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Development of Mind Mapping Learning Media for Science Learning in Madrasah Ibtidaiyah

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Abstract: In elementary science education, traditional instructional methods often struggle to effectively convey abstract ecological interdependencies, necessitating the development of innovative visual learning media. This study aimed to develop and evaluate the feasibility and practicality of digital Mind Mapping learning media tailored for ecosystem topics in Madrasah Ibtidaiyah (Islamic elementary schools). Employing a Research and Development (R&D) approach, the study utilized the six-stage Luther development model: concept, design, material collecting, assembly, testing, and distribution. The interactive media was designed for Grade V students using a combination of FreeMind and Canva applications. The product's feasibility was evaluated through rigorous expert validation, while its practical utility was assessed via a small-group trial involving five Grade V students at MIN 10 Aceh Besar. Data gathered through media validation sheets, material validation sheets, and student response questionnaires were analyzed descriptively using percentage-based criteria. The evaluation results demonstrated that the developed digital Mind Mapping media possesses exceptional instructional quality. The product achieved a media expert validation score of 92.5% and a material expert validation score of 89.28%, both positioning the media in the highly feasible category. Furthermore, the small-group trial yielded a student practicality score of 90.8%, confirming that the application is highly pragmatic for real-world classroom implementation. These findings suggest that the integration of digital Mind Mapping effectively bridges the gap between abstract science concepts and young learners' cognitive schemas. This study contributes a validated technological framework to primary science education, offering a scalable instructional alternative that optimizes conceptual organization and enhances student engagement.

Keywords: Digital mind mapping, research and development, ecosystem learning, elementary science, pedagogical media.

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INTRODUCTION

Science education at the elementary school level plays a fundamental role in developing students' understanding of natural phenomena and preparing them to respond to various challenges in daily life. Through science learning, students are expected not only to acquire factual knowledge but also to develop the ability to observe, analyze, and connect

concepts systematically. In recent years, improving the quality of science learning has become an important concern in many educational systems because conceptual understanding established at the elementary level serves as the foundation for subsequent learning experiences (OECD, 2023).

The growing complexity of educational demands requires teachers to adopt instructional approaches and learning resources that can facilitate meaningful learning experiences. Learning is no longer viewed merely as a process of transmitting information from teachers to students but as an active process in which learners construct knowledge through interaction with various learning resources and media. Consequently, the availability of effective learning media has become an essential component in supporting student engagement and conceptual understanding (Mayer, 2021).

Numerous studies have demonstrated that instructional media significantly contribute to improving learning quality by facilitating visualization, increasing student participation, and enhancing comprehension of abstract concepts. The integration of appropriate learning media allows students to connect new information with prior knowledge more effectively, thereby promoting meaningful learning outcomes (Moreno & Mayer, 2020). In elementary education, visual-based media are particularly important because students are still developing their abstract reasoning abilities and often rely on concrete representations to understand scientific concepts.

The importance of learning media is increasingly evident in science education, where many concepts involve relationships among components, processes, and systems that cannot always be directly observed. Topics such as ecosystems require students to understand interactions among living organisms and their environments. These concepts involve multiple interconnected elements that may be difficult for students to organize and retain when presented solely through conventional explanations or textbook-based instruction.

Despite the recognized importance of instructional media, many elementary classrooms continue to rely heavily on teacher-centered approaches and textbook-oriented learning. Such practices often limit opportunities for students to actively construct knowledge and visualize relationships among concepts. Consequently, students may experience difficulties in understanding complex scientific content and maintaining learning motivation throughout the instructional process.

The challenge is particularly relevant in Madrasah Ibtidaiyah, where teachers are expected to implement meaningful learning experiences while simultaneously addressing diverse student characteristics and curriculum demands. Although teachers acknowledge the importance of innovative instructional media, the development and utilization of appropriate learning resources often remain limited. As a result, learning activities may not fully support students' conceptual understanding and engagement.

Teacher competence has been identified as a critical factor influencing the quality of instructional practices and learning innovation. Teachers with stronger professional competencies tend to demonstrate greater capacity to design, adapt, and utilize instructional resources effectively. A comparative study conducted by Muluk and Lubis (2026) found that professional education programs contribute significantly to enhancing teachers' pedagogical and professional competencies, which are closely associated with instructional quality and innovation. Nevertheless, disparities in competence levels and contextual constraints continue to affect teachers' ability to develop learning media independently.

In addition to competency-related issues, teachers frequently encounter practical constraints in developing instructional media. Limited time allocation, insufficient technological support, inadequate facilities, and heavy administrative workloads often reduce opportunities for teachers to design innovative learning resources. These challenges become more apparent when teachers are required to create media that are pedagogically appropriate, visually appealing, and aligned with curriculum objectives.

Preliminary observations conducted in the research setting indicated that science learning on ecosystem topics was predominantly delivered through textbooks and verbal explanations. Although such approaches provide essential information, they often do not adequately facilitate students' understanding of relationships among ecosystem components. Students tended to memorize concepts rather than develop integrated conceptual frameworks that connect various aspects of ecosystem interactions.

The observations also revealed that teachers recognized the need for instructional media capable of supporting conceptual visualization and student engagement. However, they reported difficulties in developing such media due to limitations in technological competence, time availability, facilities, and instructional design experience. Consequently, the demand for practical and accessible learning media remains substantial within the Madrasah Ibtidaiyah context.

One instructional approach that has attracted considerable attention in recent years is the use of Mind Mapping. Mind Mapping is a visual representation technique that organizes information through interconnected branches, keywords, images, colors, and symbols. This structure enables learners to identify relationships among concepts and construct knowledge in a more organized manner. Previous studies have shown that Mind Mapping can support information retention, conceptual organization, and meaningful learning processes (Buzan, 2018).

The effectiveness of visual learning resources has been reported across various educational contexts. Research by Masyitah et al. (2025) demonstrated that instructional media significantly improved students' conceptual understanding by providing concrete visual representations of abstract content. Similarly, Rizka et al. (2025) reported that integrating learning media into classroom instruction enhanced student participation and learning engagement. These findings suggest that appropriately designed media can contribute substantially to learning quality.

The growing availability of digital technologies has expanded opportunities for developing Mind Mapping media beyond traditional paper-based formats. Applications such as FreeMind and Canva enable teachers to create visually attractive, structured, and customizable learning materials. Digital Mind Mapping media can incorporate images, colors, symbols, and hierarchical relationships among concepts, thereby facilitating students' comprehension and information processing.

The relevance of digital learning media has become increasingly apparent in contemporary educational environments. Studies have shown that technology-supported learning resources can enhance student engagement, improve accessibility, and provide flexible opportunities for knowledge construction (Bond et al., 2021). Therefore, integrating digital Mind Mapping into science learning represents a promising strategy for addressing instructional challenges in elementary education.

Several recent studies have investigated the use of Mind Mapping in educational settings and generally reported positive outcomes regarding student engagement and conceptual understanding. However, most existing studies have focused on the effectiveness of Mind Mapping as a learning strategy rather than on the systematic development and feasibility evaluation of digital Mind Mapping media specifically designed for ecosystem learning in Madrasah Ibtidaiyah contexts. This indicates a gap in the existing literature.

Another limitation identified in previous studies concerns the limited attention given to teacher needs and contextual constraints during media development. Many studies evaluate learning outcomes after implementation but provide insufficient discussion regarding the feasibility of media use in schools where teachers face challenges related to technological competence, time constraints, and resource availability. Consequently, there remains a need for research that develops practical instructional media while considering the realities of classroom implementation.

The present study seeks to address these gaps by developing digital Mind Mapping learning media using FreeMind and Canva for ecosystem learning in Madrasah Ibtidaiyah.

Unlike conventional Mind Mapping applications that primarily focus on note-taking activities, the developed media are specifically designed to support science learning through visual organization of ecosystem concepts and relationships. The media are also intended to be accessible and adaptable for teachers operating within resource-constrained educational environments.

The importance of media-assisted learning has been consistently highlighted in recent educational research. Studies involving innovative instructional approaches and educational media have demonstrated positive contributions to students' learning motivation, conceptual understanding, critical thinking, and engagement (Lubis, 2025a; Lubis, 2025b; Lubis & Idris, 2025; Lubis et al., 2026). These findings reinforce the argument that appropriate instructional media can serve as an important catalyst for improving learning quality in elementary education.

Furthermore, the integration of visual and technology-supported learning resources aligns with contemporary perspectives on student-centered learning. By providing structured visual representations of ecosystem concepts, digital Mind Mapping media may facilitate knowledge organization, reduce cognitive overload, and encourage active student participation during learning activities. Such characteristics are particularly relevant for elementary students who benefit from concrete and visually rich instructional experiences.

From a practical perspective, the development of digital Mind Mapping media offers potential benefits not only for students but also for teachers. The media provide an alternative instructional resource that can reduce teachers' dependence on conventional teaching methods while supporting more interactive and engaging learning environments. In addition, the use of readily available applications such as FreeMind and Canva increases the likelihood of adoption and adaptation in classroom practice.

Based on the theoretical considerations, empirical findings, and contextual challenges discussed above, this study aims to develop and evaluate the feasibility of digital Mind Mapping learning media for ecosystem learning in Madrasah Ibtidaiyah. Specifically, the study focuses on assessing the validity and practicality of the developed media as an alternative instructional resource for supporting science learning and enhancing the organization of ecosystem concepts among elementary-level learners.

METHODS

This study employed a Research and Development (R&D) approach to develop and evaluate the feasibility of digital Mind Mapping learning media for ecosystem learning in Madrasah Ibtidaiyah. Research and Development is an appropriate methodological approach for producing educational products and evaluating their quality before broader implementation. The study focused on developing a digital learning medium that integrates visual representation, concept organization, and instructional content to facilitate students' understanding of ecosystem concepts in elementary science education. The development process adopted the multimedia development model proposed by Luther, which consists of six interconnected stages: concept, design, material collecting, assembly, testing, and distribution. The Luther model was selected because it provides a systematic framework for designing, developing, and evaluating digital learning media while emphasizing the integration of instructional content, visual design, and usability considerations.

The research was conducted at MIN 10 Aceh Besar, Indonesia. The study was initiated based on preliminary observations indicating that ecosystem learning was primarily conducted through textbook-based instruction and teacher explanations. Although teachers recognized the importance of instructional media in facilitating conceptual understanding, they experienced difficulties in developing appropriate learning resources due to limitations in technological competence, time availability, supporting facilities, and instructional workload. These conditions highlighted the need

for practical and accessible learning media that could support both teachers and students in science learning activities.

The participants involved in this study consisted of one media expert, one material expert, and five Grade V students. The media expert was responsible for evaluating the technical quality, visual communication, usability, and design aspects of the developed media. The material expert evaluated content accuracy, curriculum alignment, learning objectives, language appropriateness, and the suitability of the content for elementary school students. The five students participated in a small-group trial and represented the intended users of the developed media.

The selection of participants was conducted purposively based on their relevance to the product development process. In educational product development research, purposive participant selection is commonly employed because the primary objective is not statistical generalization but rather the evaluation and refinement of the developed product. The small-group trial involving five students was conducted as a preliminary implementation stage to identify usability issues, gather student feedback, and evaluate the practicality of the developed media before wider-scale application. Such small-group evaluations are frequently recommended in educational development research because they allow researchers to obtain detailed feedback from target users while maintaining close observation of the implementation process.

The development process began with the concept stage, which focused on identifying instructional needs, learning challenges, and media requirements. Information was gathered through classroom observations and discussions with teachers regarding ecosystem learning. The findings revealed that students frequently experienced difficulties in understanding the relationships among ecosystem components because learning activities relied heavily on textual explanations. At the same time, teachers expressed the need for learning media capable of presenting ecosystem concepts in a more visual and structured manner. These findings became the foundation for determining the objectives and specifications of the media to be developed.

The design stage involved preparing the conceptual framework and visual structure of the digital Mind Mapping media. During this phase, ecosystem learning materials were analyzed and organized into a hierarchical structure that could be visually represented through branches, keywords, images, colors, and symbols. The design process considered curriculum requirements, students' cognitive characteristics, and principles of visual communication. Storyboards and layout plans were also developed to ensure consistency between instructional content and visual presentation.

The material collecting stage involved gathering all resources required for media development. These resources included ecosystem learning materials, curriculum documents, scientific illustrations, supporting images, visual icons, and other relevant educational materials. The collected resources were reviewed to ensure content accuracy, curriculum relevance, and suitability for Grade V students. Particular attention was given to selecting visual components capable of supporting students' understanding of ecosystem relationships and interactions.

The assembly stage focused on constructing the digital Mind Mapping learning media using FreeMind and Canva applications. FreeMind was utilized to organize ecosystem concepts into structured mind maps, while Canva was used to enhance visual presentation through the integration of images, color combinations, icons, and layout arrangements. During this stage, ecosystem concepts were systematically organized around central themes and interconnected through branching structures representing conceptual relationships. The resulting media was designed to facilitate concept organization, improve readability, and enhance students' learning experiences through visual representation.

The testing stage was conducted to evaluate the feasibility and practicality of the developed product. Expert validation was carried out before student implementation to ensure that the media met both pedagogical and technical quality standards. Feedback

provided by experts was used to identify aspects requiring improvement and to refine the product before the small-group trial. Following the revision process, the developed media was implemented with five Grade V students, who subsequently completed response questionnaires to evaluate the practicality of the media.

In the Luther development model, the final stage is distribution. However, in the context of the present study, the distribution stage was limited to preparing the finalized media product for potential future implementation and broader utilization. Large-scale dissemination was not conducted because the primary objective of this study was to develop and evaluate the feasibility and practicality of the media at the preliminary stage.

Data collection was conducted using documentation, expert validation sheets, and student response questionnaires. Documentation techniques were used to collect information related to curriculum requirements, instructional materials, and the media development process. Expert validation sheets were administered to the media expert and material expert to evaluate the quality of the developed product. Student response questionnaires were administered after students interacted with the media to obtain information regarding its practicality, attractiveness, comprehensibility, and usability.

The research instruments consisted of a media validation sheet, a material validation sheet, and a student response questionnaire. The media validation instrument evaluated three primary aspects, namely communication with users, technical design quality, and media usefulness. These aspects were assessed to determine whether the developed media effectively facilitated learning activities and met technical quality standards. The material validation instrument assessed curriculum relevance, alignment with learning objectives, conceptual accuracy, content clarity, language appropriateness, and suitability for students' cognitive development. Meanwhile, the student response questionnaire evaluated the practicality of the media through indicators related to visual attractiveness, ease of understanding, learning enjoyment, support for creativity, clarity of language, appropriateness of images, color presentation, and overall learning experience.

To enhance the credibility of the findings, expert judgment was employed as a form of content validation. The involvement of experts enabled the evaluation of both pedagogical and technical aspects of the developed product. In addition, data obtained from student responses provided complementary information regarding media practicality from the perspective of end users. The combination of expert evaluations and user responses contributed to a more comprehensive assessment of product quality.

Data analysis was conducted using descriptive quantitative techniques. Scores obtained from expert validation and student response questionnaires were converted into percentages to determine the feasibility and practicality levels of the developed media. The percentage scores were subsequently interpreted according to predetermined feasibility criteria. Media feasibility was determined based on the evaluations provided by the media expert and material expert, while practicality was determined based on student responses following implementation. The analysis focused on identifying the extent to which the developed digital Mind Mapping media fulfilled quality standards and met user expectations within the context of ecosystem learning in Madrasah Ibtidaiyah.

Ethical considerations were maintained throughout the research process. All participants were informed about the objectives and procedures of the study before data collection. Participation was conducted voluntarily, and the information obtained was used exclusively for academic purposes. Student identities were not disclosed in the reporting of research findings, thereby ensuring participant confidentiality. Furthermore, all learning activities conducted during the trial phase remained aligned with regular instructional objectives and did not interfere with students' educational experiences.

Through the systematic implementation of the Luther development model, the involvement of expert evaluators, and the utilization of a small-group trial involving intended users, this study sought to ensure that the developed digital Mind Mapping learning media achieved acceptable levels of validity and practicality for supporting ecosystem learning in Madrasah Ibtidaiyah.

RESULTS

The development of digital Mind Mapping learning media for ecosystem learning in Madrasah Ibtidaiyah was carried out systematically using the Luther development model. The development process consisted of six stages, namely concept, design, material collecting, assembly, testing, and distribution. Each stage contributed to the production of a learning medium that was pedagogically appropriate, visually attractive, and feasible for use in elementary science learning.

The concept stage was initiated through a preliminary needs analysis conducted at MIN 10 Aceh Besar. The analysis revealed that ecosystem learning was predominantly implemented through textbook-based instruction and teacher explanations. Although these approaches enabled content delivery, students frequently encountered difficulties in understanding the relationships among ecosystem components and ecological interactions. Teachers also reported challenges in presenting ecosystem concepts in a structured and visually meaningful manner.

The needs analysis further indicated that students tended to memorize ecosystem concepts without fully understanding the relationships among living organisms, food chains, food webs, and environmental components. This condition suggested the necessity of developing instructional media capable of organizing concepts visually and facilitating meaningful learning experiences.

From the teachers' perspective, the findings demonstrated a strong need for practical learning media that could be easily implemented in classroom instruction. However, limitations in technological competence, instructional preparation time, supporting facilities, and workload constraints hindered teachers from independently developing innovative media. These findings became the basis for developing a digital Mind Mapping learning medium.

The design stage focused on preparing the overall structure of the media. Ecosystem concepts were organized into a hierarchical framework beginning with the central concept of ecosystems, followed by branches representing biotic components, abiotic components, ecological interactions, food chains, and food webs. This structure was intended to help students visualize relationships among concepts and facilitate information retention.

The visual design was developed by integrating educational principles and visual communication considerations. The media employed colors, icons, illustrations, and connecting branches to improve readability and maintain students' attention. The design also emphasized simplicity and clarity to ensure compatibility with the cognitive characteristics of Grade V students.

During the material collecting stage, ecosystem learning resources were gathered from curriculum documents, science textbooks, educational references, and visual materials relevant to ecosystem concepts. The collected resources were reviewed to ensure consistency with curriculum objectives and scientific accuracy.

Particular attention was given to selecting illustrations that could support conceptual understanding. Images representing living organisms, environmental components, and ecological relationships were incorporated to strengthen the visual representation of ecosystem concepts and enhance students' learning experiences.

The assembly stage involved constructing the digital Mind Mapping media using FreeMind and Canva applications. FreeMind was utilized to organize concepts and establish hierarchical relationships among ecosystem components. Canva was employed to improve visual quality through the integration of educational illustrations, color combinations, icons, and layout adjustments.

The resulting product consisted of a digital Mind Mapping medium presenting ecosystem concepts in a structured and interconnected format. The media enabled students to identify conceptual relationships more easily than conventional text-based

learning materials. The final product also incorporated visual elements designed to increase learning attractiveness and support concept retention.

Following the completion of the product, expert validation was conducted to evaluate its feasibility. Validation involved one media expert and one material expert. The evaluation focused on determining whether the developed media met technical, pedagogical, and content-related quality standards before implementation in the student trial stage.

The media expert evaluated the product based on three primary aspects: communication with users, technical design quality, and media usefulness. The assessment results are presented in Table 1.

Table 1. Media Expert Validation Results

Assessment Aspect	Percentage (%)	Category
Communication with Users	90.00	Highly Feasible
Technical Design Quality	95.00	Highly Feasible
Media Usefulness	92.50	Highly Feasible
Overall Average	**92.50**	**Highly Feasible**

The results indicate that all evaluated aspects achieved scores within the highly feasible category. The highest score was obtained in the technical design quality aspect, suggesting that the visual presentation, layout organization, readability, and interface design successfully fulfilled expected quality standards.

The communication aspect also achieved a high score, indicating that the media effectively conveyed information and facilitated interaction between students and learning content. The usefulness aspect demonstrated that the developed media possessed substantial potential for supporting ecosystem learning activities in Madrasah Ibtidaiyah. The high validation score obtained from the media expert suggests that the integration of FreeMind and Canva successfully produced a digital learning medium that was visually attractive, technically functional, and suitable for classroom implementation.

In addition to media validation, content validation was conducted to ensure that the learning materials were scientifically accurate and aligned with curriculum requirements. The material expert evaluated curriculum relevance, learning objectives, conceptual accuracy, language clarity, and suitability for students' developmental characteristics. The results of material validation are presented in Table 2.

Table 2. Material Expert Validation Results

Assessment Aspect	Percentage (%)	Category
Curriculum Relevance	90.00	Highly Feasible
Learning Objectives Alignment	88.00	Highly Feasible
Conceptual Accuracy	90.00	Highly Feasible
Language Appropriateness	87.00	Highly Feasible
Student Suitability	91.40	Highly Feasible
Overall Average	**89.28**	**Highly Feasible**

The findings demonstrate that the developed media achieved a high level of content validity. The highest score was obtained in the student suitability aspect, indicating that the material was considered appropriate for Grade V learners in terms of complexity, presentation, and comprehensibility.

The curriculum relevance aspect also achieved a strong score, demonstrating alignment between the media content and the competencies expected within ecosystem

learning. Similarly, conceptual accuracy received a high evaluation, suggesting that the scientific content was presented correctly and consistently.

The material expert also indicated that the language used throughout the media was understandable and suitable for elementary school students. Although minor revisions were recommended regarding wording consistency and content presentation, these suggestions did not substantially affect the overall feasibility of the product.

Following expert validation and revision, the media was implemented in a small-group trial involving five Grade V students. The trial aimed to evaluate the practicality of the developed media from the perspective of intended users.

Students were introduced to the digital Mind Mapping media and subsequently completed response questionnaires evaluating various aspects of practicality. The practicality assessment results are presented in Table 3.

Table 3. Student Practicality Evaluation Results

Assessment Aspect	Percentage (%)	Category
Visual Attractiveness	92.00	Highly Practical
Ease of Understanding	91.00	Highly Practical
Learning Enjoyment	90.00	Highly Practical
Creativity Support	89.00	Highly Practical
Language Clarity	91.00	Highly Practical
Image and Color Presentation	92.50	Highly Practical
Overall Average	**90.80**	**Highly Practical**

The results reveal that students responded positively to the developed media. Visual attractiveness obtained one of the highest scores, indicating that the integration of colors, images, and visual structures successfully captured students' attention during learning activities. Students also reported that the media facilitated understanding of ecosystem concepts. The hierarchical organization of information enabled learners to identify relationships among concepts more clearly, thereby reducing confusion when studying ecosystem interactions.

The learning enjoyment aspect received a highly positive evaluation, suggesting that students perceived the learning experience as engaging and interesting. The use of visual representations appeared to increase students' willingness to participate in learning activities and explore ecosystem concepts independently.

The creativity support aspect also achieved a high score. Students indicated that the media encouraged them to organize information and generate ideas through visual representation. This finding suggests that Mind Mapping media may contribute to more active learning experiences compared with conventional instructional approaches.

The practicality score of 90.80% indicates that the developed media was highly practical for classroom implementation. The positive responses obtained from students demonstrate that the media successfully fulfilled user expectations regarding usability, attractiveness, and learning support.

The combined results of expert validation and student practicality evaluation provide strong evidence regarding the quality of the developed digital Mind Mapping learning media. The media achieved highly feasible ratings from both media and material experts and received highly practical evaluations from students. These findings indicate that the developed product is suitable for supporting ecosystem learning in Madrasah Ibtidaiyah and has the potential to serve as an alternative instructional medium for elementary science education.

DISCUSSION

The findings of this study indicate that the developed digital Mind Mapping learning media achieved a high level of feasibility based on expert evaluations and demonstrated a high level of practicality based on student responses. These results suggest that the integration of visual concept mapping, supported by digital technologies such as FreeMind and Canva, can provide an effective instructional resource for ecosystem learning in Madrasah Ibtidaiyah. The findings reinforce the growing recognition that visual learning media play a crucial role in supporting conceptual understanding at the elementary education level.

The media expert validation score of 92.50% indicates that the developed product fulfilled essential criteria related to technical quality, visual communication, and instructional usability. This finding is consistent with contemporary perspectives emphasizing that the effectiveness of educational media depends not only on content quality but also on how information is visually structured and presented to learners. Effective visual design helps learners process information more efficiently and supports the construction of meaningful cognitive representations (Clark & Mayer, 2023).

One of the highest-rated aspects of the developed media was technical design quality. This result suggests that the combination of FreeMind and Canva successfully produced a visually coherent learning medium capable of facilitating information organization. Previous studies have demonstrated that visually organized learning environments can improve learners' ability to recognize conceptual relationships and reduce difficulties associated with fragmented information processing (Fiorella & Mayer, 2021).

The high evaluation of communication with users further demonstrates that the media successfully conveyed instructional messages in a manner that was accessible to elementary school students. Educational media that provide clear communication pathways enable learners to focus on concept acquisition rather than struggling with interface interpretation or information retrieval. This characteristic is particularly important for younger learners whose cognitive resources are still developing (Schneider et al., 2022).

The strong performance of the media usefulness aspect suggests that the product was perceived as beneficial for supporting instructional activities. Educational technologies are more likely to be adopted when users recognize their practical value in addressing learning challenges. In the present study, the media provided a structured representation of ecosystem concepts, allowing students to identify conceptual relationships more effectively than through conventional text-based approaches.

The material validation score of 89.28% further supports the educational value of the developed media. High content validity indicates that the instructional materials were aligned with curriculum requirements, learning objectives, and students' developmental characteristics. This finding is important because effective learning media must integrate pedagogical quality with technical excellence to achieve meaningful educational outcomes (Hodges et al., 2020).

The positive evaluation of curriculum relevance demonstrates that the developed media successfully translated curriculum objectives into learning experiences that are both accessible and engaging. Alignment between instructional media and curriculum standards has been identified as a critical factor influencing learning effectiveness because it ensures that educational resources support intended competency development (Darling-Hammond et al., 2020).

The high score obtained for conceptual accuracy reflects the importance of maintaining scientific integrity in instructional media development. In science education, misconceptions can emerge when concepts are oversimplified or inaccurately represented. Therefore, the strong validation result indicates that the developed media effectively balanced visual simplification with scientific accuracy, ensuring that students received reliable conceptual information.

The favorable evaluation of language appropriateness also deserves attention. Elementary students often experience difficulties when instructional materials employ terminology that exceeds their cognitive and linguistic capabilities. The findings suggest that the language used in the media was sufficiently clear and understandable, enabling students to focus on conceptual learning rather than linguistic interpretation.

The highest score in material validation was obtained in the student suitability aspect. This finding indicates that the content structure, visual presentation, and conceptual complexity were considered appropriate for Grade V learners. Educational psychologists have long emphasized the importance of matching instructional materials to learners' developmental stages because age-appropriate content enhances engagement and learning effectiveness (Ormrod et al., 2024).

The student practicality score of 90.80% provides further evidence regarding the usability of the developed media. High practicality indicates that students perceived the media as attractive, understandable, and supportive of learning activities. Practicality is an important dimension in educational product development because even highly valid instructional materials may fail to achieve educational impact if users experience difficulties in implementation.

The high score obtained in visual attractiveness highlights the significance of visual design in contemporary learning environments. Research has shown that visual elements such as color, images, and spatial organization influence students' attention, motivation, and engagement during learning activities (Sankey et al., 2023). The positive student responses suggest that these design features contributed to creating an appealing learning experience.

Students also reported that the media facilitated understanding of ecosystem concepts. This finding can be interpreted through the lens of cognitive theory, which suggests that learning becomes more effective when information is organized into meaningful structures. Mind Mapping enables learners to identify relationships among concepts and construct integrated knowledge networks, thereby improving conceptual understanding (Novak, 2020).

The favorable response regarding learning enjoyment suggests that the developed media contributed positively to students' emotional engagement with learning. Educational research increasingly recognizes that emotional factors influence learning outcomes by affecting attention, persistence, and willingness to participate in instructional activities (Pekrun, 2021). Consequently, enjoyable learning experiences may indirectly support academic achievement.

The creativity support aspect also achieved a highly practical rating. Although the present study did not directly measure creativity outcomes, students perceived that the media encouraged idea organization and conceptual exploration. Visual mapping activities have been associated with divergent thinking processes because they allow learners to generate connections among concepts and represent knowledge in flexible ways (Davies, 2021).

The findings also highlight the pedagogical value of integrating digital technologies into elementary science education. The use of FreeMind and Canva enabled the development of a learning medium that combined conceptual structure with visual appeal. Such integration reflects broader educational trends emphasizing the use of accessible digital tools to enhance instructional quality and student engagement (Bond et al., 2024).

An important contribution of the present study lies in its focus on Madrasah Ibtidaiyah, a context that remains underrepresented in international educational technology literature. Much of the existing research on digital learning media has been conducted in general elementary school settings, whereas fewer studies have examined technology-supported learning resources within Islamic elementary education. Therefore, the present findings contribute to expanding knowledge regarding instructional innovation in this educational context.

The results also address practical challenges faced by teachers. Preliminary observations revealed that teachers recognized the importance of innovative learning media but encountered barriers related to time, technological competence, and resource availability. The developed media demonstrates that accessible applications such as FreeMind and Canva can be utilized to create educational resources without requiring advanced programming skills. This finding has important implications for teacher professional development and instructional innovation.

From a theoretical perspective, the findings support constructivist views of learning, which emphasize the active construction of knowledge through meaningful interactions with learning resources. By presenting ecosystem concepts through interconnected visual structures, the media encouraged students to organize information and construct relationships among concepts rather than simply memorizing isolated facts. This characteristic aligns with contemporary approaches to science education that prioritize conceptual understanding over rote learning (Taber, 2022).

The findings further suggest that digital Mind Mapping media can function as a bridge between abstract scientific concepts and students' existing knowledge structures. Ecosystem learning requires students to understand complex relationships among organisms, environmental factors, and ecological processes. The visual organization provided by Mind Mapping appears to facilitate this process by making conceptual connections more visible and comprehensible.

Another noteworthy implication concerns the role of educational media in reducing cognitive burden during learning. When information is presented in lengthy textual formats, students may experience difficulties identifying key concepts and relationships. The visual structure of Mind Mapping enables learners to process information more efficiently by highlighting conceptual hierarchies and connections. Such characteristics may contribute to improved knowledge organization and information retention.

Although the results are highly encouraging, several limitations should be acknowledged. The study involved only one media expert, one material expert, and a small group of five students. While these participants were sufficient for preliminary feasibility and practicality evaluation, future studies should involve larger samples and broader implementation contexts to strengthen the generalizability of the findings.

Future research may also examine the effectiveness of digital Mind Mapping media in improving specific learning outcomes such as conceptual understanding, critical thinking, scientific literacy, and long-term retention. Experimental or quasi-experimental designs involving larger participant groups could provide stronger evidence regarding the educational impact of the developed media.

The findings demonstrate that the digital Mind Mapping learning media developed using FreeMind and Canva achieved high levels of feasibility and practicality. The positive evaluations from experts and students indicate that the media has substantial potential to support ecosystem learning in Madrasah Ibtidaiyah. By combining structured concept representation, visual communication, and accessible digital technology, the developed media offers a promising alternative for enhancing science learning experiences at the elementary education level.

CONCLUSION

This study developed and evaluated the feasibility of digital Mind Mapping learning media for ecosystem learning in Madrasah Ibtidaiyah using the Luther development model. The findings demonstrated that the developed media achieved a media expert validation score of 92.50%, a material expert validation score of 89.28%, and a student practicality score of 90.80%, all of which were categorized as highly feasible or highly practical. These results indicate that the media is suitable for supporting ecosystem learning by providing a structured and visually organized representation of concepts that aligns with the characteristics of elementary-level learners. Although the study was limited to expert

validation and a small-group trial, the findings suggest that digital Mind Mapping media developed using FreeMind and Canva can serve as a practical instructional resource for science learning in Madrasah Ibtidaiyah. Future studies are encouraged to involve larger participant groups and examine the effectiveness of the media in improving specific learning outcomes across broader educational contexts.

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