

Digital Pathways to Literacy: E-Reading Interventions for Junior High School Learners

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Abstract

This study developed and evaluated Digital Pathways to Literacy: E-Reading Interventions for Junior High School Learners, a voice-assisted mobile application designed to support struggling readers through interactive reading activities, text-to-speech, speech recognition, real-time feedback, assessment, and progress tracking. The study was anchored in socio-constructivism, cognitive theory of multimedia learning, self-determination theory, and the technological pedagogical content knowledge framework. A pre-experimental pretest-posttest design and developmental research approach within a research-and-development framework were employed. Respondents comprised 30 Grade 7 struggling readers, 11 English teachers, and one Public School District Supervisor selected through purposive sampling. A researcher-made, expert-validated questionnaire assessed usability and acceptability, while an assessment adapted from the Philippine Informal Reading Inventory measured reading comprehension before and after the four-week intervention. Students and educators rated the application as highly usable, with weighted means of 3.93 and 3.96, respectively, and highly acceptable, with weighted means of 3.92 and 3.83. Learners also demonstrated improved reading comprehension from pre-test to post-test, although difficulties with longer sentences were initially observed. The study concluded that the application is a usable, acceptable, and effective supplementary tool for supporting junior high school reading comprehension. Further development, classroom integration, institutional support, larger samples, and longer intervention periods were recommended. The study supports SDG 4 (Quality Education), SDG 9 (Industry, Innovation and Infrastructure), and SDG 10 (Reduced Inequalities) by applying accessible digital technology to literacy support for struggling learners. Its sustainability impact lies in supporting continued literacy development, independent reading practice, accessible learning support, and technology-assisted literacy intervention within public secondary education.

Keywords: Digital Literacy; E-Reading, Junior High; Reading Comprehension; Speech Recognition; Struggling Readers; Voice Assistance

1. Introduction

Literacy is fundamental to communication, learning, and participation in society, yet reading comprehension and basic decoding remain persistent challenges among learners in Philippine public schools. The severity of the broader learning crisis is reflected in the high level of learning poverty reported for the Philippines and other low- and middle-income settings (World Bank, 2022). Recent reviews also show that struggling readers in the upper elementary and secondary grades benefit from explicit, structured, and targeted reading interventions (Filderman et al., 2022; Learned et al., 2022; Sohn et al., 2023). These findings support the continuing need for interventions that provide focused reading assistance while allowing learners to practice with increasing independence.

Recent literature demonstrates that technology-supported literacy instruction can supplement conventional reading intervention. Meta-analytic and systematic-review evidence indicates that digital interventions can support word reading, fluency, comprehension, and engagement when technology is aligned with instructional goals (Dahl-Leonard et al., 2024; Díaz Calle et al., 2024; Hall et al., 2023; Murphy & Arciuli, 2024; Vanbecelaere et al., 2023; Verhoeven et al., 2022). Digital reading, however, does not automatically produce better comprehension than print; outcomes depend on learner characteristics, text type, instructional design, and the quality of digital enhancements (Furenes et al., 2021; Hare et al., 2024; Salmerón et al., 2023). These findings emphasize the importance of designing digital reading tools around specific literacy needs rather than using technology as an end in itself.

Multimodal and interactive features may provide additional support to learners who require repeated practice and immediate feedback. Multimedia learning principles emphasize the purposeful coordination of words, audio, and visual information while avoiding unnecessary cognitive demands (Mayer, 2021). Digital reading programs that incorporate modeling, repeated practice, and immediate corrective feedback have shown promise for learners with significant reading difficulties (Whitney & Ackerman, 2023). Technology-supported learning environments may also promote engagement when they provide clear structure, appropriate challenge, learner control, and responsive support (Chiu, 2021, 2022; Nkomo et al., 2021; OECD, 2021; Rosli et al., 2022).

The effectiveness of digital interventions also depends on accessibility, usability, teacher readiness, and the educational context in which the technology is implemented. Research on educational technology adoption consistently identifies perceived usefulness, ease of use, facilitating conditions, system accessibility, and user-related factors as important to adoption and continued use (Al-Maroofof & Salloum, 2021; Al-Nuaimi & Al-Emran, 2021; Granić, 2022; Gupta et al., 2022). In addition, technology integration is strengthened when technological features are deliberately aligned with pedagogy and subject content. Recent TPACK reviews continue to emphasize the contextual and integrative nature of technological, pedagogical, and content knowledge in educational practice (Irwanto, 2021; Jiménez Sierra et al., 2023; Schmid et al., 2024; Yeh et al., 2021).

The theoretical basis of the study integrates socio-constructivism, multimedia learning, self-determination theory, and the technological pedagogical content knowledge framework. Vygotsky (1978) explains learning as a socially mediated process in which guided support can assist learners within their developmental capabilities, while Wood et al. (1976) describe scaffolding as temporary assistance that supports performance until greater independence is achieved. Self-determination theory identifies autonomy, competence, and relatedness as important psychological needs underlying motivation (Deci & Ryan, 1985). Contemporary technology-supported learning research continues to show the relevance of these motivational needs to student engagement (Chiu, 2021, 2022; Rosli et al., 2022). Multimedia learning provides a basis for integrating text, sound, and visual information in ways that support rather than overload learning processes (Mayer, 2021).

The TPACK framework further guides the alignment of technology, pedagogy, and literacy content. The original framework emphasizes that effective technology integration requires understanding the interaction among technological, pedagogical, and content knowledge (Mishra & Koehler, 2006). Contemporary reviews have continued to develop and examine this framework across educational contexts (Irwanto, 2021; Jiménez Sierra et al., 2023; Schmid et al., 2024; Yeh et al., 2021). Developmental research likewise supports an iterative process of analysis, design, development, implementation, and evaluation when educational products are created and refined for specific contexts (Richey & Klein, 2007).

Despite increasing use of digital resources, important implementation gaps remain. Digital reading outcomes vary according to design, learner characteristics, instructional support, and access to technology (Furenes et al., 2021; Hare et al., 2024; Murphy & Arciuli, 2024). Evidence nevertheless indicates that well-designed technology-delivered literacy instruction and targeted reading intervention can improve literacy outcomes for learners who require additional support (Dahl-Leonard et al., 2024; Filderman et al., 2022; Sohn et al., 2023; Vanbecelaere et al., 2023). Recent research also highlights the need to consider engagement, teacher integration, and practical implementation when digital tools are introduced into learning environments (Granić, 2022; Nkomo et al., 2021).

To address this need, the study developed Digital Pathways to Literacy: E-Reading Interventions for Junior High School Learners, a voice-assisted digital reading application intended to provide independent practice and real-time feedback to learners experiencing reading difficulties. The application integrates digital reading materials, interactive activities, speech recognition, text-to-speech technology, comprehension support, assessment, and progress tracking. Speech recognition functionality was implemented using Google Speech-to-Text, which converts spoken language into text for application-based interaction (Google Cloud, n.d.). The study focuses on designing and developing the application, determining its usability among students and educators, evaluating learners' reading comprehension, and assessing its acceptability. The project supports SDG 4 (Quality Education),

SDG 9 (Industry, Innovation and Infrastructure), and SDG 10 (Reduced Inequalities) through the use of accessible digital technology to support literacy development and educational inclusion.

2. Material and methods

2.1 Research Design

The study used a pre-experimental pretest-posttest design involving thirty (30) Grade 7 learners identified as struggling readers based on the Philippine Informal Reading Inventory (Phil-IRI) assessment and evident difficulties in decoding, fluency, and comprehension. All thirty (30) learners were assigned to the experimental group and used the voice-assisted reading application during the four-week intervention. The study also employed a developmental research design embedded within a research-and-development (R&D) framework to develop, implement, evaluate, and improve the educational application. During the intervention, learners used the application for guided and independent reading sessions. Its features included voice-assisted reading for pronunciation and fluent reading models, adaptable text difficulty, real-time feedback, interactive comprehension activities, and progress tracking. Students could use personal digital devices or the school's available facilities, with home reading also possible for those with internet access. The evaluation of the application was guided by the Technology Acceptance Model (TAM), particularly perceived usefulness and perceived ease of use (Davis, 1989). TAM remains widely used in educational technology research, with recent reviews confirming its continuing relevance to technology adoption and acceptance in educational settings (Al-Nuaimi & Al-Emran, 2021; Granić, 2022; Gupta et al., 2022).

2.2 Locale of the Study

The study was conducted at Don Panaca High School, a public secondary school in Barangay Don Panaca, Magpet, Cotabato. The setting provided an environment for implementing the digital reading intervention using students' available devices and internet connectivity. It also allowed the application to be evaluated under conditions requiring minimal teacher supervision and with the capacity to operate on basic devices and offline when necessary. This setting supported the study's objective of providing an accessible and self-directed reading intervention to learners requiring focused reading assistance. The geographic representation in the manuscript locates Barangay Don Panaca within Magpet, Cotabato, establishing the physical setting of Don Panaca High School and the community in which the intervention was implemented.

2.3 Respondents of the Study

The respondents consisted of three groups: thirty (30) Grade 7 students identified as struggling readers, eleven (11) English teachers from schools within the Magpet East District, and one (1) Public School District Supervisor. The students were identified based on reading difficulties involving decoding, fluency, and comprehension and participated in the voice-assisted intervention. The English teachers were selected because of their direct involvement in language and literacy instruction and evaluated the application's classroom integration, usability, and instructional usefulness. The Public School District Supervisor served as an expert evaluator and provided perspectives on pedagogical soundness, curricular alignment, scalability, and relevance to district-level literacy initiatives. Together, the respondents represented student, teacher, and supervisory perspectives on the application's usability, acceptability, instructional practicality, and educational relevance.

2.4 Sample and Sampling Procedure

Purposive sampling was used to select respondents who met conditions directly related to the objectives of the study. The thirty (30) Grade 7 students were identified as struggling readers based on recommendations from English teachers and the Philippine Informal Reading Inventory (Phil-IRI) assessment, particularly evidence of poor decoding, fluency, or comprehension. These students used the voice-assisted Digital Pathways to Literacy application, with parental consent required before participation. **METHODOLOGY**

The eleven (11) English teachers were purposively selected because of their active involvement in language and literacy instruction in the Magpet East District and their familiarity with students' reading abilities. Their experience enabled them to assess the application's acceptability, usefulness, and instructional applicability. The Public School District Supervisor was likewise included as an expert respondent to evaluate the program's alignment.

2.5 Research Instrument

The study used a researcher-made survey questionnaire validated by three (3) experts to assess the usability and acceptability of Digital Pathways to Literacy. A 4-point scale was used for usability, with 4 indicating high usability, 3 usable, 2 slightly usable, and 1 not usable. Acceptability was similarly measured using a 4-point scale, with 4 indicating highly acceptable, 3 acceptable, 2 slightly acceptable, and 1 not acceptable. The expert validation yielded an overall mean of 3.89, corresponding to a descriptive rating of "Highly valid." The usability instrument classified ratings from "Highly Usable" to "Not Usable," while the acceptability instrument classified responses from "Highly Acceptable" to "Not Acceptable." In addition to the surveys, reading comprehension was measured using an assessment adapted from the Philippine Informal Reading Inventory (Phil-IRI), which was administered

before and after the intervention to determine learners' reading performance. The use of a researcher-made instrument was retained because the study required context-specific evaluation of the developed application, while the acceptance-related constructs were informed by TAM (Davis, 1989; Granić, 2022).

2.6 Data Gathering Procedure

Data collection was conducted in three stages: pre-implementation, implementation, and post-implementation. During pre-implementation, the researcher coordinated with the Public School District Supervisor and English teachers in the Magpet East District to finalize participants and secure the necessary consent. Participants received an orientation concerning the study objectives, ethical requirements, and responsibilities. A pretest adapted from the Philippine Informal Reading Inventory (Phil-IRI) was then administered to establish baseline reading comprehension and identify struggling readers. The implementation lasted four weeks, during which the thirty (30) Grade 7 students used the voice-assisted application during scheduled reading sessions on their available devices. Teachers and the researcher monitored participation and gathered observations concerning reading behavior, performance, and engagement. The application's workflow guided learners from the pretest through easy, medium, and hard reading levels, requiring completion of each stage before progression and concluding with the posttest and system-generated feedback. During post-implementation, the reading comprehension measure was administered again to determine changes in reading proficiency. Usability and acceptability surveys were subsequently administered to the district supervisor, English teachers, and students. The supervisor and teachers also provided qualitative feedback concerning the feasibility of integrating the application into classroom instruction. The collected information was then organized for analysis.

2.7 Data Analysis Techniques

The collected data were systematically organized according to the study objectives and the primary variables of usability and acceptability. Responses from students, teachers, and the district supervisor were reviewed for accuracy and completeness and examined for patterns, trends, and differences in perceptions of the digital reading intervention. Qualitative feedback from the district supervisor and teachers was subjected to thematic analysis to identify common observations and themes concerning implementation, classroom use, acceptability, usability, and educational value. Pretest and posttest reading comprehension results were compared to determine changes in learner performance following the intervention. Means and standard deviations were used to describe reading comprehension levels before and after implementation. A paired-sample t-test was specified to determine significant differences in pretest and posttest performance, while weighted means were used to determine respondents' overall assessments of the application's usability and acceptability. These quantitative findings were considered together with the qualitative feedback to provide a more comprehensive assessment of the intervention. The developmental and iterative orientation of the project is consistent with design and development research, in which educational products are systematically developed and evaluated within their intended context (Richey & Klein, 2007).

3. Results and Discussion

3.1 Digital Pathways to Literacy System and Learning Features

3.1.1 Application Access and Learner Onboarding

The application begins with a loading interface that prepares the reading content and provides learners with direct access to the digital environment. Students then enter their names before proceeding, allowing the application to establish an individualized user session. The interface was designed to remain simple and accessible so that junior high school learners could navigate the application with minimal difficulty. The straightforward entry process supports the application's emphasis on accessibility and personalization. Requiring only the learner's name before beginning reduces unnecessary navigation and allows students to proceed directly to the reading activities, while the personalized entry helps create a more learner-centered digital experience.

3.1.2 Structured Reading Progression and Assessment

The dashboard organizes the learning process into a pre-test followed by easy, medium, and hard reading levels. The pre-test establishes the learner's initial reading ability, after which the easy level focuses on identifying letter sounds using listening and spoken-response functions. The medium level progresses to combining sounds to form words, while the hard level requires students to read sentences aloud. The post-test then uses multiple-choice questions progressing from easy to difficult and displays the current question and score. This progression provides a guided sequence from foundational phonics to word formation and sentence reading. Audio and speech-response functions provide opportunities to practice listening and oral reading, while pre-test and post-test assessments enable progress to be monitored. The structured progression is intended to support learners gradually as they move from basic to increasingly complex reading tasks.

3.1.3 Learner Progress and Feedback

The result interface provides learners with pre-test and post-test scores together with performance across phonics, words, and sentences. The example presented in the application showed an increase from 15/30 in the pre-test to

16/30 in the post-test. The learner obtained 19/26 in phonics, 31/50 in words, and 42/50 in sentences, with sentence reading representing the strongest performance among the three learning levels. These results demonstrate how the application provides immediate and organized information about individual reading performance. By presenting both overall assessment results and performance at different reading levels, the interface allows learners to identify areas of progress and areas requiring continued practice.

3.2 Usability of Digital Pathways to Literacy

3.2.1 Usability According to Students

Students rated the application as Highly Usable, with an overall weighted mean of 3.93 and a standard deviation of 0.061. Individual indicators ranged from 3.70 to 3.93 and were all classified as Highly Usable. Ease of finding needed information obtained 3.93, while feeling welcomed, becoming productive, and completing tasks quickly each received 3.90. The organization of information received the lowest weighted mean of 3.70 but remained within the Highly Usable category. The findings indicate that students generally experienced the application as easy to navigate, comfortable, functional, and supportive of independent task completion. This positive usability evaluation is consistent with multimedia learning and digital-engagement research emphasizing clear, purposeful, and learner-centered design (Hattie, 2023; Mayer, 2021; Nkomo et al., 2021). The application's usability can therefore support self-directed reading practice at the learner's own pace, particularly for students with varying abilities.

3.2.2 Usability According to Educators

Educators rated the application as Highly Usable, with an overall weighted mean of 3.96 and a standard deviation of 0.051. Eight of the ten indicators received a perfect weighted mean of 4.00, including simplicity, ease of finding information, interface clarity, organization, productivity, effectiveness of information, and expected functionality. Liking the interface obtained 3.83, while completing tasks quickly received 3.75; both remained Highly Usable. The consistently high educator ratings indicate that the system was perceived as clear, functional, and manageable for instructional use. These findings are consistent with evidence that well-designed multimedia environments and coherent technology integration can support instructional effectiveness and usability (Hattie, 2023; Mayer, 2021; Schmid et al., 2024). The results suggest that the application can be incorporated into classroom instruction with minimal difficulty in learning its basic functions.

3.3 Reading Comprehension of Learners

The pre-test and post-test results of the thirty (30) junior high school learners showed a general increase in reading comprehension following the intervention. The pre-test scores were consistently lower, whereas most learners achieved substantially higher scores in the post-test. The results also showed that learners initially experienced difficulty with longer sentences, which contributed to incomplete or incorrect responses, but their performance improved following continued practice and interactive support. The observed improvement indicates that structured and progressive digital reading activities supported learners as they practiced increasingly complex reading tasks. This result is consistent with recent evidence showing that structured reading interventions and technology-supported literacy instruction can improve reading outcomes for struggling learners (Dahl-Leonard et al., 2024; Filderman et al., 2022; Sohn et al., 2023; Vanbecelaere et al., 2023; Verhoeven et al., 2022). Research on digital reading also indicates that instructional design and the way digital tools are used influence comprehension outcomes (Murphy & Arciuli, 2024; Salmerón et al., 2023).

3.4 Acceptability of Digital Pathways to Literacy

3.4.1 Acceptability According to Students

Students rated the application as Highly Acceptable, with an overall weighted mean of 3.92 and a standard deviation of 0.041. All indicators were classified as Highly Acceptable. The highest reported weighted means were 3.93 for ease of getting the application to perform desired functions and for clear and understandable interaction. The lowest rating was 3.63 for long-term use, although it remained within the Highly Acceptable category. The high acceptability rating indicates that students perceived the application as useful, understandable, flexible, and appropriate for supporting their learning. These findings are consistent with self-determination-based research showing that digital support can strengthen engagement when learners experience autonomy, competence, and appropriate instructional support (Chiu, 2021, 2022; Rosli et al., 2022). The findings therefore support the application's potential as a supplementary digital intervention for sustained reading development and learner engagement.

3.4.2 Acceptability According to Educators

Educators rated the application as Highly Acceptable, with an overall weighted mean of 3.83 and a standard deviation of 0.129. Improving reading skills and usefulness in school each received a weighted mean of 4.00, as did acceptance for long-term use. The lowest reported rating was 3.58 for the application's ability to meet users' needs in accomplishing their goals, but this remained within the Highly Acceptable category. Overall, educators demonstrated strong acceptance of the application as an instructional support tool. The results indicate that educators recognized the application's usefulness, ease of use, and potential for continued implementation, although some aspects related to meeting specific learner needs may still be strengthened. This interpretation is

consistent with recent educational technology adoption research emphasizing perceived usefulness, ease of use, facilitating conditions, and system-related factors in continued technology use (Al-Nuaimi & Al-Emran, 2021; Granić, 2022; Gupta et al., 2022). The findings consequently suggest potential for longer-term classroom integration, with further improvement in content alignment and customization for different learner needs.

3.5 Overall Evaluation and System Functionality

Overall, students and educators evaluated Digital Pathways to Literacy as highly usable and highly acceptable. Students recorded usability and acceptability weighted means of 3.93 and 3.92, respectively, while educators recorded corresponding means of 3.96 and 3.83. The findings indicate positive perceptions of the application's ease of use, clarity, functionality, flexibility, and usefulness. The results further showed improvement in learners' reading comprehension after exposure to the digital reading activities. The application's functionality is further supported by artificial intelligence-based voice recognition using tools such as Google Speech-to-Text, which converts learners' spoken responses into text. Google Cloud (n.d.) documents Speech-to-Text as a service that converts spoken language into text. Through an Android device, learners can provide spoken responses during reading activities, while the system converts speech into text to support pronunciation and comprehension checking. User responses and progress are also stored for monitoring, enabling immediate feedback and organized management of learning information.

4. Conclusion & Recommendations

The study successfully developed Digital Pathways to Literacy: E-Reading Interventions for Junior High School Learners as an interactive mobile application that supports reading through text-to-speech, speech recognition, assessment, and progress-tracking features. The application was rated highly usable by students and educators, with weighted means of 3.93 and 3.96, respectively, and highly acceptable, with corresponding weighted means of 3.92 and 3.83. Learners also demonstrated improved reading comprehension from pre-test to post-test, particularly after guided practice with progressively challenging reading activities. Overall, the findings indicate that the application is a usable, acceptable, and effective supplementary tool for supporting reading comprehension among junior high school learners.

The application may be further enhanced by incorporating real-time notifications for monitoring students' usage, progress, and reading levels, as well as features that allow content and questions to be edited and used across different devices and hybrid learning environments. Teachers are encouraged to integrate the application as a supplementary reading tool, while school administrators may support its implementation by providing appropriate devices, stable internet access, and teacher training. Students are encouraged to use the application actively to improve their reading skills and comprehension, while future researchers may involve a larger sample and a longer intervention period to further validate and extend the study's findings.

The study was limited to forty-two respondents selected through purposive sampling, including students from Don Panaca High School and educators from the Magpet East District. The intervention was conducted within a specific school and district context, and the study itself recommends a larger sample size and longer intervention period for future research. Thus, the findings reflect the respondents and implementation conditions included in the present study and may require further validation using a broader sample and an extended intervention period.

5. Compliance with ethical standards

The author affirms that no conflict of interest exists in relation to this study. The study involved Grade 7 students from Don Panaca High School, English teachers from the Magpet East District, and the Public School District Supervisor, with parental consent required for participating students. Participants were oriented regarding the study objectives, ethical requirements, and their responsibilities before data collection, and the researcher coordinated with the Public School District Supervisor and English teachers during the pre-implementation stage.

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