



Improving Students' STEM Skills Through the Development of an E-Learning Chemistry Book Integrated with Sasak Local Wisdom

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Abstract: This study aims to develop a feasible and effective e-learning chemistry book integrated with Sasak's local wisdom to enhance students' science, technology, engineering, and mathematics (STEM) skills. The research adopts a development approach utilizing the ADDIE model include analysis, design, development, evaluation and implementation. Product trial on chemistry education students at UIN Mataram employing a quasi-experimental pre-test and post-test control group design. The study reveals that the e-learning chemistry book, integrated with Sasak local wisdom, achieves an Aiken's validity coefficient of 0.890, an intraclass correlation coefficient (ICC) value of 0.810, and a Cronbach's alpha reliability value of 0.875. Furthermore, the results of the independent sample T-test indicate a significance value of 0.01, which is less than α (0.05), affirming that the e-learning chemistry book integrated with Sasak local wisdom meets valid and reliable criteria and is declared effective in enhancing students' STEM skills

Keywords: E-learning; Sasak Local Wisdom; STEM Skills

Introduction

Implementing technology in learning plays an essential role in enhancing the quality of the nation's younger generation, especially in the millennial era. This technology support aligns with the implementation of 21st-century learning in the age of Industrial Revolution 5.0 (Verawati et al., 2022; Wahyudiati & Qurniati, 2022). The availability of technology-based learning resources, representing a form of learning innovation, must be integrated into education to cultivate students' 21st-century skills during the Industrial Revolution 5.0 era (Gunawan et al., 2020; Irwanto et al., 2023; Ramdani et al., 2021; Zhou, 2022). The aspects of 21st-century skills that warrant development include problem-solving, communication, collaboration, and Science, Technology, Engineering, and Mathematics (STEM) skills (Verawati et al., 2021, 2022).

In the context of learning chemistry, the significance of learning resources and media lies in

concretizing abstract concepts to facilitate students' understanding. However, technology is predominantly utilized in learning as an information source rather than a process-based tool for developing students' STEM skills (Ramma et al., 2015). This issue is consistent with the findings of previous research indicating that the development of students' STEM skills tends to be neglected, with a greater focus on achieving cognitive learning outcomes, leading to lower STEM skills among students (Verawati et al., 2021; Pavlova 2013). Similarly, initial observations at three universities in the city of Mataram revealed that 60% of students scored in the deficient category for STEM skills in Basic Chemistry courses. with STEM skills can train students to think critically, analyze and improve thinking skills high level that supports the achievement of learning objectives.

To cultivate STEM skills in response to rapid technological advancements, the current global trend in learning is shifting towards e-learning or virtual learning systems (Esteve-Mon et al., 2022; Krumsvik,

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2012). Consequently, conventional teaching materials and media are no longer employed in classroom learning design. Education providers are encouraged to prepare IT-based learning media and teaching materials through e-learning to align with ongoing technological developments (Astawa et al., 2022; Castro et al., 2020; Esteve-Mon et al., 2022). E-learning aids in visualizing abstract concepts, making them more concrete and factual (Tapia et al., 2018). Additionally, the integration of technology with students' daily life experiences, as reflected in the local wisdom of an area, proves highly effective in rendering abstract concepts comprehensible, thereby enhancing students' understanding of chemistry material. One such local wisdom suitable for integration with e-learning is Sasak culture, as its traditions and cultural products are pertinent to chemical materials, such as chemical bonds, material changes, and the periodic system of elements (Ador, 2017; Ogunkunle et al., 2015; Suharta et al., 2017; Sutrisno et al., 2020; Wahyudiati, 2022b, 2022d, 2022c).

Considering the empirical conditions and theoretical studies, there is a need to develop an e-learning chemistry book integrated with Sasak's local wisdom, a project that has not been undertaken previously. This research aims to produce a feasible and effective e-learning chemistry book product integrated with Sasak's local wisdom, with the ultimate goal of enhancing students' STEM skills to prepare students for careers in technology, science, and engineering

Method

The development of the e-learning chemistry book, integrated with Sasak's local wisdom, utilized the ADDIE development model (Branch, 2009). The research subjects were first-semester Chemistry Education students at UIN Mataram. Data were collected through a non-test technique using a questionnaire to measure students' STEM skills, aiming to gather data on product feasibility and students' STEM skills.

The design of the teaching material product, an e-learning chemistry book integrated with Sasak Lombok's local wisdom, and research instruments underwent a preparation process involving lecturer discussions with content experts, media experts, and Sasak culture experts. The trial activity went through two stages: product validation and trials with Chemistry Education students at UIN Mataram. The trial design employed a quasi-experimental pre-test and post-test control group design (Campbell & Stanley, 1963; Gerbing, 1984)

Result and Discussion

The learning media produced in this research is the Sasak Local Wisdom Integrated e-learning Chemistry Book, which can be seen in Figure 1 and can be accessed at:

<https://modul.buanatechno.id/kampus/kimia/1/mobile/index.html>. The examples of images and videos in the e-learning chemistry book integrated with Sasak's local wisdom can be seen in Figures 2 and 3.



Figure 1. The e-learning chemistry book integrated with Sasak local wisdom cover



Figure 2. The stage of *pintal benang* (processing cotton into thread)



Figure 3. Video of physical and chemical changes

Before validating the product, it underwent a preliminary check by a team of two proofreaders, including a chemistry content expert and a Sasak culture expert. Input and suggestions from the proofreading

team encompassed several aspects: the alignment of teaching materials with learning indicators, the relevance of Chemistry material to the selected Sasak local wisdom, the appropriateness of material coverage in relation to learning time allocation, and the use of language to avoid creating ambiguous meanings. Following the improvement process, the subsequent stage involved product validation.

The validity of the e-learning Chemistry Book Integrated with Sasak Local Wisdom engaged seven validators, including a chemistry content expert, a local Sasak culture expert, a language expert, a media expert, and a chemistry user or lecturer. The validity assessment covered three aspects: rationality, content and presentation appropriateness, and linguistic aspects. The material coverage comprised four subjects: material changes, separation of mixed components, periodic system of elements, and chemical bonds. Data analysis indicated a validity value of 0.890 (falling within the very high category) with a reliability value of 0.875. This implies that the Chemistry Book Integrated with Sasak Local Wisdom is valid and reliable for application in Basic Chemistry courses at universities.

The effectiveness of product development indicated the quality of a product. In this research, the efficacy of the product developed; the e-learning Chemistry Book Integrated with Sasak Local Wisdom, was determined by analyzing how the book was in improving students' STEM skills. Therefore, students' STEM (science, technology, engineering, and mathematics) skills were assessed after students studied using the e-learning Chemistry Book Integrated with Sasak Local Wisdom. The results obtained can be seen in Table 1.

Table 1. Independent Samples Test Result

N-Gain STEM	Sig. (2-tailed)
Equal variances assumed	0.01
Equal variances not assumed	0.02

Table 1 displays the significance value of $0.01 < \alpha$ (0.05). The results indicated that e-learning Chemistry Book Integrated with Sasak Local Wisdom effectively improves students' STEM skills. The students' STEM skills were assessed according to STEM skills indicator including: formulating questions and problems, developing and using models, planning and conducting investigations, analyzing and interpreting data, using mathematics and information technology, building explanations and designing solutions, engaging in arguments based on evidence, evaluating and communicating information (Aninda et al., 2019). STEM learning able to improve the skills needed by 21st-century society (Aykan & Yildirim, 2022; Turner et al.,

2022). In addition, STEM approaches enable learners to solve problems better, able to become innovators, inventors, independent workers, logical thinkers, and technology literates (Sumarni & Kadarwati, 2020).

The e-learning Chemistry Book Integrated with Sasak Local Wisdom has the potential to enhance students' STEM skills as it serves as an e-learning medium. Through e-learning, students engage in listening to lecturers' explanations and actively observe, perform, and demonstrate concepts. The chemistry material in the e-learning book can be presented in various virtual formats, making the learning experience more exciting and dynamic, ultimately motivating students to become more active in their learning process. This aligns with the findings of Dahiya (2012), who observed that e-learning enables students to learn anytime and anywhere, bringing a new dimension to various learning developments. E-learning also helps improve students' critical thinking skills (Indriana, 2023).

Furthermore, proper utilization of e-learning has the potential to maximize learning outcomes, particularly in the development of students' STEM skills. With e-learning innovation, students can enhance their proficiency in using and developing technology. According to Rohmah (2016), the benefits of e-learning include reduced learning time and more cost-effective studying; facilitated interaction between students and learning materials; the ability to share information and access learning materials at any time and repeatedly, thereby allowing students to reinforce their mastery of the material; and the involvement of students in the teaching and learning process outside the traditional classroom setting, thanks to computer and network technology. E-learning has proven to be a very effective, interactive, easy to use learning medium that can improve critical thinking skills, interest and motivation to learn, science process skills and scientific attitudes (Sati et al., 2022; Verawati, 2020; Aurora, 2019; Ihsan, 2019). The development of e-learning becomes a new need in the implementation of learning activities in the classroom, supporting the improvement of students' creative thinking skills and the implementation of the independent curriculum (Nazhifah, 2023).

Furthermore, the e-learning Chemistry Book Integrated with Sasak Local Wisdom has the potential to enhance students' STEM skills by integrating Basic Chemistry material with Sasak local wisdom, specifically focusing on chemical bonds, substances and matter, and the periodic system of elements. Broadly, the local wisdom values present in various traditions of the Sasak community encompass concepts such as mutual need, cooperation, mutual give and take, compassion,

and social solidarity (Street, 2020; Sutrisno et al., 2020; Zulfa, 2017). These local wisdom values bear significant relevance to the concept of chemical bond theory, which is analyzed from various perspectives such as the concept of electron stability, stable electron configurations, and the theory of chemical bond formation. The concepts of substance and matter are explored in terms of elements, compounds, and mixtures, as well as changes in matter and their types, types of changes in mixtures, and distinctions between elements, compounds, and mixtures. The concept of the periodic system of elements is examined through the properties of chemical elements in Sasak cultural products, which incorporate numerous chemical elements in the creation of traditional ceremonial tools, traditional craft and art tools, and household equipment (Sumardi & Wahyudiati, 2022; Wahyudiati, 2022a; Wahyudiati & Fitriani, 2021; Wahyudiati & Ningrat, 2019).

The integration of Basic Chemistry material with Sasak local wisdom is approached through various methods, including analogy, representation, apperception, visualization, and interpretation. These approaches aim to assist students in understanding chemical concepts by utilizing culture as a natural laboratory. The analogy approach involves drawing parallels between domains, especially in the context of chemical bonding. The diverse local wisdom of the Sasak people is connected to chemical bond theory through analogies, considering concepts such as electronic stability, stable electronic configuration, positive and negative ions, bonds between atoms (ionic bonds, polar covalent bonds, non-polar covalent bonds, coordination covalent bonds, metallic bonds), and intermolecular bonds (hydrogen bonds and van der Waals bonds). Various traditions of the Sasak people, such as those observed in traditional wedding processions (merariq) like nenarih, sorong serah, and nyongkolan, closely relate to the theory of chemical bonds. The connection lies in the similarity of meaning, values, and the underlying theory or concept.

The integration of basic chemical materials with Sasak local wisdom in the application of the e-learning Chemistry Book Integrated with Sasak Local Wisdom is based on the representation approach. This approach is linked to the characteristics of chemical materials, which consist of macroscopic, microscopic, and symbolic components, making chemistry a challenging subject for students to grasp (Santos & Arroio, 2016). Combining these three aspects—macroscopic, microscopic, and symbolic—is essential in teaching chemistry to ensure students have a comprehensive understanding of the subject. However, integrating these three levels poses the most significant challenge in learning chemistry. To

address these challenges, a visual tool is required, incorporating images and concrete models that utilize tools and materials in the students' environment to enhance visualization and understanding of student representation in Basic Chemistry Course 1. This aligns with the findings of Santos and Arroio (2016) research, which concluded that using images, concrete models, graphics, photos, computing programs, diagrams, and other visualization tools effectively enhances students' visualization ability and understanding of representation.

The application of the E-Learning Chemistry Book Integrated with Sasak's Local Wisdom can enhance students' visualization skills by utilizing concrete or real models (cultural products) relevant to chemical concepts. This facilitates contextual-based learning and comprehension of concepts. For instance, to understand the concepts of elements, compounds, and mixtures, concrete examples related to the existence of elements, compounds, and mixtures in the daily lives of the Sasak people are presented. Examples include gold, silver, and copper elements found in traditional ceremonial instruments (marriage) and traditional arts. After gaining macroscopic and microscopic understanding, students then progress to symbolic understanding. For example, the gold element is symbolized by Au (aurum), and the symbol for silver is Ag (Argentum). This is followed by calculating Au and Ag levels using mathematical calculations (symbolic levels), enabling students to develop representation skills in chemistry learning that positively impact learning outcomes and scientific skills (Rahmawati, 2018; Sutrisno et al., 2020).

Integrating Basic Chemistry materials with Sasak local wisdom in the application of the e-learning chemistry book, integrated with Sasak local wisdom, is based on the interpretation approach related to pronunciation, language, and cultural symbols. This involves the analysis of the Sasak language and cultural symbols, referring to three cultural forms: ideas, social systems, and concrete culture. This analysis is substantiated through literature studies, expert validation, and consultation with traditional Sasak leaders.

Applying the apperception approach to the integration of Basic Chemistry materials with Sasak local wisdom involves uniting and assimilating observations with experiences, understanding, and interpreting them (Nasution, 2012). It incorporates the experiences and prior understanding that individuals possess (Rohani, 2010). The implementation of apperception in the e-learning chemistry book integrated with Sasak local wisdom occurs at the beginning of learning. For instance, when discussing material changes in physics and chemical changes, the process begins by prompting

students to share experiences from their daily lives related to Sasak's local wisdom, such as kereng sesek coloring, poteng, and gule beaq. These questions aim to stimulate curiosity and motivation among students in learning chemistry, facilitating their understanding of concepts and positively impacting the development of their scientific attitudes. Research by Koballa, Glynn, & Upson (2005) also indicates that motivation significantly influences science learning, contributing to more effective learning outcomes. To enhance student motivation in Basic Chemistry learning, incorporating Sasak's local wisdom-based learning stimulation is essential to improve student learning outcomes. Motivation aspects have been proven effective in enhancing student science performance, fostering scientific attitudes, and improving overall learning outcomes (Pintrich, 2004). The result of students' STEM skills of each indicator can be seen in Figure 4.

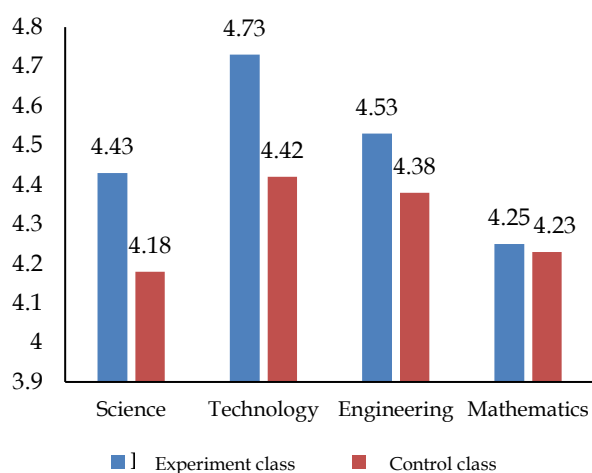


Figure 4. Student average score in each STEM indicator

Based on Figure 4, the experimental class that utilized the e-learning chemistry book integrated with Sasak Local Wisdom achieved higher average STEM skill values in each indicator. This indicates that students' STEM skills in the experimental class were superior to those in the control class across all fields of science, technology, engineering, and mathematics.

Science ability refers to the skill of applying learning by using scientific knowledge and connecting learning with nature. The use of the E-Learning Chemistry Book Integrated with Sasak Local Wisdom could enhance students' science ability because the book offers a more interactive and multimedia explanation related to chemical topics. Additionally, the book features videos, animations, images, and practice questions integrated with Sasak's local wisdom to aid students in understanding complex chemical concepts. These results align with various previous research

findings, indicating that the integration of chemical materials with Sasak local wisdom can make learning more meaningful and positively impact problem-solving skills, scientific attitudes, and learning outcomes (Rahmawati et al., 2017; Sumardi & Wahyudiati, 2022; Sutrisno et al., 2020; Tobin & Roth, 2019; Wahyudiati et al., 2021).

Technological ability involves skills related to linking learning with technology, including using, analyzing, and developing technology. Digital content can be used as an attractive learning media for students and facilitate learning models that are applied in the classroom, so learning can run optimally because in a learning process there are two important elements that can affect the efficiency, effectiveness, and learning outcomes of learning models and learning media (Lestari, 2020). Utilizing the E-Learning Chemistry Book Integrated with Sasak Local Wisdom can enhance students' technological skills because the book provides access to the latest materials integrated with Sasak's local wisdom directly related to the latest technological developments. Similarly, research conducted by Verawati et al. (2022) and Wahyudiati (2023) has demonstrated that incorporating technology into learning can improve students' STEM skills.

Engineering ability is the capacity to comprehend technology developed through the design process. Utilizing the e-learning Chemistry Textbook Integrated with Sasak Local Wisdom in learning can enhance students' engineering skills because the book provides an interactive approach that allows them to engage with simulations, software, and interactive videos integrated with Sasak Local Wisdom, thereby aiding in their understanding of complex technical concepts. The results of this research are pertinent to previous studies, demonstrating that the application of the STEM approach in learning can cultivate STEM skills, critical thinking skills, and enhance students' cognitive learning outcomes (Sumarni & Kadarwati, 2020; Sun & Bian, 2022; Verawati et al., 2022; Wahyudiati, 2023).

Mathematics ability is the skill to formulate and solve problems with judgment, interpret solutions to mathematical problems in their application, and communicate ideas effectively. Using the e-learning Chemistry Book Integrated with Sasak Local Wisdom in learning can enhance students' mathematics skills because the book provides more comprehensive and in-depth explanations through videos, narratives, or examples integrated with Sasak Local Wisdom, thereby assisting students in understanding the steps for solving problems. The results of this research align with various studies, indicating that integrating chemical material with local Sasak wisdom through STEM-based learning

positively influences the ability to formulate and solve problems through assessment, as well as the ability to interpret problem solutions mathematically, enabling the optimal achievement of chemistry learning objectives (Verawati et al., 2022; Wahyudiati, 2023).

Based on the advantages of e-learning chemistry book integrated with local wisdom, this book serves as an alternative learning medium for improving students' STEM abilities in chemistry.

Conclusion

Based on the research findings, the following conclusions can be obtained: The e-learning Chemistry book Integrated with Local Wisdom has an Aiken's validity coefficient of 0.890, an intraclass correlation coefficient (ICC) value of 0.810, and a Cronbach's alpha reliability value of 0.875. Consequently, the e-learning chemistry book integrated with Sasak local wisdom meets the criteria for validity and reliability, The results of the independent sample T-test yielded a significance value of 0.01, which is less than α (0.05), indicates that the e-learning chemistry book integrated with Sasak local wisdom is effective in enhancing students' STEM skills

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Author Contributions

Conceptualization, D. W, D. Q.; methodology, D. W.; software, D. Q.; formal analysis, D. W, D. Q.; investigation, D. Q.; resources, D. W.; data curation, D. Q.; writing—original draft preparation, D. Q.; writing—review and editing, D. W.

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Conflicts of Interest

The authors declare no conflict of interest.

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