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Integration of Batik in Science Learning to Overcome Students' Low Critical Thinking Skills in Junior High School: Teacher's Perspective

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Abstract

This study aims to review materials that are difficult for students to develop critical thinking skills, appropriate learning models to improve critical thinking skills, and effective learning approaches. In addition, it is necessary to review the development of teaching materials that integrate local wisdom and improve critical thinking skills. The research strategy used is qualitative descriptive with a case study research strategy with purposive sampling techniques and thematic analysis methods. This study shows the low critical thinking skills of junior high school students in science learning, especially in abstract materials such as temperature, heat, and expansion. The integration of local wisdom, such as the batik process, through interactive e-books equipped with videos, animations, and quizzes, as well as discovery learning models, can improve students' understanding and critical thinking skills contextually and engagingly. This innovation is a solution to the challenges of learning science and developing student competencies.

Keywords: Critical thinking skills, temperature heat and expansion materials, e-book, discovery learning, batik

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INTRODUCTION

Science learning has a vital role in developing students' knowledge while training objective thinking, fostering process skills, and deepening their understanding of the environment and scientific concepts. In the 21st-century education era, the integration of digital technology is a key component in the learning process. The focus of education is now directed at the development of four essential skills: creative thinking skills (Sukma, 2020). According to some experts, critical thinking skills are important in science education and the development of a democratic society. Santos (2017) emphasised that understanding the Nature of Science (NOS) contributes to decision-making related to socio-science issues. Demir (2015) mentioned that critical and reflective thinking skills are important for educators to train future generations who are able to see problems from various perspectives.

Through the development of critical thinking, students can identify real-life problems, analyse various relevant information, evaluate alternative solutions, and make the right decisions to solve problems effectively. This ability not only helps them solve academic challenges but also face real-world situations in a logical, creative, and responsible way (Muhfahroyin et al., 2023). In addition, Marques Vieira (2011) emphasised that critical thinking should be integrated into the science curriculum to build citizenship competencies in a plural society. In general, critical thinking in science education plays a role in various processes such as observation, exploration, problem identification, decision-making, argumentation, evaluation, and the construction of reliable knowledge. It is also important to ensure the responsible use of science in society. Hikmat (2022)critical thinking and problem-solving, communication, and collaboration, commonly referred to as the 4Cs (Partono et al., 2021).

Critical thinking skills are one of the important components in science learning, considering the complex characteristics of the material and requiring in-depth analysis In the international context, according to the TIMSS assessment initiated by (Nurcahyani, 2024). *The International Association for the Evaluation of Educational Achievement* (IEA) measures various indicators of critical thinking, such as interpretation, analysis, evaluation, *inference, explanation,* and *self-regulation* (Mullis, 2017). Implementing science learning that integrates critical thinking skills still faces various challenges. PISA data in 2018 shows that the science ability of Indonesian students is ranked 70 out of 78 countries with an average score of 396, far below the international average of 489 (OECD, 2019). This result is emphasised by the achievement of TIMSS 2015, where Indonesia ranks 44th out of 49 countries with an average score of 297, very far below the international average of 500 (Hadi, 2019).

A study conducted by Ramdani (2020) on 156 junior high school students in Jakarta showed that only 23% of students achieved a high level of critical thinking, while 77% of students were still at a low to moderate level. Similar research by Putri (2021) in 107 junior high school students in Mojokerto revealed that students' interpretation ability only reached 43%, analysis ability 52%, evaluation ability 79%, inference ability 40%, explanatory ability 54%, and self-regulation ability 40%. This data shows that most students still have difficulties developing critical thinking skills, especially in science learning. The low critical thinking skills in science learning can be improved by providing local wisdom materials in science learning (Hidayat, 2024). Batik is a form of local wisdom that is also one of Indonesia's distinctive identities in the eyes of the international world. The inclusion of batik in the list of world intangible cultural heritage in 2003 made batik an identity for Indonesia and must be preserved.

Batik is one of Indonesia's most recognised cultural heritages, which has become an important part of the country's social and cultural life ((Lestari, 2021). Batik is not only a patterned cloth but also a symbol of local wisdom that reflects creativity, aesthetic values, and traditions that have existed for a long time. As a form of local wisdom, batik is also one of Indonesia's distinctive identities that is recognised internationally(Puspasari et al., 2019). In 2003, batik received official recognition from the United Nations Educational, Scientific and Cultural Organization (UNESCO) as an Intangible Cultural Heritage. This recognition further strengthens batik's status as a very important cultural symbol for Indonesia and emphasises the need for the preservation and recognition of the tradition worldwide (Selamet, 2018). In this context, batik is not only seen as an art product but also as part of the national identity that reflects the richness of Indonesian culture.

To ensure its preservation, one of the steps that can be taken is to integrate batik into the learning process, especially in Science subjects. This aims to introduce batik to the younger generation in a more applicable and relevant way, for example, through learning that connects the batik-making process and science concepts, such as an understanding of the natural materials used, chemical processes in colouring, or the application of physics principles in manufacturing techniques (Damayanti et al., 2017). In this way, students not only gain knowledge about batik but also understand the importance of cultural preservation from a scientific perspective.

The approach of integrating batik in learning has not been widely applied before due to several main factors. First, there is a lack of awareness of the potential of local wisdom as a relevant and contextual source of learning. Teachers tend to use conventional methods and standard teaching materials that do not accommodate the local cultural context (Safirah & Ningsih, 2024). Second, the limited resources and teaching materials that support this integration are obstacles. Interactive teaching materials that combine science concepts with the process of making batik have not been widely developed, so teachers find it difficult to implement this approach in learning (Nurharini, 2022). Third, there is an assumption that learning based on local wisdom requires additional time and effort in planning and implementation, especially when compared to established teaching models (Hidayat et al., 2024).

The purpose of this research is to determine students' critical thinking skills and to identify the challenges and needs of science learning at the junior high school level that are relevant to the development of students' critical thinking skills. This research also aims to evaluate the effectiveness of learning models, teaching materials, and learning approaches that support the improvement of students' critical thinking skills.

METHODS

Research Design and Data Collection

The research strategy used is qualitative descriptive with a case study research strategy. Qualitative case studies use a descriptive approach to better understand the subjective experiences, perceptions, opinions, and attitudes of individuals or groups toward real-life phenomena (De Rosa et al., 2022).

The data collection was done using the purposive sampling technique. This technique is used because the researcher selects participants based on certain criteria that are relevant to the research objectives (Sugiyono, 2019). The research was conducted in schools in the batik artisan area of Central Java involving 10 science teachers with more than 5 years of experience. The initial selection involves science teachers from batik artisan regions to ensure cultural relevance. Furthermore, teachers from culture-based schools are selected and considered to have more potential in integrating batik elements into learning. Thirty candidates who met the initial criteria were screened again based on teaching experience, and 10 teachers with in-depth understanding and relevant experience were screened to support the research.

Data Collection Instruments

The instrument used in this study is an interview sheet consisting of twenty-two questions divided into six aspects, namely the curriculum in school, science learning materials, teaching material sources, science learning models, science learning approaches, and students' critical thinking skills. To ensure the validity of the test, a review of the grid is carried out to ensure that the test questions reflect the material that must be mastered proportionally.

Validity is based on logical analysis, not on statistical calculations (Ramadhan et al., 2024). Validity in qualitative research is based on the certainty of whether the research results are accurate from the point of view of researchers, participants, or readers in general; the term validity in qualitative research can also be called trustworthiness, authenticity, and credibility (Doyle, 2020). Two learning experts carried out this validation process through a Focus Group Discussion (FGD), which resulted in the conclusion that the instruments used had met good and relevant criteria with research objectives.

Data Analysis Techniques

This study uses a thematic analysis method to analyse qualitative data obtained from interviews in depth. Thematic analysis is one of the ways to analyse data with the aim of identifying patterns or finding themes through data that has been collected by researchers (Heriyanto, 2019). This method was chosen because of its ability to identify, analyse, and report patterns or themes in data (Nurislaminingsih & Heriyanto, 2024).

For the process of thematic analysis, according to Febriandiela (2023), clickClick or tap here to enter text. It begins with understanding the data that has been collected. Researchers read and analyse interview transcripts or recordings in depth to gain an understanding of the phenomenon being studied while taking important notes. Next, the researcher assigns labels (codes) to the relevant data, either descriptively using participant words or interpretively to reveal deeper meanings. Once the codes are grouped, researchers look for key themes that describe the patterns of the phenomenon being studied, check their consistency with the data, and develop these themes to ensure their relevance to the research objectives.

RESULTS & DISCUSSION

Results

Materials that are considered difficult (Understanding the data that has been collected)

The thematic analysis process in this study revealed important findings about the low critical thinking skills of students, especially in understanding some materials. Based on interviews with teachers, students consider materials related to measurements, such as temperature, heat, and expansion, difficult. These difficult materials can be seen in the Figure 1.

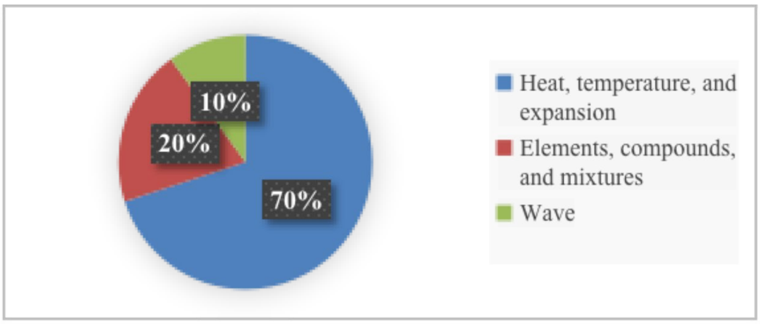

Figure 1. Science material at the junior high school level that is considered difficult by students

In the interview, Teacher 1 stated, *"Students often experience difficulties in calculation materials, such as temperature, heat, and expansion. They have difficulty understanding the basic concepts underlying the calculations, so when faced with critical problems, they often feel confused and do not know where to start."*

This is in line with the opinion of Teacher 2, who stated, *"In materials such as temperature, heat, and expansion, many students only memorise formulas without really* *understanding the application of the formula in the problem. They have trouble connecting concepts to real-life situations, which makes it difficult for them to do math problems."*

Teacher 3 also added, *"Calculation materials such as temperature and expansion are indeed a big challenge for students. They are often unable to visualise the concept in the abstract critically and have difficulty in applying the existing formulas in the context of more complex problems."*

Low Critical Thinking Skills (Labeling, Coding)

In the thematic analysis stage, the researcher provides descriptive and interpretive codes on the relevant data, which are then grouped based on the similarity of meaning. This grouping of codes leads to a major theme that illustrates students' low critical thinking skills in understanding science concepts, especially on more complex materials. The results of interviews with teachers showed that students' critical thinking skills were still low, especially in understanding material related to calculations and abstract concepts, such as temperature, heat, and expansion.

Teacher 4 stated, "*Students' critical thinking skills are still low, especially in temperature, heat, and expansion materials, due to difficulties in understanding basic concepts and relating them to real situations*."

Teacher 5 adds, "*Students often just memorise formulas without understanding their application in complex problems*."

Teacher 6 says, "*Students have difficulty identifying relevant information, especially in materials that require calculations*."

Teacher 7 revealed, "*In addition, students are unable to draw proper conclusions or make logical inferences*." In the explanatory aspect, Teacher 6 emphasised, "Students have difficulty explaining the results with logical reasons." These findings show the need to develop a more effective learning model to improve students' critical thinking skills.

Appropriate Learning Models, Approaches, and Teaching Materials (Main theme search)

The results of the thematic analysis showed that students' critical thinking skills were low, especially in understanding complex science concepts. Difficulties are found in five key indicators of critical thinking skills: identifying, analysing, evaluating, inferring, and explanatory. This highlights the need for more effective learning approaches, such as the use of teaching materials or interactive media and contextual methods. The existing learning model has not sufficiently optimised students' critical thinking skills. Therefore, the evaluation of learning models and the development of more interesting teaching materials are needed to improve student's critical thinking skills, especially in materials that require in-depth analysis and the application of abstract concepts.

The results of the interviews revealed the teachers' view that the source of teaching materials used by students has a significant effect on the understanding of concepts so it can cause difficulties for students in critical thinking. From the analysis carried out, it can be seen that most teachers rely on textbooks as the main source in the teaching process. The source of teaching materials that teachers often use can be seen in the following Figure 2.

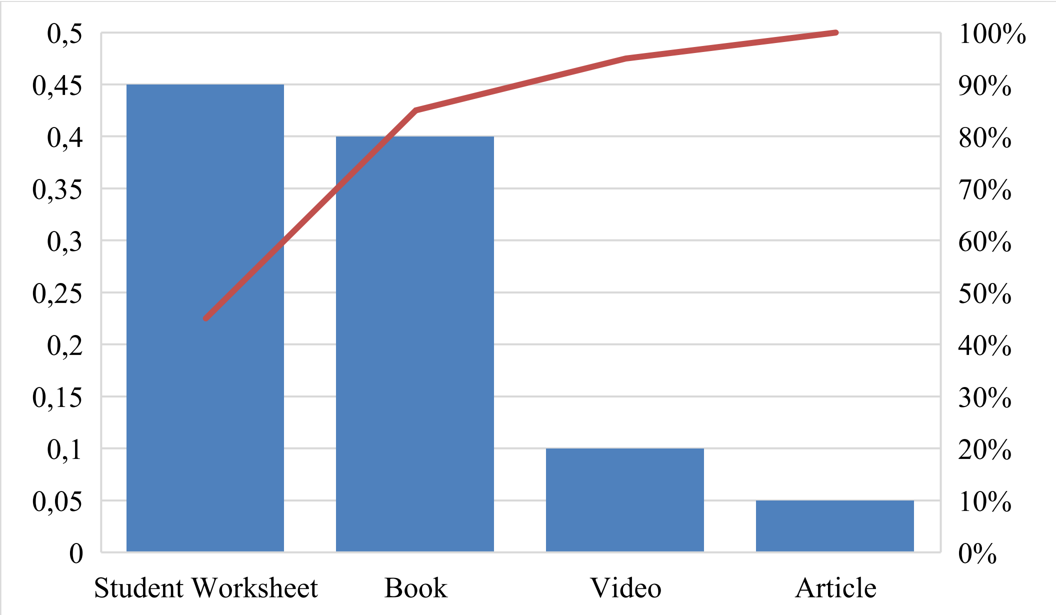

Figure 2. Source of Student Teaching Materials

The results of the interview succeeded in identifying the learning model that is often used in science teaching. The learning models and methods often used by teachers can be seen in the following Figure 3.

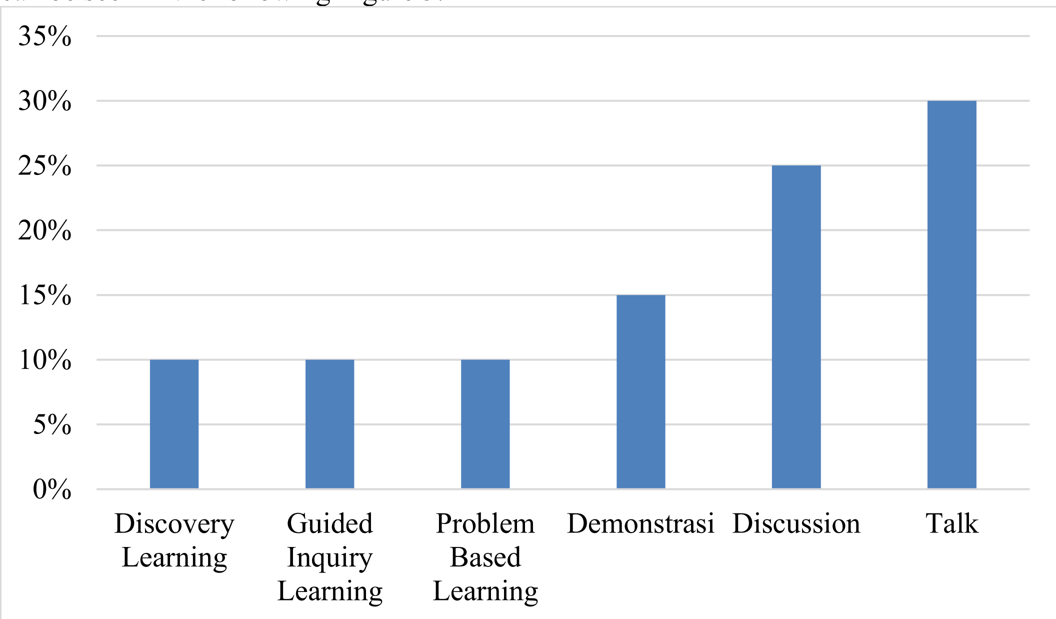

Figure 3. Learning Models and Methods Often Used by Teachers

Discussion

In learning, the ability to think critically is an ability that must be possessed and mastered by students because it aims to enable each student to make decisions and solve problems (conclusions) from various aspects and perspectives (Zuniari et al., 2022). Students' difficulties in understanding temperature, heat, and expansion materials are closely related to the need for critical thinking skills. Temperature, heat, and expansion materials are considered difficult by about 70% of students due to several factors. The concepts of Temperature and Heat have a close relationship with daily life. Understanding the concepts of Temperature and Heat is key to understanding other concepts (Setyaningrum & Polite, 2021). If students have a low mastery of this material, they will face difficulties in understanding more complex material at the next level (Ma'rifah, 2016).

The thematic analysis process in this study revealed important findings about students' low critical thinking skills, especially in understanding some materials. Based on interviews with teachers, materials related to measurement, such as temperature, heat, and expansion, are considered the most difficult by students. As shown in Figure 1, 70% of students had difficulty with these materials, compared to elements, compounds, and mixtures (20%) or waves (10%).

First, these concepts of matter temperature, heat, and expansion involve an understanding of abstract basic principles, such as particle movement and energy change, which are difficult to understand without adequate practical experience, resulting in misconceptions (Iswanto et al., 2022). Second, students often have difficulty making accurate measurements, both with different measuring instruments and in the context of real applications (Winarti et al., 2020). Third, the existence of difficulties in relating theory to practice, for example, in experiments involving changes in temperature or expansion of materials, can lead to confusion (Astari et al., 2022). In addition, many students feel that this material requires good math skills to complete calculations, which can be a challenge for them.

This material has abstract concepts, such as particle movement and energy changes, that require in-depth analysis and evaluation in order to be well understood. Students' difficulties in understanding this material are often due to the abstract nature of concepts such as particle movement and energy change (Susanti, 2021). In addition, the ability to accurately measure and relate theory to practice in experiments is often an obstacle to overcoming these difficulties; critical thinking skills such as identifying problems, analysing relationships between concepts, and evaluating data are essential. However, based on the results of the interviews, many students are still low in these skills, which has an impact on their difficulty understanding the material that requires logical analysis and reasoning (Amalia, 2020).

The interviews identified the learning models that are often used in teaching science. As shown in Figure 3, the lecture learning method dominates with a percentage of 30%. Meanwhile, group discussion was used by only 25%, and demonstration was used by 15%. Other methods, such as simulation and experimentation, are only used by 10% each. This shows that teacher-centred learning approaches, such as lectures, are still more dominant than more interactive or student-centred methods. The Culturally Responsive Teaching (CRT) approach is effective in improving students' critical thinking skills by making learning more relevant and easy to understand through cultural context (Surayya & Patonah, 2024). Research by Lasminawati (2023) shows that CRT improves learning outcomes, student engagement, and the application of concepts in daily life. Safirah and Ningsih (2024) also emphasised that the combination of CRT and higher-order thinking Skills (HOTS) is able to increase critical thinking as well as appreciation for cultural diversity. The integration of local wisdom, such as the batik process, is in accordance with the principles of the regional potential-based curriculum formulated by BSNP. However, the practice of incorporating local materials is still minimal in the school curriculum.

Research conducted by Latip (2024) related to a systematic literature review related to Science in the Community (SciCom) explains that temperature and heat materials are concepts that have much relevance to various daily life activities and naturally develop into the knowledge of local communities so that they can be integrated with local wisdom.

The material on temperature and heat is one of the chapters that is considered dense, where students often have difficulty in converting temperature and doing calculation problems. The selection of this material is able to make students understand the material using formulas in calculation problems, as well as to increase their knowledge. The concept of temperature and heat material is often encountered in daily life so that it can be easier for students to understand (Roenah, 2019). According to Agustin (2018), local wisdom can be integrated with temperature, heat, and expansion materials, namely the process of making batik, such as in barn batik and tofu plants.

The process of making batik is closely related to the concepts of temperature, heat, and expansion, so it has the potential to develop students' critical thinking skills. The relationship between the process of making batik and the concept of science can be seen in Table 1.

Table 1. The relationship between the process of making batik and the concept of science

Stages of Batik Making Process	Relevant Science Concepts	Explanation
Melting the wax	Change in state of matter (melting)	The wax is heated until it melts and used to make patterns on the fabric (Puspasari et al., 2019). 
Fabric dyeing	Heat transfer (convection, conduction)	Heat moves through the water (convection) and the dye bath (conduction) (Wijayaningputri, 2023).
Night removal	Change in the form of substance (melting)	The cloth is boiled so that the malam melts, separates from the cloth, and produces a batik pattern (Regina, 2022). 
Fabric drying	Evaporation	Water evaporates when the cloth is dried in the sun (Warli & Moses, 2022). 

The involvement of these concepts not only stops at theoretical understanding but can also be designed to hone students' critical thinking skills. For example, students may be asked to analyse the challenges of keeping the wax temperature consistent during canning or determine the amount of heat energy required for each stage of the batik-making process. To facilitate the application of Natural Sciences in daily life, it is necessary to improve student's critical thinking skills by practising mastery of a concept by students not only in the form of memorising some concepts that they have learned (Zuniari, 2022). In this case, students are invited to identify problems, gather relevant data, and evaluate arguments about process efficiency. In addition, they can also design alternative solutions, such as more energy-efficient methods for the colouring or dyeing process, before concluding how temperature, heat, and expansion affect the final result of batik making (Warli & Moses, 2022).

Interviews with teachers revealed that students' low critical thinking skills include five main indicators: identifying, analysing, evaluating, making inferences, and explaining. Students' difficulties in understanding complex material, such as temperature, heat, and expansion, are often exacerbated by the limited learning resources available. Based on Figure 2, textbooks are the most widely used source of teaching materials by teachers, with a percentage reaching 40%. On the other hand, video as an interactive learning resource is only used by 10%, while articles have the lowest percentage of use, which is 5%.

The use of learning resources dominated by textbooks provides several advantages, such as the completeness of systematic material. However, this does not support the development of students' critical thinking skills because they tend to be passive. In contrast, interactive learning resources such as videos or LKPD, which are only used 10% to 20%, have great potential to help students understand abstract concepts but are not optimally utilised in the learning process.

One way to improve critical thinking skills and the implementation of local wisdom in the batik-making process is to use appropriate teaching materials, such as e-books. According to Djono (2024), 40% of research is related to digital learning media, and e-books are a tool that supports learning achievement and skills in the 21st century. Its interactive features, such as animation, audio, and question feedback, encourage self-study and better comprehension of the material. Susantini et al. (2021) added that e-books enrich learning through audiovisuals, hyperlinks, and interactive quizzes. Dewi (2023) also mentions that e-books are effective in improving critical thinking skills. The integration of local wisdom in e-books, such as Batik, enriches the learning experience and fosters students' love for local culture (Syafani & Tressyalina, 2023).

Based on Figure 3, it can be seen that the learning model most often used by teachers in teaching science is the talking model, with the largest percentage compared to other models. The talk model has the advantage of conveying material directly so that students can obtain information quickly. However, the disadvantage is that students tend to be passive and only receive information without much involvement in critical thinking skills. Meanwhile, the Problem-Based Learning (PBL), discovery learning, and guided inquiry models were each used with the same percentage of 10%. PBL has the advantage of involving students to solve real problems so as to improve critical thinking skills, but there are several disadvantages; namely, if students do not have the confidence that the problem being studied can be solved, they tend to be reluctant to try (Rakhmawati et al., 2021). In addition, book support is needed to help students understand during the learning process. The Problem-Based Learning (PBL) learning model itself takes a long time to implement, and not all topics in the subject are suitable for using this model (Yulianti & Gunawan, 2019). Guided inquiry guides students to explore concepts but still limits students' freedom to find independent solutions. In addition, this approach requires effective classroom management with complex processes, and teachers must provide appropriate directions so that students do not experience difficulties in finding factual information. In addition, students with higher competence tend to be more actively involved in learning than other students. The application of this model also requires careful planning, longer learning duration, and supporting media that can help the inquiry-based learning process and need to be distributed evenly (Asyarifah et al., 2024).

Compared to other models, discovery learning is a suitable model to be applied in local wisdom-integrated learning. This model allows students to be more active in discovering concepts independently, improving critical thinking skills, and connecting theory with real situations (Salam et al., 2023). However, the disadvantage is that it requires careful preparation from the teacher and requires supporting learning resources. By considering the advantages and disadvantages of each learning model as well as the context of students' low critical thinking skills in understanding science concepts, the discovery learning model is considered the most suitable for improving these skills. This is also supported by the need to present an effective and interesting learning approach.

Strategies to improve students' critical thinking skills can be done by changing the learning process using an interactive approach, both through the use of media and the learning models applied (Apriliana, Handayani, & Awalludin, 2019). The Discovery Learning learning model has proven to be effective in improving students' critical thinking skills. The study by Rahayuningsih (2024) found that out of 230 relevant articles (2017-2022) in Scopus, this model had a major influence on improving students' critical thinking skills with a side effect of more than 0.8. Similar results were supported by Kurniawati, Oktradiksa, and Dewi Shalikhah (2021), a review of 25 journals. They showed that Discovery Learning is often used in 21st-century learning, integrating theory and facts to critique surrounding phenomena. According to Tyas and Hardini (2019), in Discovery Learning, students actively engage in discovering and investigating on their own, thereby improving their accuracy and memory. This model is not only related to discovery but is also capable of developing critical thinking systematically and analytically. Students' curiosity is the main motor, motivating them to understand the material deeply and independently(Selamet, 2018). With a combination of interactive media and an exploration-enabled learning model, Discovery Learning helps students understand difficult material while improving their critical thinking skills.

CONCLUSION

This study reveals the low critical thinking skills of junior high school students in science learning, especially in complex materials such as temperature, heat, and expansion. The abstract nature of the material causes this difficulty, lack of understanding of basic concepts, and less effective conventional learning methods. The integration of local wisdom, such as the process of making batik, can help students understand concepts contextually and interestingly. Interactive e-books featuring videos, animations, and quizzes, as well as learning models such as discovery learning, have the potential to improve students' critical thinking skills by blending theory, practice, and active exploration. This innovation is important to answer the challenges in science learning while improving student competence.

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