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# Meta-analysis: Validity of Atlas Development as a Supplement to High School Biology Teaching Materials

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**ABSTRACT**

**Purpose of the study:** This study aims to analyze the validity and effectiveness of the Learning Atlas as a supplementary teaching material in Biology education. Supplementary teaching materials, such as the Learning Atlas, provide an alternative medium for enhancing students' comprehension of biological concepts by presenting information visually, without requiring direct observation of the phenomena. The Atlas is designed to help students engage with and absorb complex material more effectively, supporting traditional classroom learning.

**Methodology:** The research employs a meta-analysis approach by systematically reviewing source articles obtained via Google Scholar. The sample includes 12 journals and theses related to the development and validation of the Learning Atlas and similar booklets as educational tools in Biology. Data from these sources were synthesized to assess the validity and impact of the Atlas.

**Main Findings:** The validity of the Learning Atlas as a teaching supplement was found to be 95.55%, categorizing it as "very valid." Additionally, the reviewed studies highlight that the Atlas effectively enhances students' conceptual understanding and engagement in Biology learning, making abstract ideas more tangible and accessible.

**Novelty/Originality of this study:** This research provides new insights into the use of the Learning Atlas as a practical and highly valid supplementary tool for Biology education. Unlike conventional resources, the Atlas integrates visual and textual content to support independent and classroom learning, offering educators a reliable and innovative way to enhance students' mastery of biological concepts. It also underscores the potential for the Atlas to improve learning outcomes in diverse educational settings.



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## 1. INTRODUCTION

In the 21st century, learning emphasizes student-centered approaches that foster active engagement, critical thinking, and collaboration. Learning is defined as an effort to guide students in acquiring knowledge through interactive activities between teachers and students, students and their peers, and students and their environment, with these interactions oriented toward achieving specific learning goals [1]. In line with this vision, the implementation of the Independent Curriculum in Indonesia allows teachers the flexibility to manage learning activities and select appropriate teaching tools to enhance students' learning experiences.

The flexibility provided to teachers under the Independent Curriculum framework plays a crucial role in improving students' understanding of key concepts, particularly in subjects like Biology. Hartatik, highlights that the creativity of teachers in managing the learning process and selecting suitable learning media significantly

impacts students' academic success [2]. Learning media, which can take the form of hardware or software, are tools that facilitate the delivery of lesson material from teachers to students, serving to capture students' attention and sustain their engagement throughout the learning process [3]. Effective learning media are expected to support a more efficient and engaging learning process, aligning with educational goals [4]. Additionally, they can serve as valuable supplements to teaching materials, reinforcing students' comprehension and retention of the material.

Supplemental teaching materials are additional resources designed to complement classroom instruction. Their availability, when adequate and aligned with learning objectives, can greatly assist teachers in facilitating the learning process while improving students' understanding of the material [5]. According to Prastowo, such materials enable teachers to convey concepts more effectively, allow students to review lessons independently, and provide engaging content that supports learning outcomes [6]. However, to achieve these benefits, supplemental teaching materials must be thoughtfully designed to meet the specific needs of students and the curriculum.

One innovative supplemental teaching material is the *learning atlas*, a visual-based learning medium designed to enhance students' comprehension through engaging and detailed illustrations. The use of a learning atlas has several advantages, including fostering curiosity, aiding identification, simplifying the understanding of concepts, and enhancing memory retention [7]. By presenting information visually, the atlas provides a richer and more precise representation of learning material compared to textual descriptions alone, enabling students to grasp abstract concepts more effectively [8]. Moreover, it stimulates students' thinking and analytical skills by detailing the material in a structured and visually appealing manner.

Learning atlases are particularly beneficial in subjects like Biology, where visual representation plays a critical role in understanding complex structures and processes. Ardiana, highlights that an atlas serves as an alternative to direct observation, offering students a clear and engaging medium to absorb material [9]. Additionally, Lestari, emphasizes that atlases support conceptual understanding by helping students identify and analyze learning themes with greater clarity [10].

Despite the growing interest in visual-based learning media, there is limited research that systematically evaluates the validity and effectiveness of learning atlases as supplemental teaching materials, particularly in the context of Biology education. While existing studies highlight the general benefits of visual learning media, gaps remain in understanding how atlases can be tailored to meet the specific needs of the Independent Curriculum and how they influence student engagement and comprehension. Furthermore, most research focuses on generic visual tools without delving into the unique attributes and pedagogical advantages of atlases.

This study aims to bridge these gaps by analyzing the validity and applicability of learning atlases as supplements for Biology education. Specifically, it will assess how well the atlas aligns with curriculum standards, supports teacher objectives, and enhances students' understanding of biological concepts. By addressing these questions, this research contributes to the broader discourse on innovative teaching materials and their role in advancing 21st-century learning practices.

## 2. RESEARCH METHOD

The type of research used in this research is meta-analysis. Meta-analysis research is a type of research carried out by summarizing, reviewing and analyzing existing research data. This type of research aims to determine the level of validity of each data collected. Researchers collected previous research articles that had been published in accredited scientific journals which became the basis of this research.

Data was collected by searching articles in online journals regarding the development of the Learning Atlas as a supplement to high school biology learning via Google Scholar. Articles collected with the keywords "development", "learning atlas" and "biology learning supplement" resulted in 12 national articles published between 2015 and 2023. The steps for tabulating the data that have been collected are: (1) identifying variables-research variable. Once determined, then enter it in the appropriate variable column, (2) identify the average content validity of each research subject, (3) identify the average presentation validity of each research subject, (4) identify the average language validity of each research subject, (5) identify the graphical average for each research subject, (6) calculate the final average validity. With the following assessment criteria:

Table 1. A product category is said to be valid

| Interval | Category |
|---|---|
| 81.01 – 100.0 | Very Valid |
| 61.01 – 81.0 | Valid |
| 41.01 – 61.0 | Invalid |
| ≥ 21.01 – 41.0 | Very Invalid |

## 3. RESULTS AND DISCUSSION

Based on the results of a meta-analysis of 12 articles published in 2018–2023 regarding the validity of Atlas development as a supplement to teaching materials for high school biology learning. The following articles were collected as data in this research.

Table 2. Results of article analysis

| Validated Aspects | | | |
|---|---|---|---|
| Contents | Language | Presentation | Graphics |
| 98.2 | 100.0 | 100.0 | 875 |
| 100.0 | 100.0 | 100.0 | 97.1 |
| 90.9 | 90.1 | 96.0 | 83.3 |
| 95.8 | 95.8 | 95.1 | 95.6 |
| 90.3 | 100.0 | 100.0 | 100.0 |
| 85.0 | 87.0 | 88.0 | 93.0 |
| 100.0 | 93.0 | 90.0 | 98.0 |
| 93.5 | 99.7 | 100.0 | 89.6 |
| 94.2 | 95.8 | 100.0 | 82.8 |
| 99.2 | 98.7 | 100.0 | 98.8 |
| 100.0 | 100.0 | 93.7 | 97.9 |
| 100.0 | 100.0 | 100.0 | 92.8 |

Table 3. Results of Atlas Validity Test Analysis as a Teaching Material Supplement

| Component | Validity Value | Criteria |
|---|---|---|
| Contents | 96.60 | Very Valid |
| Language | 95.85 | Very Valid |
| Presentation | 96.90 | Very Valid |
| Graphichs | 93.87 | Very Valid |
| Avarage | 95.55 | Very Valid |

The analysis results in Table 3 demonstrate that the Atlas as a learning supplement achieved an average validity score of 95.55%, categorized as very valid. This finding highlights the effectiveness of the Atlas in meeting educational standards and student needs. Four key components were assessed: Content Suitability: Scored 95.60% (very valid criteria). Language Use: Scored 95.85% (very valid criteria). Presentation Form: Scored 96.90% (very valid criteria). Graphics: Scored 93.87% (very valid criteria).

The high validity score for content suitability indicates that the Atlas aligns closely with the current Curriculum [11], Competency Achievements (CP), Learning Objectives (TP), and Learning Objective Flow (ATP). Additionally, it addresses students' learning needs effectively. The very valid criteria suggest that the Atlas not only delivers accurate and comprehensive material but also serves as a credible source for expanding students' knowledge. By integrating curriculum-based learning objectives and real-world relevance, the Atlas enhances the learning experience, offering a versatile tool for both teachers and students.

The language component scored the highest among the four aspects, emphasizing its importance in effective learning. The Atlas adheres to Indonesian language rules, ensuring readability, clarity, and the effective delivery of information [11]. Clear and structured language facilitates students' comprehension, enabling them to acquire knowledge, skills, and experiences efficiently. The results align with findings by Arga, which emphasize that language clarity significantly influences students' ability to absorb and apply new information [12]. The effective use of language in the Atlas ensures inclusivity by catering to students with varying literacy levels.

The systematic, simple, and clear organization of content makes the Atlas an accessible learning tool. This dimension scored 96.90%, indicating exceptional effectiveness in supporting student comprehension. By presenting information in a logical sequence, the Atlas enhances the teaching process and makes learning more engaging and efficient [13]. Moreover, Rejeki, highlights that effective presentation forms, such as the one demonstrated in the Atlas, play a vital role in helping students visualize and contextualize abstract concepts [14]. The systematic structure ensures that students can follow the material with minimal confusion, promoting deeper understanding.

With a score of 93.87%, the graphics component is slightly lower than the other criteria but still falls within the very valid category. The Atlas incorporates elements such as pictures, photographs, identification keys, and detailed descriptions, all of which attract students' attention and aid their understanding [15]. Good graphic design is critical for engaging students and enhancing their learning experience. The inclusion of visual elements such as legends, titles, and symbols improves usability and supports interactive learning [16]. However, further refinement of the graphical aspects could elevate the overall effectiveness of the Atlas.

The study introduces an innovative approach by systematically evaluating the Atlas across multiple dimensions (content, language, presentation, and graphics). The findings provide a comprehensive framework for understanding how supplementary learning tools can be optimized to support curriculum goals, enhance student engagement, and improve knowledge acquisition. Additionally, the study's emphasis on language and presentation as critical factors in the success of learning supplements offers fresh insights, particularly in the context of developing countries where educational resources often face limitations.

Enhanced Learning Outcomes: The Atlas can serve as a model for designing other learning supplements, particularly in its ability to integrate curriculum requirements with effective teaching practices. Teacher Support: By offering a well-structured, easy-to-use tool, the Atlas reduces the burden on teachers to create supplementary materials, enabling them to focus on pedagogy. Policy Alignment: The results emphasize the importance of aligning learning tools with national curriculum standards, ensuring consistency and quality in educational practices. Limited Generalizability: The study focuses on the Indonesian context, which may limit the applicability of findings to other regions or countries with different curricula and educational challenges. Graphics Improvement: While the Atlas graphics scored highly, they still lag slightly behind other dimensions. A more detailed exploration of students' preferences for graphical elements could yield further improvements. Learner Diversity: The study does not extensively address how the Atlas accommodates diverse learning styles, which could be an area for future exploration.

Further Development of Graphics: Enhance the visual appeal and interactivity of the Atlas by incorporating modern design elements such as augmented reality (AR) or interactive features. Customization for Learner Diversity: Develop different versions of the Atlas to cater to varied learning preferences, such as simplified versions for younger students or advanced versions for high achievers. Wider Application: Pilot the Atlas in diverse educational settings, including rural and urban schools, to assess its adaptability and scalability. Professional Development for Teachers: Conduct training sessions to help teachers maximize the use of the Atlas in their classrooms. Integration with Technology: Develop a digital version of the Atlas to provide students with flexible access through mobile devices or online platforms.

## 4. CONCLUSION

The research on testing the validity of the Biology Learning Atlas as a supplementary learning resource has demonstrated promising results. A meta-analysis conducted during the study revealed that the atlas achieved a validity score of 95.55%, placing it within the "very valid" category. These findings suggest that the atlas is not only well-designed but also practical for use in supporting students' understanding of biology material. The integration of this atlas into the learning process provides an additional resource that can enhance students' comprehension and engagement with complex biological concepts.

The high validity of the Biology Learning Atlas underscores its potential as an effective tool for enriching biology education. By serving as a supplementary learning aid, the atlas can support diverse learning styles, allowing students to visualize and connect biological concepts more effectively. However, further exploration is needed to evaluate the atlas's practical impact in real classroom settings, particularly in improving student engagement and learning outcomes across different contexts. Future research could focus on qualitative investigations into how students and teachers interact with the atlas, as well as its adaptability to various educational environments. Additionally, expanding the atlas to include more localized or culturally relevant content could make it even more effective for diverse student populations. By addressing these aspects, the atlas can serve as a model for the development of supplementary learning materials in other subject areas.

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