen, presenting the research title prior to user redirection to the primary dashboard, as shown in Fig. 20.



Fig. 20. Application intro interface.

b. Main Menu Interface: This interface serves as the primary dashboard, presenting users with structured navigation pathways to access the interactive learning modules, as illustrated in Fig. 21.



Fig. 21. Main menu interface.

c. Module Selection Interface: This intermediary screen enables users to filter and select specific educational categories, as presented in Fig. 22.



Fig. 22. Module selection interface.

d. Exit Dialog Interface: This module processes application termination protocols using binary confirmation triggers, as depicted in Fig. 23.



Fig. 23. Application exit interface.

e. Alphabet Module Overview: This sub-menu orchestrates the alphabet asset indexes, integrating voice commands, phonetic pronunciations, and lexical definitions, as illustrated in Fig. 24.



Fig. 24. Alphabet module dashboard.

Journal of Science and Social Research ISSN 2615 – 4307 (Print)
Oct 2026, IX (5): 8800 – 8013 ISSN 2615 – 3262 (Online)
Available online at http://jurnal.goretanpena.com/index.php/JSSR

f. Numbers Module Overview: This interface manages numerical literacy acquisition by linking mathematical symbols with audio-linguistic translations, as shown in Fig. 25.



Fig. 25. Numbers module dashboard.

g. Fruits Module Overview: This dashboard displays vocabulary sets for fruits, accompanied by individual audio and graphic components, as presented in Fig. 26.



Fig. 26. Fruits module dashboard.

h. Animals Module Overview: This interface displays animal-related terminology alongside systematic phonetic keys, as depicted in Fig. 27.



Fig. 27. Animals module dashboard.

i. Alphabet Content Execution: Figures 28, 29, and 30 demonstrate the specific user interfaces generated when alphabetic triggers (e.g., "A", "E", and "Z") are executed by the user.



Fig. 28. Content execution for letter “A”.



Fig. 29. Content execution for letter “E”.



Fig. 30. Content execution for letter “Z”.

j. Numbers Content Execution: Figures 31, 32, and 33 show the visual data output and auditory delivery when numerical triggers (e.g., "1", "5", and "10") are activated.

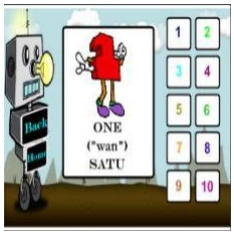


Fig. 31. Content execution for number “1”.

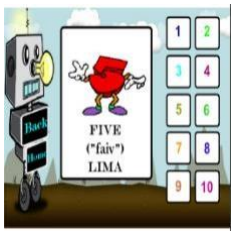


Fig. 32. Content execution for number “5”.

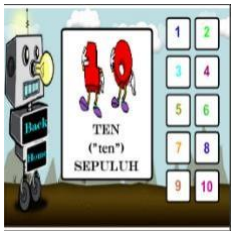


Fig. 33. Content execution for number “10”.

k. Fruits Content Execution: Figures 34, 35, and 36 illustrate the active runtime interfaces for specific vocabulary items, including grapes

Journal of Science and Social Research ISSN 2615 – 4307 (Print)
Oct 2026, IX (5): 8800 – 8013 ISSN 2615 – 3262 (Online)
Available online at http://jurnal.goretanpena.com/index.php/JSSR

Anggur), mangoes (*Mangga*), and strawberries (*Stroberi*).

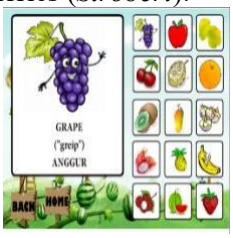


Fig. 34. Content execution for "Grapes".



Fig. 35. Content execution for "Mango".

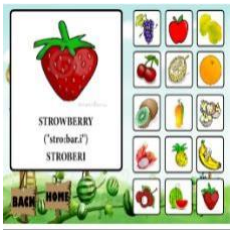


Fig. 36. Content execution for "Strawberry".

l. Animals Content Execution: Figures 37, 38, and 39 represent the dynamic interface generation for animal modules, specifically displaying lions (*Singa*), deer (*Rusa*), and snakes (*Ular*).



Fig. 37. Content execution for "Lion"



Fig. 38. Content execution for "Deer".



Fig. 39. Content execution for "Snake".

m. Exercise Evaluation Interface: Figures 40, 41, 42, and 43 show the interactive question panels distributed across the animal, number, alphabet, and fruit assessment categories.



Fig. 40. Exercise panel for the Animals module.



Fig. 41. Exercise panel for the Number module.



Fig. 42. Exercise panel for the Alphabet module.



Fig. 43. Exercise panel for the Fruits module.

3. Discussion

The experimental compilation and software validation indicate that the

developed Adobe Flash CS3 application addresses the dual requirements of software reliability and student interaction within elementary school environments. By utilizing a vector-based stage configuration ($1{,}000 \times 500$ pixels), the visual objects scale uniformly without pixelation artifacts, satisfying standard human-computer interface guidelines for elementary educational displays (Shneiderman, 2016).

The incorporation of non-linear navigation mechanics through ActionScript 2.0 allows primary students to autonomously skip through vocabulary groups (alphabet, numbers, fruits, and animals). This structural arrangement implements Mayer's multimedia learning principles, specifically the self-pacing effect, which isolates learners from the rigid, fixed timelines characteristic of video playbacks or conventional classroom models (Anderson & Rainie, 2022). Furthermore, by synchronizing compressed audio tracks (WAV/MP3) with vector text animations during runtime, the system reduces split-attention effects, leading to dual-coding pathways that support cognitive vocabulary mapping in young learners (Dhivya et al., 2014; Utami et al., 2021).

The functional results obtained from testing the Exercise Module align with previous discoveries by Susantini and Kristiantari (2021), which highlighted that real-time evaluation feedback hooks increase intrinsic engagement during foundational language drill sessions. However, while standalone deployment files (.swf/.exe) ensure reliable performance on local computers with low specifications (Rabbiyanti, 2021), the legacy dependency of ActionScript 2.0 poses specific technical limitations. Unlike modern, mobile-friendly educational architectures built on responsive HTML5 and component systems (Suryadi, 2025), standalone compilation requires local Windows installations (Wahyono et al., 2020).

Despite these deployment challenges, the systematic asset pipeline documented in this study provides a valuable operational framework for elementary institutions that are under-equipped with high-speed internet connections. The logical flowchart maps out clear design templates, illustrating how interactive visual cues can be adapted for migrating foundational English content into cloud-based multimedia environments (Wanja et al., 2026).

CONCLUSIONS

The objective of this study was to develop and evaluate an interactive multimedia-based learning application using Adobe Flash CS3 to resolve instructional constraints in early childhood English literacy, specifically targeting alphabets, numbers, fruits, and animals. The integration of text, dynamic animations, and audio pronunciation guides successfully produced a more engaging learning platform compared to conventional tools, while simultaneously simplifying the lesson delivery process for educators. This study contributes practically by providing an interactive, dual-channel pedagogical tool that enhances student interest and minimizes instructional barriers in the classroom. Theoretically, these findings expand knowledge in the area of cognitive multimedia learning by illustrating a structured design pipeline that transitions from problem identification to programmatic deployment using independent, synchronized assets. Despite these advancements, a primary limitation of this research is its architectural reliance on a legacy development framework and the absence of extended feature variations such as embedded video files. Furthermore, the application lacks an automated system to quantify and record learning progress for each category. Future research should prioritize migrating the underlying vector and audio assets to modern open-source web standards with more comprehensive

toolsets, incorporating diverse video animations, and integrating dedicated scoring metrics within individual module quizzes to dynamically evaluate student understanding.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to Universitas Dharma Wacana for providing financial support for this research through the 2026 research funding program. The authors also extend their appreciation to the Lembaga Penelitian dan Pengabdian kepada Masyarakat (LPPM) of Universitas Dharma Wacana and the Faculty of Business, Technology, and Science for their institutional support and facilitation throughout the research process.

REFERENCES

Agustin, M. (2020). Teacher challenges and technology adoption barriers in elementary school digital ecosystems. *Journal of Digital Learning, 11*(2), 95–104.

Anderson, J., & Rainie, L. (2022). The future of digital learning ecosystems and interactive media architectures in school education. *Pew Research Center Technology Series, 4*, 45–60.

Angelica, L. (2023). Language development and baseline vocabulary in early primary school education. *International Journal of Child Development, 8*(1), 44–52.

Anisma, Y., Sulistyo, B., & Rahmawati, D. (2021). Pengembangan aplikasi interaktif pembelajaran bahasa Inggris berbasis animasi untuk sekolah dasar. *Jurnal Teknologi Edukasi, 9*(1), 45–53.

Chai, Z. F., Rosman, N. B., & Basri, M. F. B. (2021). Using word recognition instruction and visual aids to enhance ESL primary learners' vocabulary achievement. *Journal of English Language Teaching and Learning (JETLE), 3*(1), 28–39.

Chen, R. W., & Chan, K. K. (2019). Using digital flashcards to learn vocabulary in elementary school education. *Journal of Educational Computing Research, 57*(7), 1812–1831.

Crystal, D. (2012). *English as a global language* (2nd ed.). Cambridge University Press.

Darsana, K. I. P. D. (2025). The use of digital flashcards as learning media to teach English vocabulary for primary school young learners. *The Art of Teaching English as a Foreign Language (TATEFL), 6*(1), 70–82.

Dhivya, D. S., Hariharasudan, A., & Nawaz, N. (2023). Unleashing potential: Multimedia learning and Education 4.0 in learning Professional English Communication. *Cogent Social Sciences, 9*(2), Article 2248751.

Elisa, H., & Tuti, T. (2020). An evaluation of the use of flashcards for teaching vocabulary at elementary schools in Sintang. *JETL (Journal of Education, Teaching and Learning), 5*(2), 385–391.

Fauzi, Y., & Basikin. (2020). First and second language acquisition stages in primary schools. *ELT Journal of Indonesia, 5*(2), 112–124.

Firdaus, M., & Muryanti, E. (2020). Educational games for developing English vocabulary in lower-grade elementary school students. *Jurnal Pendidikan Tambusai, 4*(2), 1216–1227.

Ikhwati, H., Sudarmin, S., & Parmin, P. (2017). Developing interactive learning pipelines through integrated multimedia frameworks. *Unnes Science Education Journal, 6*(2), 145–153.

Ilham, M., Rahman, F., Sari, D. D., & Annisaturrahmi. (2023). Enhancing elementary school English vocabulary through multimedia tools: Insights from a mixed-methods study. *Al-Athfal: Jurnal*

Pendidikan Anak, 9(2), 93–102. https://doi.org/10.14421/al-athfal.2023.92-02

Jayanti, S., & Norhayati, N. (2019). Desain aplikasi pembelajaran bahasa Inggris mengenal lingkungan bagi siswa sekolah dasar menggunakan Macromedia Flash. *Jurnal Ilmu Komputer dan Multimedia, 1*(2), 78–85.

Lusianah, V., Jannah, W. N., & Labudasari, E. (2025). The effect of digital interactive applications in improving beginning literacy skills of primary students. *IDEAS Journal on Language Teaching, 13*(2), 6179–6188.

Mayer, R. E. (2020). *Multimedia learning* (3rd ed.). Cambridge University Press.

Nuraeni, M. (2019). Encouraging self-confidence and motivation through interactive language models in primary classrooms. *Journal of Elementary School Pedagogy, 14*(2), 78–89.

Oranç, Y., & Küntay, A. C. (2019). Interactive multimedia technology and concrete learning experiences in digital primary classrooms. *Computers & Education*, 138, 99–112.

Pransiska, R. (2020). Language acquisition theory and interactive environments for primary school students. *Journal of Language Teaching and Research, 11*(4), 589–597.

Pressman, R. S., & Maxim, B. R. (2020). *Software engineering: A practitioner's approach* (9th ed.). McGraw-Hill.

Rabbiyanti, E. N. (2021). Interactive multimedia application pipelines for standalone localized school deployment. *Journal of Software Engineering and Applications, 14*(3), 102–115.

Rosiyanah, R., Yufiarti, Y., & Meilani, S. M. (2020). Developing interactive sensory stimulation media for primary classroom deployment. *Jurnal Obsesi: Jurnal Pendidikan, 5*(1), 941–956.

Sanusi, R., Dianasari, E. L., Khairiyah, K. Y., & Chairudin, R. (2020). Developing digital assets to enhance character and letter recognition for primary school. *Jurnal Pendidikan Edutama, 7*(2), 37–46.

Shin, J. K. (2017). Teaching English to young learners: Globalization and pedagogical challenges. *Journal of Primary Language Education, 12*(3), 201–215.

Shneiderman, B. (2016). Designing the user interface: *Strategies for effective human-computer interaction* (6th ed.). Pearson.

Silalahi, C. S. (2016). *Animasi media pembelajaran bahasa Inggris dan game pada tingkat sekolah dasar berbasis Adobe Flash CS3* [Laporan teknis, Universitas Sumatera Utara]. Repositori Universitas Sumatera Utara.

Smaldino, S. E., Lowther, D. L., & Mischel, C. (2019). *Instructional technology and media for learning* (12th ed.). Pearson.

Suryadi, T. (2025). Interactionist educational platforms and multi-component systems for elementary school systems. *International Journal of Computer Applications, 185*(9), 14–22.

Susantini, N. L. P., & Kristiantari, M. G. R. (2021). Interactive multimedia flashcards for introducing English vocabulary to primary students. *Jurnal Pendidikan Sekolah Dasar Undiksha, 9*(3), 439–448. https://doi.org/10.23887/paud.v9i3.37606

Tazkiyatunnupus, S. A., Gunawan, Y. I., & Suhendar, A. (2025). Enhancing primary school English vocabulary through digital interactive media: A case study. *Jurnal Pendidikan Unesa, 10*(1), 69–77.

Utami, F., Rukiyah, R., & Andika, W. D. (2021). Developing multimedia-based interactive applications for learning animal terminology. *Jurnal*

Obsesi: Jurnal Pendidikan Sekolah Dasar, 5(2), 1718–1728.

Vaughan, T. (2014). *Multimedia: Making it work* (9th ed.). McGraw-Hill.

Wahyono, P., Husamah, H., & Budi, A. S. (2020). Multimedia design baselines and developer documentation for legacy standalone platforms. *Procedia Computer Science*, 172, 341–349.

Wanja, F. H. W., Sabrina, R., Arif, M., & Nabilah, A. F. (2026). Applying interactive media to teach vocabulary recognition to primary school students. *Celtic: A Journal of Culture, English Language Teaching, Literature and Linguistics, 13*(1), 348–364.