EDUCARE Journal of Primary Education

ISSN 2716-1021 (p) 2716-1013 (e)

OPEN ACCESS

https://educare.uinkhas.ac.id/index.php/jie

DOI: 10.35719/educare.v5i2.306
Vol 5, No 2 (2024): pp. 175-192

Improving elementary school students' science literacy through Office Sway interactive learning media

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Article Information:
Received 2024-10-12
Revised 2024-11-28
Accepted 2024-12-27

Keywords:
Instructional Media, Office Sway, Science Literacy

ABSTRACT

This study addresses the need to improve science literacy among elementary school students. Although traditional teaching methods are important, they sometimes fail to fully engage students or deepen their understanding of the material. Therefore, this study explores the potential of using Office Sway as an interactive learning media to enhance science literacy. The aim of this study is to assess the effectiveness of using Office Sway in supporting the improvement of science literacy among elementary school students. This study employed an R&D approach using the APPED model to develop interactive learning media based on Office Sway, including needs analysis, design, production, expert evaluation, and dissemination, with effectiveness measured through tests, questionnaires, and interviews. The results of the study show that Office Sway has significant potential to increase student engagement and science literacy in elementary schools by presenting content in a more dynamic and engaging way through interactive multimedia features. However, the success of using Office Sway heavily depends on several factors, such as well-structured teacher training, supportive technological infrastructure, and continuous content updates. To maximize its effectiveness in learning, a holistic approach and continuous evaluation are necessary. This study provides important contributions by identifying the potential of Office Sway as a learning tool that can enhance student engagement and understanding of scientific concepts, while also highlighting the importance of teacher training, proper infrastructure, and ongoing evaluation.

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To cite this article (APA Style):
Sulastri, D., Andriana, E., & Syachruroji, A. (2024). Improving elementary school students' science literacy through Office Sway interactive learning media. *EDUCARE: Journal of Primary Education, 5(2)*, 175-192. https://doi.org/10.35719/educare.v5i2.306

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INTRODUCTION

In education, the selection of learning media plays a crucial role in helping students understand the material and strengthening the teacher's delivery (Chang et al., 2020; Liu, 2024). Alalwan (2022) and Harefa et al. (2023) emphasized that effective media increases student engagement and understanding. However, using traditional media such as whiteboards is often less engaging and interactive, which can reduce student engagement (Lee et al., 2022). Students' misunderstandings about the material are usually caused by inadequate reference materials, a challenge that must be addressed to improve science literacy (Darling-Hammond et al., 2019; Doshi et al., 2024). Mulder et al (2023) suggested that developing science education materials for the web is essential in addressing this problem. According to Rosenthal (2020) and Holincheck et al (2022), computer-based media and regular internet access can improve science literacy. Levrini et al. (2019) and Hamaker et al (2020), also stated that in-depth scientific understanding requires media to convey temporal patterns and causal explanation models effectively. Therefore, educational institutions must implement modern and interactive learning media to help students build connections between scientific concepts and real-world problems while improving their scientific literacy.

Based on the current literature review, several studies have been conducted on developing Office Sway media in various learning contexts. First, research by Kim et al., (2022) and Sunarti et al (2023) shows that this media is practical and feasible for learning reading comprehension in elementary school with non-fiction text material, recorded with a percentage of material expertise of 90 and a median of 88.6. Second, research by Dayu et al. (2024) found that Office Sway effectively teaches poetry writing skills at the same level, showing a high level of validity, practicality, and effectiveness. Third, according to Markamah (2022), using Sway-based media for fine arts lessons in elementary schools has increased student learning motivation and learning outcomes. Fourth, research by Sujanem & Suwindra (2023) indicates that interactive physics modules assisted by Microsoft Sway successfully improve students' critical thinking skills. However, current research focuses more on using Office Sway to improve the scientific literacy skills of grade IV students in the material style of science lessons. In contrast to previous studies that focused more on improving specific skills such as writing, reading, critical thinking, and art, this study aims to explore the potential of Office Sway in advancing science literacy, demonstrating different purposes in its use.

This study aims to develop interactive learning media using Office Sway, focusing on improving students' scientific literacy. The main objectives of this study are to evaluate the media development process, collect feedback from students, and validate the media quality through expert assessments. This learning media is expected to improve elementary school student's understanding of the concept of force in Natural and Social Sciences material as an essential part of scientific literacy. Students can more easily access scientific data by utilizing the hyperlink feature that can be shared in Office Sway presentations. This strategy is designed to overcome obstacles that often occur in science learning and open up opportunities for innovation in this field. With the integration of this technology, students will gain broader and more relevant insights into technological advances and the needs of the current digital era. This learning media is also expected to increase interest in learning, motivate students, and positively impact their mental health.

In this study, the hypothesis proposed is that using interactive learning media, Office Sway will improve elementary school student's understanding of the concept of force in Natural and Social Sciences material compared to conventional learning methods. In addition, it is also hypothesized that the use of Office Sway will increase students' interest in learning IPAS material. Furthermore, it is expected that integrating hyperlinks in Office Sway presentations will make it easier for students to access scientific information, which will support the improvement of their scientific literacy. An additional hypothesis proposes that this interactive learning media will positively impact students' learning motivation and mental health. These hypotheses will be tested through an experimental research design using pre-tests and post-tests to measure changes in students' understanding, interest, and motivation before and after the implementation of Office Sway as a learning tool.

RESEARCH METHOD

This research was conducted in elementary schools in Tangerang Regency using the Research and Development (R&D) approach. According to Tetteh (2024), R&D serves as a method to generate innovation or refine existing products, ensuring they become more effective and ideal. Within the educational field, Brame (2016) argues that R&D plays a pivotal role in designing impactful learning media, including platforms such as Office Sway. In line with this view, the development process in this study involved continuous refinement to improve the functionality and quality of the digital media product. The overarching goal was not only to enhance current instructional practices but also to ensure greater effectiveness for future implementation. By adopting the R&D model, this study seeks to produce interactive learning media that are both relevant to contemporary educational demands and capable of fostering improved student engagement and learning outcomes.

This study adopts the APPED development model, which consists of five stages: Initial Analysis and Research, Design, Production, Evaluation, and Dissemination, as proposed by Banyen et al. (2016) and Wahjono et al. (2021), to guide the creation of interactive multimedia technology-based learning products. According to these scholars, the Initial Analysis and Research stage is crucial for understanding student characteristics and integrating the latest technological trends. During the Design stage, storyboards and visual layouts are developed to ensure pedagogical and aesthetic coherence. In the Production stage, the product is constructed following the planned design, while the Evaluation stage, emphasized by Zafar et al. (2014) and Vallee et al. (2020), involves critical assessment by experts in content, media, language, and end-users to guarantee quality and usability. Finally, the Dissemination stage, as highlighted by Banyen et al. (2016), focuses on introducing the product to the wider community, demonstrating its educational benefits, and ensuring that the media can be effectively adopted in real-world learning contexts.

The data for this study were collected from various sources, including expert evaluations, interviews, tests, and questionnaires completed by both students and teachers. According to Tetteh (2024), assessments such as these are essential in gathering a comprehensive understanding of the subject. The test itself consisted of 15 questions, with 10 focused on general knowledge and five on essay-style responses. Brame (2016) emphasized that using different questions in the pre-test and post-test, while still referencing the same indicators of scientific literacy, allows for a more effective assessment of the participants' progress. This approach ensures that the evaluation process accurately measures the intended learning outcomes. The following data management technique formula is used to analyze the expert validation test questionnaire with the formula:

$$NP = \frac{R}{SM} \times 100\%$$

The Likert scale, widely applied to measure individual and group attitudes, was utilized in expert assessments to evaluate feasibility and determine categorical scores. Heo et al. (2022) argue that this scale offers a reliable framework for capturing subjective responses and systematically organizing evaluation outcomes. In a similar vein, da Cunha et al. (2022) emphasize its value in transforming expert judgments into quantifiable data, thereby ensuring evaluations are both structured and objective. By integrating qualitative perspectives with numerical scoring, the Likert scale strengthens the credibility of assessment results, providing a balanced approach that captures expert insight while maintaining methodological rigor. Each of the five dimensions that make up the Likert scale is described as follows:

Table 1
Description of Likert Scale

Scale	Description
5	Very Poor
4	Poor
3	Quite Good
2	Good
1	Very Good

Based on Table 1, this Likert Scale starts from "1," which means "Very Good," indicating the highest level of satisfaction, to "5," which means "Very Poor," indicating significant dissatisfaction. The number "2" marks "Good," which still allows for improvement, while "3," or "Quite Good," indicates an average standard. "4" or "Poor" means a deficiency. This scale makes it easy to categorize and analyze various views or levels of respondent satisfaction with a topic.

The students' science literacy skills test scores were measured using data collected from two test sessions. The first test was conducted before the students used the Sway media, and the second was conducted after using the press. Then, the scores from the pre-test and post-test that had been assessed were converted into numeric values using the following equation:

$$\text{Mark} = \frac{\text{Score obtained}}{\text{Maximum score}} \times 100\%$$

The formula used to calculate the results of student questionnaire responses is expressed as NP = n/N × 100% (Wu et al., 2022). Wu et al. (2022) highlight that this approach offers a simple yet effective way to quantify responses and evaluate overall performance, making it particularly useful in educational research. In this study, the student survey applied a Yes/No scale, also referred to as the Guttman scale, which is widely recognized for assessing binary responses. According to Wu et al. (2022), the Guttman method not only streamlines the process of data analysis but also ensures clarity in interpretation. By reducing complexity and presenting results in straightforward percentages, this method enables researchers to capture student feedback more accurately and efficiently.

RESULTS AND DISCUSSION

Results

Steps to develop Office Sway interactive learning media

In the development stage of learning media using Office Sway for this study, researchers conducted a series of structured activities to ensure the effectiveness of the media in the educational context. The process began with analyzing school conditions to identify specific student needs and existing learning conditions. Furthermore, the media design stage was carried out to develop a design based on the results of the analysis. Media production was then carried out, followed by an evaluation to test the feasibility and effectiveness of the media in an authentic learning environment. The final stage is dissemination, where the learning media that has been developed is disseminated to more classes and schools for broader use. Each of these stages is crucial to ensure that the learning media developed is innovative, relevant, and beneficial to the student learning process.

Table 2
Media Development Steps

No	Activities	Description
1	Analysis of Needs, Curriculum, Media and Characteristics of Students	Most students have mobile phones but are less interested in science lessons because the complex material and monotonous teaching methods such as lectures, discussions, and questions and answers make them bored quickly. Although the Independent Curriculum aims for more active and independent learning, its practice is still too teacher-centered, resulting in minimal independent learning activities from students. In addition, the use of traditional learning media and the rare integration of technology, such as interactive software, which is limited by teacher time, are also obstacles. Students' diverse characteristics and tendency to get bored quickly indicate the need for a more innovative learning approach to increase interest in learning.
2	Design of Office Sway Learning Media	In the design stage of this interactive learning media, researchers prepare a detailed outline, adjusting the style topic according to students' learning objectives and needs. The outline includes the primary material and sub-materials, with real examples to facilitate understanding. The media design integrates various components, such as images, videos, audio, and text, with learning resources coming from books, YouTube, and other internet. For navigation in Office Sway, the flowchart guides users by clicking links that lead to media through various pages such as home, media information, materials, learning videos, quizzes, singing, evaluations, bibliographies, and developer profiles.
3	Production of Office Sway	In the production stage, researchers develop media prototypes using various digital tools. Images and videos are created using Canva, while instrumental music is taken from

	Interactive Learning Media	SoundCloud. Interactive quizzes are created through Wizer.me, and evaluations are done using Microsoft Forms. In addition, research instruments such as validation sheets, tests, and questionnaires have also been prepared. This media is designed to increase student engagement by integrating text, images, animation, and video in an interactive display.
4	Evaluation of Office Sway Learning Media	The evaluation of interactive learning media shows its effectiveness, with smooth functionality, customized and error-free materials, and visual displays that support an optimal learning experience.
5	Dissemination	This dissemination was carried out to class teachers. It was held more widely at SDIT Tunas Muda Unggul on September 20, 2024, aiming to reach schools lacking information about learning media, with further details on the provided link.

The development of Office Sway learning media follows several essential stages aimed at creating innovative and engaging instructional tools. The process begins with a needs analysis, which revealed that a monotonous curriculum and complex subject matter often reduced student motivation and engagement. Based on these findings, the design stage was carried out by tailoring interactive materials and intuitive navigation features to suit the needs of elementary school students. During the production stage, digital tools such as Canva and SoundCloud were utilized to develop visually appealing and interactive content that integrates multimedia elements. This was followed by the evaluation stage, where experts and users assessed the product's functionality, clarity, and pedagogical relevance to ensure its effectiveness. Finally, the dissemination stage focuses on introducing the media more broadly in elementary schools, thereby improving access to innovative digital learning resources. Each stage is interconnected, ensuring that the final product maximizes both student engagement and learning outcomes.

Office Sway media feasibility test in learning for students

The feasibility of using Office Sway as a learning media for students can be evaluated based on the results of a validity test conducted by a team of material experts, media experts, and language experts. The research team gathered scores from each group of experts, assessing various aspects of the media's effectiveness in supporting student learning. Material experts evaluated the content's accuracy and relevance, while media experts focused on its technical aspects and user interface. Language experts reviewed the clarity and coherence of the language used in the media. These expert evaluations provided valuable insights into the suitability and potential of Office Sway as an effective educational tool for students.

Table 3
Average Results of Expert Validation Assessment

Validator Expert	Percentage	Category
Media	85%	Very Eligible
Material	95%	Very Eligible
Language	78,88%	Eligible
Average Score	86,29%	Very Eligible

The table above presents the results of the expert assessment, based on the average percentage from each validation test assessor. The findings indicate that the three validations conducted fall within the "very feasible" category. This suggests that the development of interactive Office Sway learning media has met the standards set by experts, confirming its effectiveness and quality. The assessment results demonstrate that the media is well-received and deemed suitable for educational purposes, supporting its potential for use in enhancing the learning process. Thus, it reflects a high level of approval from the validation experts.

Results of students' science literacy skills after using Office Sway media

During the trial, students were very enthusiastic, although many had difficulty understanding and answering long questions in the pre-test. The pre-test consisted of ten multiple-choice questions and five essays that had been validated and revised based on expert input. An explanation of using the media was given before the learning process, and a post-test was provided with different questions after the activity was completed. Initially, students felt anxious during the pre-test but became calmer and more understanding when working on the post-test after the learning process. The table below shows the average results of the pre-test and post-test for each indicator:

Table 4

Average Results of Pre-test and Post-test Per Indicator

No.	Indicators Science Literacy	Percentage (%)	
		Pre-test	Post-test
1.		50,2%	84%
2.	Remembering and applying appropriate scientific knowledge.	48%	77%
3.	Identifying, using, and producing transparent and representative models.	39,3%	84,5%
4.	Explaining the potential implications of scientific knowledge for society.	25%	75%
5.	Proposing ways to explore given questions scientifically.	4,2%	91%
6.	Transforming and changing data from one representation to another.	25%	89%
7.	Making and justifying appropriate predictions.	84%	66%

Based on the results of the scientific literacy assessment using seven indicators with a total of 30 questions, consisting of 15 items in the pre-test and 15 items in the post-test, there was a noticeable improvement in student performance. In the pre-test stage, six indicators were categorized as inferior, while only one indicator reached the good category. This finding reflects the initial difficulties students faced in understanding and applying scientific concepts. However, after the implementation of the learning intervention using Office Sway, the post-test results showed significant progress. Four indicators achieved the good category, two indicators reached the excellent category, and only one indicator remained at the sufficient level. The overall average score also improved considerably, increasing from 40.04% ("Very Poor") in the pre-test to 76.37% ("Good") in the post-test. These results highlight the effectiveness of the developed media in enhancing students' mastery of scientific literacy skills.

The results of the N-Gain calculation after collecting pre-test and post-test data. The results of the N-Gain analysis show that students' scientific literacy increased after following instructions with Office Sway. The table below shows the N-Gain results:

Tabel 5

Average of Pre-test and Post-test

Information	*Pre-test*	*Post-test*
Highest Score	64	96
Lowest Score	4	52
Amount	1.280	2.444
Average	40,04	76,37
Average N-Gain	0,59	
Category	Currently	

The results of the pre-test and post-test demonstrated a notable improvement in students' scientific literacy. During the pre-test, the highest score achieved was 64 and the lowest was 4, with 29 students categorized as inferior, one as less, and two as sufficient. In contrast, the post-test revealed significant progress, with the highest score rising to 96 and the lowest increasing to 52. The distribution also shifted considerably: one student was still categorized as very poor, two as low, nine as good, 14 as very good, and six as excellent. Improvements were recorded across levels, with three students advancing from low performance, 17 showing progress at the medium level, and 12 reaching the high level. The overall gain score was 0.59, placing it in the medium improvement category. Despite some students continuing to provide careless answers and struggling to grasp key points, the use of Office Sway media effectively enhanced scientific literacy through higher-order thinking skills such as analysis, creativity, and critical reasoning beyond rote memorization.

Student responses to office Sway interactive learning media

The Office Sway interactive learning media was tested in a limited trial to assess student responses. During the trial, a questionnaire covering three key aspects was distributed to the students. A total of 32 students participated in filling out the questionnaire, providing valuable feedback on their experiences with the media. This trial aimed to gather insights on the effectiveness and engagement of the Office Sway learning tool, based on students' direct responses and evaluations. The feedback from the students will be used to refine and improve the media for future use. The students' responses can be seen in the following table:

Table 6
Average Student Response Score

Aspects	Percentage	Category
Media display	97,91%	Very Eligible
Media content	89,06%	Very Eligible
Material presentation	100%	Very Eligible
Language	100%	Very Eligible
Average	96,74%	Very Eligible

Based on student responses, the interactive learning media Office Sway achieved remarkable results across multiple aspects: 97.91% for media display, 89.06% for media content, 100% for material presentation, and 100% for language. When combined, these four aspects reached an overall score of 96.74%, placing the media in the "Very Good" category. Critically, however, a minor shortcoming of 3.26% was noted, primarily due to some students being unable to access the quiz section using their email addresses, which slightly limited the media's full accessibility. Comparatively, despite this limitation, Elementary School students consistently rated Office Sway as "Very Good," particularly in relation to the material on styles around us. This positive feedback suggests that the platform effectively delivers educational content while maintaining student engagement. The findings indicate that Office Sway not only presents information clearly and interactively but also supports a student-centered learning process. Overall, these results underscore the media's potential as a highly effective tool for enhancing comprehension, motivation, and active participation in elementary education.

Discussion

Implementation of Office Sway Interactive Learning Media Based on School Needs

Budiarto and Jazuli (2021) and Matteson and Grant (2024) suggest that Office Sway offers a significant advancement in interactive learning media for elementary education, providing a more dynamic alternative to conventional tools like Microsoft PowerPoint. Research by Zhao and Ko (2022) and Petruse et al. (2024) supports this, highlighting Sway's capacity to integrate multimedia elements videos, 3D visuals, and interactive quizzes thus creating a richer, more immersive learning environment. However, while Abrori et al. (2023) emphasize the potential for enhanced comprehension through such interactivity, some studies note that the effectiveness of these tools depends on teacher facilitation and alignment with learning objectives. Lei (2023) further argues that fostering active student participation is crucial for achieving meaningful learning outcomes, suggesting that technology alone is insufficient without pedagogically sound implementation. Collectively, these perspectives indicate that Office Sway can improve classroom engagement and understanding, provided its use is strategically integrated into instructional design.

The use of the Research and Development (R&D) approach in developing Office Sway-based content allows for continuous adaptation to the needs of both students and teachers. Sjolie and Ostern (2020) argue that incorporating direct user feedback enhances the alignment of educational media with students' learning requirements, while Goldshaft et al. (2022) emphasize that iterative refinement ensures materials remain relevant and responsive to classroom realities. Menon et al. (2023) further highlight that tailoring content to accommodate diverse learning styles visual, auditory, and kinesthetic can significantly improve learning effectiveness. However, critical evaluation of these studies suggests that the success of R&D-driven media depends not only on technological features but also on pedagogical integration and teacher facilitation. Comparatively, research indicates that while conventional static media may deliver content efficiently, interactive and responsive platforms like Office Sway foster deeper engagement, personalized learning, and a more meaningful educational experience for elementary students.

Implementing Office Sway in elementary schools presents notable challenges, particularly regarding teacher proficiency and infrastructural limitations. Darling-Hammond (2017) argues that while technology can enhance learning, reliance on it may create barriers if technical problems occur, a view supported by Daza et al. (2021), who emphasize that inadequate teacher training can limit the effectiveness of digital tools. Qushem et al. (2021) suggest that providing comprehensive technical support and access to necessary devices is essential for meaningful technology integration, while Ojong (2023) highlights that schools with limited infrastructure face greater obstacles in realizing the potential of interactive media. Comparatively, these perspectives indicate that successful implementation of Office Sway depends not only on the media itself but also on strategic teacher training and robust technological support, ensuring that digital innovations translate into improved learning outcomes.

The implementation of Office Sway for elementary students, guided by the APPED Model analysis, design, production, evaluation, and dissemination offers a structured approach to developing interactive learning media. Chun Tie et al. (2019) argue that the analysis stage is crucial for understanding students' learning needs, while Strojny et al. (2023) emphasize that the subsequent design and evaluation stages ensure content is relevant, accessible, and engaging. Critically, these studies suggest that multimedia integration alone does not guarantee effective learning; teacher facilitation and alignment with learning objectives are equally important. Comparatively, research indicates that Office Sway, when applied adaptively, can enrich learning experiences by promoting active student engagement and accommodating diverse learning styles. This positions Office Sway not merely as a presentation tool but as an interactive medium capable of delivering meaningful, relevant, and 21st-century-appropriate learning experiences tailored to students' educational needs.

The successful implementation of Office Sway in elementary schools relies on several interconnected strategies. Providing teachers with comprehensive training and adequate resources is essential, as the technology alone cannot ensure improved learning outcomes. Strategic integration into the curriculum, positioning Office Sway as a core instructional tool rather than a supplementary aid, enhances student engagement and learning effectiveness. Ongoing evaluation is also crucial to monitor its impact on learning outcomes and guide iterative improvements. Overall, the potential of Office Sway is maximized when technical capabilities, teacher competence, and continuous assessment work together, fostering an engaging, meaningful, and contextually relevant learning environment for elementary students.

Optimizing Office Sway interactive learning media for elementary schools

Karolcik et al. (2015) and Rice & Ortiz (2021) highlight the potential of Office Sway as an interactive learning medium, particularly at the elementary school level, noting that its effectiveness largely depends on how teachers utilize its dynamic features. Validation results for the theme "Optimizing Office Sway: Interactive Learning Media for Elementary Schools" show a feasibility score of 86.29%, indicating strong support for its use, especially in delivering varied content and accommodating different student learning styles. However, El-Sabagh (2021) and Al Shloul et al. (2024) emphasize that Sway is more than a digital tool; it functions as an adaptive educational platform that enables a more student-centered learning approach. Critically, these findings underscore that although Sway has high technical capacity, successful implementation still requires appropriate pedagogical strategies to ensure that technology integration genuinely enhances interactivity and the quality of classroom learning.

Rice and Ortiz (2021) emphasize that the effectiveness of Office Sway in elementary schools heavily depends on two key components: structured teacher training and the availability of adequate technological resources. They argue that without these supports, the integration of digital platforms like Sway may face significant challenges, particularly in technical execution. Badawy et al. (2024)

reinforce this view by highlighting that teacher competencies and stable access to digital devices and the internet are crucial factors for successful implementation. Critically, these findings indicate that technological capability alone is insufficient; appropriate pedagogical strategies must accompany the use of Sway to ensure truly interactive learning. Budiarto and Jazuli (2021) further suggest that optimizing digital media requires a supportive learning ecosystem, so that the use of Sway goes beyond mere technology adoption and becomes a transformative approach that enhances student participation and interaction.

Carlos (2024) and Kurniawan et al. (2024) highlight the strengths of Office Sway in technical and visual presentation aspects, with effectiveness scores ranging from 83.15% to 87.36%, indicating its strong potential as an engaging and high-quality learning medium. However, Voogt et al. (2016) caution that the rapidly changing educational environment requires digital content to be regularly updated to remain aligned with curriculum developments and pedagogical trends. Critically, this emphasizes that technical excellence alone is insufficient; content relevance is key to effectiveness. Grimus (2020) stresses the importance of collaboration between teachers and content developers to ensure that learning materials not only meet academic standards but are also engaging and impactful for students. Thus, the success of Sway depends on a balance between technical capability, content quality, and pedagogical strategy, making it an adaptive and relevant tool for modern learning.

Viberg et al. (2020) and Grassini (2023) rate Office Sway with high validation scores, ranging from 92.5% to 97.5%, highlighting its potential to meet educational standards and enhance learning quality. Critically, these scores confirm Sway's ability to deliver engaging and pedagogically sound content, yet technical excellence alone is insufficient to ensure long-term impact. Grassini (2023) emphasizes that user feedback is crucial for adapting materials to remain relevant to evolving student needs, while Viberg et al. (2020) stress the importance of iterative development to ensure digital platforms keep pace with changing learning objectives. From a comparative perspective, these findings indicate that Sway's success depends on a combination of technical quality, continuous adaptation, and responsiveness to student needs, making it a transformational and effective learning medium in modern classroom contexts.

Mondal et al. (2022) and Tlili et al. (2024) emphasize that an iterative approach in developing digital educational content allows for continuous refinement, ensuring that materials remain responsive to diverse learning styles and evolving pedagogical practices. In the context of Office Sway, this highlights the importance of linguistic validation. Variations in expert scores, ranging from 68.88% to 88.88%, indicate a critical challenge in balancing language accuracy with communication effectiveness. Tlili et al. (2024) stress that educational materials, particularly for elementary students, must be clear, engaging, and easily understandable, while Mondal et al. (2022) argue that language ambiguity can diminish the instructional value of digital tools. Comparatively, these findings suggest that Sway's success relies not only on interactivity but also on linguistic clarity, thereby optimizing comprehension, engagement, and academic achievement simultaneously.

Quadir et al. (2020) and Liu et al. (2023) note that implementing Office Sway in elementary schools effectively enhances student interaction and engagement, as shown in a case study of 32 learners, which demonstrated improved mastery and a richer learning experience. Critically, Martinez-Pelaez et al. (2023) caution that long-term effectiveness depends on ongoing evaluation and the integration of feedback from both teachers and students. Zhou et al. (2024) further highlight that optimizing Sway requires a synergy of technological resources, structured teacher training, and curriculum-aligned content development. Compared to earlier findings, Tlili et al. (2021) assert that when these elements are integrated, Sway is not merely a visually engaging platform but a dynamic, effective, and inclusive learning tool capable of meeting the diverse needs of students in modern classroom contexts.

Merino et al. (2024) and Xue et al. (2024) argue that although Office Sway demonstrates high potential as an interactive learning medium evidenced by strong validation scores and positive outcomes in elementary classrooms its implementation requires a more comprehensive and context-sensitive strategy. They emphasize that teacher training and technological infrastructure alone are insufficient; systemic issues such as curriculum alignment, teacher workload, and digital literacy gaps must also be addressed. Critically, Davies & West (2014) and Cosby et al. (2023) highlight that variations in linguistic validation scores indicate challenges in ensuring clarity and inclusivity of content. Compared to previous case studies, these findings underscore the need for ongoing collaboration among educators, content developers, and policymakers. Thus, the success of Sway depends not only on technical capabilities but also on integrated educational strategies and institutional support to make this medium effective, adaptive, and equitable across diverse learning contexts.

The influence of learning media on students' mastery of science literacy

Hsiao et al. (2019) and Azevedo (2020) highlight that integrating Office Sway as an interactive learning medium in elementary schools can substantially improve students' science literacy, evidenced by the increase in average scores from 40.04% on the pre-test to 76.37% on the post-test using instruments validated by experts. Critically, these findings suggest that Sway effectively supports the development of key scientific competencies, such as explanation, analysis, and evaluation. However, while the immediate gains in concept mastery are clear, the long-term impact on students' sustained motivation and interest in science is less certain. Friman et al. (2019), Lee et al. (2024), and Bareis et al. (2024) argue that increased engagement does not automatically translate to enduring curiosity, highlighting the need for continued investigation. Comparatively, this suggests that while Office Sway demonstrates strong short-term pedagogical benefits, its effectiveness as a tool for fostering lasting scientific enthusiasm may depend on additional strategies, such as continuous reinforcement and contextualized learning experiences.

Gan et al. (2015) and Gaceri et al. (2022) argue that the integration of digital tools such as Office Sway with interactive learning methods is crucial for maximizing their impact on student learning. Critically, Office Sway is more effective when embedded within comprehensive instructional strategies such as project-based learning, inquiry-driven activities, or collaborative group discussions rather than used as a standalone medium. These scholars highlight that such integration not only strengthens students' understanding of scientific concepts but also enhances engagement and participation. Comparatively, Vallée et al. (2020) emphasize that the synergy between interactive technology and student-centered pedagogy fosters deeper conceptual comprehension and critical thinking. Thus, Office Sway should be understood not merely as a content delivery platform, but as a catalyst for active learning and meaningful collaboration, illustrating that the educational value of digital tools depends on their alignment with pedagogical strategies and the learning environment.

Tulchinsky and Varavikova (2014) and Feijoo et al. (2023) argue that further evaluation is needed to identify which specific aspects of science literacy such as critical thinking, conceptual understanding, and real-world application are most enhanced through the use of Office Sway. Critically, ensuring the tool's continued effectiveness requires flexible implementation strategies, including regular content updates, ongoing teacher training, and monitoring of learning outcomes (Haleem et al., 2022; Hennessy et al., 2022). While Office Sway has shown positive impacts at Sarakan III Elementary School, Nor and Mahmud (2024) highlight persistent challenges, particularly in students' reading proficiency and comprehension, suggesting that not all dimensions of science literacy are fully addressed. Comparatively, Liu et al. (2024) note that although students report higher engagement and more independent learning, these benefits alone may not guarantee comprehensive mastery. This indicates that the successful integration of Office Sway depends on combining technological tools with systematic pedagogical support and continuous assessment to achieve meaningful learning outcomes.

The effective use of interactive learning technologies such as Office Sway depends heavily on stable internet access, which is critical for maximizing the platform's potential. Taye (2023) and Contrino et al. (2024) argue that adapting continuously to student feedback and addressing specific learning needs are essential to ensure that digital media fully support educational objectives. Critically, while Office Sway demonstrates promise as an innovative tool, its long-term success requires not only technological readiness but also proactive management of infrastructure and a commitment to ongoing refinement. Jiang and Kurnitski (2023) and Al Kez et al. (2024) emphasize that regular evaluation and iterative development based on real-world classroom experiences are key to maintaining its relevance. Comparatively, Tang (2022) highlights that technological tools alone do not guarantee learning improvements; success depends on the integration of resources, pedagogical strategies, and continuous adaptation to evolving student and educator needs, ensuring meaningful and sustainable learning outcomes.

Office Sway offers a distinctive platform that integrates visual, audio, and interactive elements to enhance student engagement and understanding. Gligorea et al. (2023) and Harris et al. (2023) highlight that the use of icons such as lightbulbs for creativity, multimedia symbols for audio and video, and group icons for collaboration demonstrates Sway's potential to provide dynamic and interactive learning experiences. Critically, its adaptive learning features, represented by icons for books and statistics, support personalized teaching approaches that address diverse student needs. However, these scholars also caution that the platform's promise is contingent on effective teacher proficiency; successful implementation may be limited by workloads and varying digital literacy. Comparatively, Taye (2023) and Contrino et al. (2024) argue that access to reliable internet and sufficient devices remains a critical barrier, particularly in resource-constrained schools, suggesting that Sway's impact is as dependent on infrastructure and educator readiness as it is on its technical capabilities.

In conclusion, Office Sway demonstrates considerable potential as an innovative tool for enhancing science literacy in elementary schools, yet its effectiveness is not inherent but contingent upon a multi-faceted approach. Studies indicate that real-time evaluation through interactive quizzes and projects can improve learning outcomes, but the impact depends critically on the alignment of assessment tools with learning objectives. Comparatively, the success of collaborative and critical thinking activities varies according to teachers' ability to integrate them within structured curricula, highlighting the interplay between technological affordances and pedagogical skill. Research further suggests that maximizing Sway's potential requires continuous professional development, robust technology infrastructure, and iterative content updates informed by student feedback and curricular demands. Without these systemic supports, the platform's innovative features alone may not translate into meaningful learning gains, underscoring the necessity of a comprehensive, context-sensitive strategy to ensure its sustainable integration and impact within modern educational settings.

CONCLUSION

In conclusion, Office Sway demonstrates substantial potential as an interactive learning tool capable of enhancing student engagement and science literacy in elementary schools. Its multimedia features including videos, 3D visuals, and interactive quizzes offer a dynamic and immersive learning experience. Critically, research indicates that these technical affordances alone are insufficient; effective implementation depends on well-structured teacher training, reliable technological infrastructure, and continuous content updates tailored to evolving student and curriculum needs. Moreover, challenges such as disparities in digital literacy and limited access to devices can constrain its impact, underscoring the importance of contextualized support. Comparatively, studies suggest that Sway achieves optimal results when integrated with pedagogically sound strategies, including collaborative activities, project-based learning, and formative assessments. By adopting a holistic, iterative approach that incorporates feedback and evaluation, Office Sway can transform learning experiences, fostering active participation, critical thinking, and improved student outcomes, positioning it as a valuable asset in modern educational contexts.

The theoretical implication of using Office Sway in education underscores the value of integrating interactive media to support active learning and constructivist approaches, which prioritize student engagement and knowledge construction. By combining multimedia elements such as videos, 3D visuals, and interactive quizzes, Sway provides an immersive and adaptive learning environment that aligns with these educational theories. Critically, however, its effectiveness is dependent on the interplay between technological affordances and pedagogical strategies. Practically, teachers require sufficient training to harness Sway's full potential, while schools must ensure reliable access to devices and internet connectivity. Comparatively, research suggests that the impact of digital tools like Sway is maximized when integrated with structured curricula, collaborative activities, and formative assessments. Regular evaluation and content updates are essential to maintain alignment with evolving curriculum standards and technological developments. With a comprehensive, context-sensitive approach, Office Sway can meaningfully enhance learning quality, engagement, and achievement in elementary education.

For future research, it is recommended to examine the long-term effects of Office Sway on student motivation and engagement in science education across diverse educational contexts. Studies should investigate how students with varying levels of digital literacy respond to Sway's interactive features, providing insights into its differential impact. Additionally, research could focus on developing effective teacher training models to ensure educators can fully utilize the platform's capabilities. The scalability of Office Sway across schools and regions with different technological infrastructures also warrants investigation to assess its broader applicability. Comparatively, incorporating continuous user feedback into content development is critical for maintaining relevance and pedagogical effectiveness. By addressing these areas, future studies can provide a more comprehensive understanding of how Office Sway contributes to learning outcomes, informs best practices in digital pedagogy, and supports adaptive, student-centered approaches in elementary science education.

ACKNOWLEDGEMENT

The researcher would like to express his deepest gratitude to all parties at Elementary School, Sepatan District, Tangerang Regency, and Sultan Ageng Tirtayasa University for the support, assistance, and facilities provided during the research process. Thanks also to the editors and all parties of the Educare journal for all their valuable suggestions and for the opportunity and support in publishing the results of this study. Close cooperation and invaluable assistance from all institutions have enabled the researcher to complete this research successfully.

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