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## Comments from the Editor

### **Dr. Eka Budhi Santosa, M.Pd.**

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This version emphasizes the international collaboration and the specific educational levels mentioned in your description.

Editorial: Global Collaboration for Educational Transformation

We are proud to present the second issue of 2025 for the Indonesian Journal of Learning and Instructional Innovation (Vol. 3, No. 02, December 2025). This special edition marks a significant milestone in our publication's history, featuring a series of scientific articles born from a cross-border research collaboration between academics from Australia and Indonesia. By bringing together diverse perspectives and expertise, this issue highlights the power of international partnership in addressing the evolving challenges of the modern classroom. The contributions within this volume focus on the fundamental pillars of educational transformation, specifically examining how technology and innovation can be harnessed to elevate the standards of teaching and learning.

The research presented here spans the critical developmental stages of early childhood, elementary, and secondary education. Each article explores nuanced strategies designed to improve learning quality, ranging from the integration of digital tools to the implementation of novel instructional frameworks. By synthesizing global academic insights with practical, localized applications, this edition provides a comprehensive roadmap for educators and policymakers alike. Collectively, these studies underscore that the future of education lies in the continuous pursuit of innovation and the strengthening of international ties to ensure a more inclusive and effective learning experience for all students.



## Effectiveness of Student Learning Outcomes Through Numbered Head Together Method Theme of Changes in The Appearance of The Earth and Sky

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### ABSTRACT

This research was motivated by the lack of understanding of students in the natural science material in grade IV Cluster II Ahmad Yani, Surakarta City. Out of 150 students, only 32% of students exceeded the minimum completeness criteria; on the other hand, 68% of students still had results that were still less than the minimum completeness criteria. The causative factor is the way teachers teach, which is not varied and tends to be boring. Teachers teach more in conventional ways, so students become fixated and less active during learning. The purpose of the research is to increase student learning outcomes on the numbered head together practice model directly with globe and flashlight media and to find out the process of day and night and to find out whether this model can run well. This research is classified as classroom action research that uses 2 cycles. Cycle 1 will be held on May 6, 2024, and cycle 2 will be held the following month, on June 3, 2024. Based on the results of the research on the numbered head together learning model, the results of the students' study can increase students' understanding of the lesson of changes in the appearance of the earth and sky. This is evidenced by the development of the percentage of student learning completeness starting from the first cycle, where only 32% increased to 79%. So, in cycle 2 completeness has been classically achieved. It can be concluded that the numbered head together learning model and using media can increase students' understanding and improve student learning outcomes on the lesson of changes in the appearance of the earth and sky.

**Keywords:** *Numbered Head Together, learning outcomes, earth and sky apparitions*



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### INTRODUCTION

Challenges in the world of education are increasingly complex with the advent of the Society 5.0 era, which demands educators' readiness to integrate innovative learning methods to improve student competency (Wibawanto et al., 2021). Natural Science learning has obstacles that are often experienced in Natural Science learning, including moderate learning, focusing on the concepts contained in the book and not using an environmental approach to learning. Some educators are maintaining the order in the book without looking at the suitability of the student's environment (Cahyono, 2023). This problem causes inefficient learning, therefore students do not respond to the material provided. So, this kind of learning will result in saturation in students (Karoso & Cahyono, 2024). Pedagogical innovation is the main key in overcoming learning boredom, where teachers must be able to transform conventional teaching

methods to be more dynamic and relevant to current developments (Raziana & Wibawanto, 2025).

In carrying out the learning process, teachers are expected not to use the usual methods, in the sense that in the coming years teaching and learning methods will not improve, educators who always use this monotonous method can cause problems that they do not understand (Hidayati et al., 2024). Therefore, as a teacher, it is mandatory to have a sense of knowing the interests of students, especially when serving and giving a lesson. Therefore, it is very necessary for a teacher to vary his teaching methods. Which is more suitable for providing material in such a way that the teaching and learning outcomes are successful to the maximum (Herwiyanti et al., 2019). In addition to methods, the use of appropriate learning media is crucial to support the effectiveness of material delivery, especially during the adaptation period to new habits that require flexible learning methods (Wibawanto & Roemintoyo, 2020).

The Numbered Head Together (NHT) learning model is a collaborative learning model that can increase student interest and involvement in learning. This model allows each student to be responsible for their group's understanding, which has been shown to improve engagement and academic achievement across various subjects (Prakoso & Radia, 2019; Fauziah, 2019; Iskatiana, 2017). The NHT model has proven effective in improving students' cognitive and social skills at various levels of education, from early childhood to secondary school. The use of this strategy also significantly improves students' science process skills, such as observation and prediction, which are highly relevant in science learning (Mahmudah & Rasyid, 2022; Palupi et al., 2022; Wiratman & Putri, 2023).

Before using the numbered head together Students often experience a lack of understanding in the learning process, so that teachers often repeat the material in general still using conventional methods and media which the reason is that teachers use conventional methods is the first is easy does not require preparation but it tends to be monotonous and boring so that students do not get meaningful learning so that the material taught by students is easily forgotten (Novibriawan et al., 2021).

Poor learning outcomes are often triggered by students' boredom with monotonous lecture methods, especially in subjects considered difficult, such as mathematics and language arts. Studies show that integrating NHT with other learning models, such as problem-solving or discovery learning, can be a solution to increase student engagement (Aditya et al., 2022; Setyaningsih & Utami, 2021; Suradi & Aliyyah, 2023; Wahyuni & Abidin, 2024). This condition requires the role of teachers to determine the direction of learning that is not boring for students in order to attract students' interest in learning, if there is no change, there will be a problem, namely low student interest in learning, not only that, if low interest in learning will affect student learning outcomes, as for the Teacher Working Group II Ahmad Yani Surakarta the students have an increase in student cognition, which is in the natural science class IV (Wijayanti et al., 2017).

However, in the improvement itself, there are several things that are questioned about the method used with this fact, researchers are interested in conducting research in Cluster II Ahmad Yani Surakarta With the above problem, the author raised the title of the article titled: "The Effectiveness of Student Learning Outcomes Through the Numbered Head Together Method of Changing the Theme of Changes in the Appearance of the Earth and Sky".

## **METHODS**

The research method of this article uses the research method Classroom Action Research by type of research field research. The class taken in the observation was class IV in the Ahmad Yani Group II Teacher Working Group with a total of 63 male students and 87 female students. The form of research is Classroom Action Research. Classroom action research is a caustic-based and context-based observation of conditions, circumstances and situations in the classroom that

are carried out to overcome problems that occur in order to improve the quality of learning in the classroom (Meesuk et al., 2020).

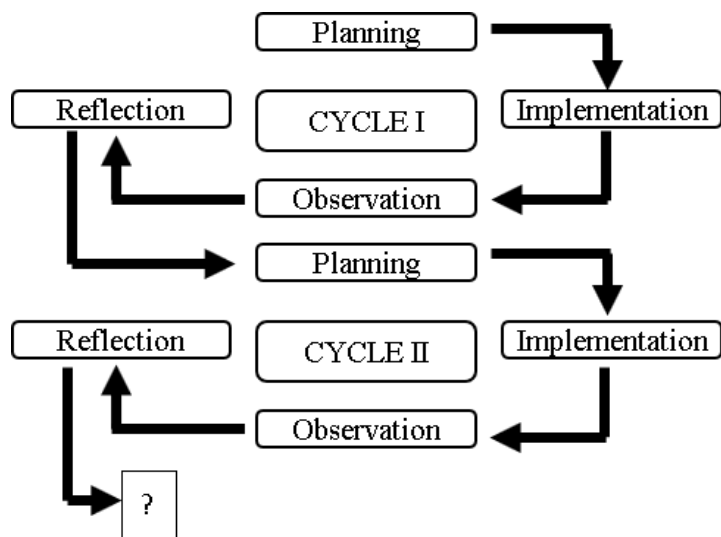


Figure 1. Action Cycle based on Kemmis and Mc Taggart

The explanation of the flow above is:

#### **Pre-Cycle**

In this activity, observations were made in grade IV of elementary school in Cluster II Ahmad Yani Surakarta in the even semester of the 2023/2024 school year, a number of 150 students with 63 male students and 87 female students.

At the beginning of the research, the researcher takes care of licensing at the intended school and obtains permission from the school, the researcher conducts research to identify problems and research learning activities in the classroom, the state and atmosphere of the school. In carrying out observations and researchers, they also conducted interviews with several students, students and teachers until the results obtained were close to the same conditions. The purpose of holding this interview is to unite information about teaching and learning activities that have occurred so far.

#### **Cycle I**

##### **Planning**

Planning is the improvement of the concept of action that is essential to advance what is happening. Planning is made based on real initial observations, therefore the researcher obtained an overview of the existing difficulties. The activities carried out towards the planning stage are as follows:

1. Forming a learning improvement plan for the material on changes in the appearance of the earth and even sky with learning aids.
2. Forming an agenda for the implementation of actions, the implementation of learning improvements in accordance with the content of the learning scenario to be implemented.
3. Forming research instruments that are to be carried out by peers on the application of actions. Namely group tasks and individual tasks.
4. Forming test instruments in accordance with the material and learning benefits.
5. Formulate answers for group work assignments and individual tasks.
6. The RPP and the agenda for the implementation of the actions that have been prepared,

submitted to the principal will apply for approval, as well as the approval of the implementation of the action, and require guidance and direction on the implementation of the action.

7. Prepare an observation sheet in the form of an observation sheet of students and educators along with documentation during the activity.

### *Implementation*

The purpose of the implementation of the action is the implementation of learning activities that have been determined in the learning implementation plan for the subject of Natural Sciences, learning Changes in the Appearance of the Earth and the sky. Natural Science learning in the first cycle is carried out once in accordance with the material that has been determined. In cycle 1, the provision of material is just invited to read and see pictures that are already in the book, students are invited to learn by looking at pictures, so that students in getting lessons understand better as focusing on an image in the book.

### *Observation*

Observation is carried out by observers during the learning method, observing the implementation of learning, observation is carried out by colleagues to research teacher activities and research student activities, then the researcher processes data from the observation sheet filled in by the observer.

### *Reflection*

The reflection of the results of the combined data is then discussed with researchers and colleagues to understand the success of the implementation of actions in cycle I, when there are shortcomings, improvements are carried out to cycle II.

## **Cycle II**

### *Planning*

The activities carried out at this stage are to prepare for learning improvements based on the reflection of Cycle I by implementing the following steps:

1. Prepare a plan for the implementation of improvement learning, improvement observation data, discussion data and improvement evaluation tools.
2. Coordination with colleagues who serve as observers in the process of implementing numbered head together type cooperatives.

### *Implementation*

The purpose of the implementation of the action for cycle II is the application of learning activities that have been prepared related to the learning implementation plan (lesson plan using image media and observing and trying and practicing the causes of changes in the earth and moon with simple props (globes, flashlights and balloons) that are easy to get and are available at school.

### *Observation*

Observation is carried out for observers during learning activities, observing the application of numbered head together cooperative learning, observation is carried out by peers, then the researcher edits the data on the observation sheet that has been filled out by the observer and the results presented have improved compared to the previous cycle.

### *Reflection*

The results obtained from the results of observation and student learning are collected and analyzed, so from the results, the researcher can reflect on the results of the observation whether the activities carried out have improved the quality of the learning process and the learning achievement of students.

### **Data Analysis Techniques**

The technique used in data collection is by looking for sources and constructed from interviews and observations. The interview is a method of collecting data, namely conducting an interview or face-to-face question and answer orally between the questioner and the respondent in order to get the information needed in the research, while the observation technique is a method of data collection that is carried out systematically and is carried out deliberately by observing and recording the phenomenon being researched, observation and interviews are used to collect data in a structured manner. The use of interviews and observations is considered sufficient to dig up information data. The method in this article uses descriptive analysis. Then the data obtained in the form of observation interview results are analyzed critically and in-depth in order to support proportions and ideas

In processing the data of the writer Using the Triangulation method, this method is a data collection technique that has the property of combining data collection techniques and existing data sources. And also, the researcher collects data by the triangulation method, so the researcher collects data that at the same time tests the credibility of the data, namely checking the credibility of the data with various data collection techniques and various data sources

The data obtained was processed so that it was able to answer the formulation of the problem and the purpose of the article Effectiveness of Student Learning Outcomes Through the Numbered Head Together Method Theme Changes in the Appearance of the Earth and Sky.

## **RESULTS AND DISCUSSION**

### *Results*

#### **Pre-Cycle**

The researcher conducted observations for 2 days in Cluster II Ahmad Yani Surakarta. With the number of students in each grade IV as many as 150 students consisting of 63 male students and 87 female students. The homeroom teacher of grade IV plays a role in educating students to understand the numbered head together method. Some grade IV students still have problems in learning activities. Likewise, the average learning outcome is still low, which is 64, classical graduation is only 50%. This is because educators provide material delivery very quickly, have not used teaching aids, therefore students have not listened or passively and teachers do not share time or opportunities with students to ask, so that the time to complete the assignment the results obtained are still below the minimum completeness criteria.

#### **Cycle I**

Cycle 1 learning will be held on May 5, 2024. The stages of implementation are in accordance with the stages in the numbered head together model. At the planning stage, the activities carried out prepare the concept of cycle 1 learning, educators convey perceptions and motivations, and goals for learning related to the material to be discussed so that students are ready to take the material and have a very strong sense of curiosity about the lessons to be examined. The preliminary activity was followed by core activities. In the implementation of cycle 1, there was a development of student learning outcomes, although not all students were complete in learning. As in the figure 2.

### Cycle II

Cycle 2 learning will be carried out on June 3, 2024. The stages of implementation are in accordance with the stages in the numbered head together model. Planning The researcher has prepared a learning improvement plan 2 which is a revision in cycle 1 learning. The instrument that has been prepared is in the form of a learning improvement plan II. Researchers have also provided learning improvement media as well as compiled improvement worksheets for students and made improvement evaluation tools. In the implementation of cycle 2, there was an increase in student learning outcomes compared to cycle 1 as shown in the figure below.

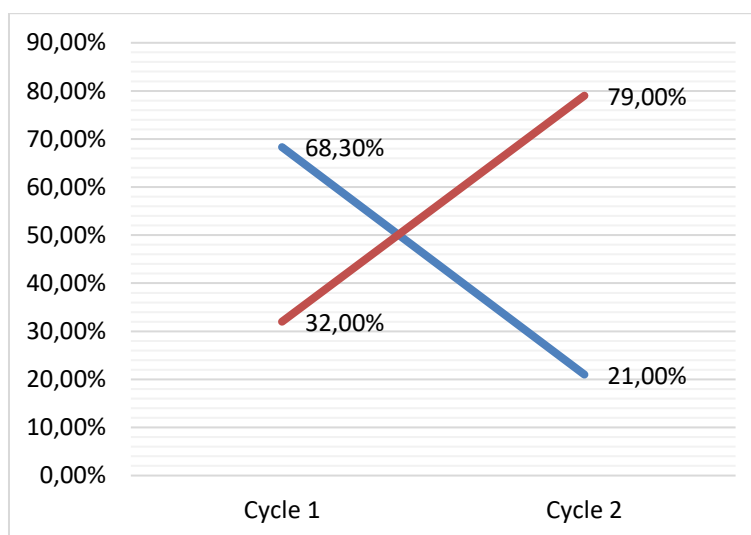


Figure 2. Comparison of Student Learning Completeness from cycle 1 to cycle 2

Based on figure 3 of the diagram above, cycle 2 students who completed the percentage of 79% of 16 students, experienced an increase in learning outcomes from cycle 1 to cycle 2, while those who did not complete the percentage were 21% and the score was still below the minimum completeness criteria. So that the explanation above can be concluded for the average student from the percentage of completeness of each cycle, the percentage of completeness of student learning outcomes has increased from cycle 1 by 47%.

### Discussion

Based on figure 3, it can be concluded that the learning outcomes of natural sciences students have increased from cycle I to cycle 2, this shows that the form of numbered head together learning can improve the learning outcomes of natural science students in grade IV in Cluster II Ahmad Yani Surakarta. The average learning result of students in the first cycle was 32%, including in the very low category. In this second cycle, the average result of learning natural sciences of students who have met the requirements for successful observation has increased by 47% because the results of students who complete above the minimum completeness criteria are 135 students (90%) of the total number of students. The significant increase in learning outcomes in Cycle II proves that the use of visual media and simple teaching aids can help students understand abstract concepts in science, in line with the findings that interactive multimedia and simulations are able to stimulate students' interest and active involvement (Wibawanto et al., 2022). In cycle 2, classical completeness is achieved. This achievement is because in teaching, educators use numbered head together learning well. The success of implementing the NHT method also depends heavily on the teacher's ability to manage learning media systematically, thereby creating a structured yet participatory learning environment (Roemintoyo & Wibawanto, 2023). The results of this study align with findings in

other fields of study, where the application of NHT successfully increased classical mastery to 100% on material considered complex. Not only does this model improve learning outcomes, it has also consistently been shown to increase students' self-confidence, vocabulary mastery, and ability to express ideas (Fatmawati et al., 2023; Kusuma et al., 2025; Mahmudah & Rasyid, 2022).

From the results of this observation, it is determined that the form of numbered head together learning has a positive impact on improving student learning outcomes. Students are more free to convey ideas and opinions together with their peers so that their difficulties quickly find a way out. The application of the numbered head together form of learning makes it easier for teachers to teach natural science lessons, especially learning about changes in the appearance of the earth and sky, the equal distribution of material abilities can be achieved in such a short time, can train students to be more active when trying, Speaking and arguing, students who are not good at solving problems can be helped to solve problems so that they can improve learning outcomes in students, students are positively dependent on each other, provide opportunities for students to cooperate with other groups, students fill in among each other.

The effectiveness of NHT in improving learning achievement has also been validated in various other disciplines, including accounting, colloidal chemistry, and reading comprehension in English. Integration with the Flipped Classroom environment has even significantly improved student self-efficacy (Afriyeni, 2020; Meiryani et al., 2021; Melati & Hadinugrahaningsih, 2024). For future development, learning about earth and sky phenomena can also be integrated with Augmented Reality (AR) technology or simulation-based interactive multimedia to provide a more realistic visual experience for students (Wibawanto & Maulana, 2025). Various other comparative and experimental studies confirm that NHT is superior to predictive and traditional learning techniques in improving students' conceptual understanding and learning outcomes in both primary and secondary schools (Agustina et al., 2020; Fauzi et al., 2019; Rambe et al., 2023).

## **CONCLUSION**

According to the results of the research and discussion, it can be concluded that the numbered head together learning method can increase the motivation and learning outcomes of natural sciences in grade IV at the Elementary School in Cluster II Ahmad Yani Surakarta. By applying the numbered head together cooperative learning method, children's absorption of material changes in the appearance of the earth and sky has increased. It can be proven that there was an increase in student learning outcomes which was initially in cycle 1 32%, then increased in cycle II by 79%.

Based on the conclusion above, the following suggestions can be formulated:

1. It is better for elementary school teachers to use a variety of learning methods. For educators who teach natural science lessons, it would be good to always have creativity by using the learning plan given to students; Also try for teachers to pay more attention to students.
2. For students: As a student, it would be nice to be more active and diligent in learning, including in following the learning process in the form of small study groups because it can improve the quality of student learning.
3. For institutions: Facilitate proper facilities and infrastructure to support teaching and learning activities in schools.

## **CONFLICT OF INTEREST**

No conflict of interest for this study.

## REFERENCES

- Aditya, B. R., Jannah, F., & Nurhas, I. (2022). Problem-based numbered head together learning approach for a successful teaching strategy. *JINoP (Jurnal Inovasi Pembelajaran)*, 8(1). <https://doi.org/10.22219/jinop.v8i1.20861>
- Afriyeni, Y. (2020). Improving Students' Reading Comprehension by Using Numbered Head Together (NHT) Strategy in SD IT Fadilah Pekanbaru. *Journal of English Language Education*, 5(1), 36–48. <https://doi.org/10.31004/jele.v5i1.54>
- Agustina, R., Setiadi, A., & Fitriani, A. (2020). Pengaruh model pembelajaran kooperatif tipe Numbered Head Together (NHT) terhadap hasil belajar IPA ditinjau dari keterampilan proses sains. *Schrodinger Jurnal Ilmiah Mahasiswa Pendidikan Fisika*, 1(1), 9–20. <https://doi.org/10.30998/sch.v1i1.3068>
- Cahyono, B. (2023). Implementasi Pemanfaatan Metode Index Card Match Untuk Mengukur Kemampuan Hasil Belajar Siswa Sekolah Dasar. *Indonesian Journal of Learning and Instructional Innovation*, 1(02), 34–40. <https://doi.org/10.20961/ijolii.v1i02.1030>
- Fatmawati, U., Usman, M. R., & Satriani, S. (2023). Komparasi Kualitas Pembelajaran Matematika Melalui Penerapan Tipe NHT dan Tipe STAD. *JURNAL MathEdu (Mathematic Education Journal)*, 6(1), 83–95. <https://doi.org/10.37081/mathedu.v6i1.4835>
- Fauzi, A., Adyagarini, G., Imani, M. K., Yanti, T. S., Vadhila, U., & Hadi, S. (2019). The Use of Numbered Heads Together to Improve The 10th Grade Students' Reading Comprehension Achievement at MAN 2 Lamongan. *Indonesian Journal of English Teaching*, 9(1), 118–123. <https://doi.org/10.15642/ijet2.2020.9.1.118-123>
- Fauziah, R. (2019). The effect of Cooperative Learning Model Numbered Heads Together (NHT) type on student learning outcomes in social sciences subjects in Grade V Elementary school. *International Journal of Educational Dynamics*, 1(1), 147–154. <https://doi.org/10.24036/ijeds.v1i1.47>
- Herwiyanti, R. D., Pd, S., Subroto, H. W. T., Pd, M., Suprijono, H. A., & Si, M. (2019). Implementation of Cooperative Learning Model in Numbered Heads Together for Improving 4 th Grade Students Learning Achievement on Social Science. *Journal of Research & Method in Education*, 9(1), 21–25. <https://doi.org/10.9790/7388-0901022125>
- Hidayati, K., Tamrin, A. G., & Cahyono, B. T. (2024). Efektivitas penggunaan platform merdeka mengajar untuk peningkatan kompetensi guru pada kurikulum merdeka. *Edukatif: Jurnal Ilmu Pendidikan*, 6(1), 232–240. <https://doi.org/10.31004/edukatif.v6i1.5765>
- Iskatiana, E. (2017). Pengaruh Strategi Pembelajaran Problem Based Learning dan Kooperatif Tipe Number Head Together (NHT) terhadap Hasil Belajar Matematika pada Siswa Kelas V di SD Bangunharjo. *TRIHAYU: Jurnal Pendidikan Ke-SD-an*, 4(1). <https://doi.org/10.30738/trihayu.v4i1.2123>
- Karoso, S., & Cahyono, B. T. (2024). Edukatif: Jurnal Ilmu Pendidikan Strategi Kepala Sekolah dalam Meningkatkan Motivasi Guru. *Jurnal Ilmu Pendidikan*, 6(3), 2421–2428. <https://doi.org/10.31004/edukatif.v6i3.6805>
- Kusuma, D. D., P, L. R. D., & Agustina, E. (2025). Students' Perceptions of Using Numbered Head Together (NHT) Learning Model to Improve Students' Speaking Achievements. *ELTR Journal*, 9(2), 156–167. <https://doi.org/10.37147/eltr.v9i2.197>
- Mahmudah, H., & Rasyid, F. (2022). Engaging Students in Cooperative Learning Model of Reading Course Through Numbered Head Together. *ETERNAL (English Teaching Journal)*, 13(1), 55–69. <https://doi.org/10.26877/eternal.v13i1.10339>
- Meesuk, P., Sramoon, B., & Wongrugsu, A. (2020). Classroom Action Research-based Instruction: The Sustainable Teacher Professional Development Strategy. *Journal of Teacher Education for Sustainability*, 22(1), 98–110. <https://doi.org/10.2478/jtes-2020-0008>
- Meiryani, N., Chang, A., Zudana, A. E., & Daud, Z. M. (2021). Implementation of Numbered Head Together learning Model for improve learning achievement. *2021 IEEE International*

- Conference on Electronic Technology, Communication and Information (ICETCI)*, 362–365. <https://doi.org/10.1109/icetci53161.2021.9563511>
- Melati, M., & Hadinugrahaningsih, T. (2024). The effect of Numbered Head Together (NHT) in a flipped classroom environment on students' Self-Efficacy and achievement on colloid topics. *Journal of Research in Education and Pedagogy.*, 1(1), 24–29. <https://doi.org/10.70232/c99bex94>
- Novibriawan, F., Nurhasanah, N., & Karma, I. N. (2021). the Effect of Numbered Heads Together (Nht) Learning Methods on Communication Skills of Students in Class Iv Elementary School. *Progres Pendidikan*, 2(3), 129–133. <https://doi.org/10.29303/prospek.v2i3.164>
- Palupi, D. I., Rahmani, E., Yusnita, E., Pertiwi, H., Gustina, H., & Priyanti, N. (2022). Mengenal model kooperatif Numbered Head Together (NHT) untuk pembelajaran anak usia dini. *EDUKASIA Jurnal Pendidikan Dan Pembelajaran*, 4(1), 21–28. <https://doi.org/10.62775/edukasia.v4i1.89>
- Prakoso, B., & Radia, E. H. (2019). Implementation of numbered head together model to increase students' activeness and learning output in primary schools. *Jurnal Pendidikan Dan Pengajaran*, 52(2), 81–86. <https://doi.org/10.23887/jpp.v52i2.18258>
- Rambe, N., Pricilia, G. M., & Nasution, S. R. A. (2023). Peningkatan Hasil Belajar Menggunakan Model NHT (Numbered Head Together) Pada Tema 7 Subtema 1 Keragaman Suku Bangsa dan Agama di Negeriku Bagi Siswa Kelas IV SD Negeri 100308 Panompuan. *JURNAL JIPDAS (JURNAL ILMIAH PENDIDIKAN DASAR)*, 3(2), 328–338. <https://doi.org/10.37081/jipdas.v3i2.542>
- Raziana, E., & Wibawanto, H. (2025). Pedagogical Innovation of Game-Based Learning for 21st Century Skills in Vocational Education: A Systematic Literature review. *Indonesian Journal of Learning and Instructional Innovation*, 3(1), 19–30. <https://doi.org/10.20961/ijolii.v3i1.2494>
- Roemintoyo, N., & Wibawanto, H. (2023). Management and use of multimedia as an ICT-Based learning media to improve the skills of vocational school students. *Journal of Humanities and Social Sciences Studies*, 5(2), 01–10. <https://doi.org/10.32996/jhsss.2023.5.2.1>
- Setyaningsih, N., & Utami, D. P. (2021). The implementation of the discovery model based on numbered head together reviewed from students' cognitive style in mathematics learning. *Journal of Physics Conference Series*, 1722(1), 012109. <https://doi.org/10.1088/1742-6596/1722/1/012109>
- Suradi, F. M., & Aliyyah, R. R. (2023). Peningkatan Hasil Belajar Matematika Melalui Model Pembelajaran Numbered Head Together (NHT) di Sekolah Dasar. *Jurnal Pengajaran Sekolah Dasar*, 2(1), 113–124. <https://doi.org/10.56855/jpsd.v2i1.351>
- Wahyuni, S., & Abidin, M. (2024). Effectiveness Numbered Head Together type Cooperative learning Model to improve Arabic language learning outcomes. *Mantiqu Tayr Journal of Arabic Language*, 4(2), 534–550. <https://doi.org/10.25217/mantiquatayr.v4i2.4664>
- Wibawanto, H., & Maulana, I. (2025). Utilization of augmented reality in facilitating geography learning to improve spatial ability of junior high school students. *Journal on Smart Learning Technologies*, 1(1), 57–66. <https://journal.unesa.ac.id/index.php/jslt/article/view/43569>
- Wibawanto, H., & Roemintoyo, N. (2020). The Learning Method of Society 5.0 during new normal in Indonesia. *Proceedings of the 4th International Conference on Learning Innovation and Quality Education*, 1–6. <https://doi.org/10.1145/3452144.3452196>
- Wibawanto, H., Roemintoyo, R., & Rejekiningsih, T. (2021). Indonesian Vocational High School Readiness Toward Society 5.0. *Journal of Education Research and Evaluation*, 5(1), 24. <https://doi.org/10.23887/jere.v5i1.31567>
- Wibawanto, H., Roemintoyo, R., & Rejekiningsih, T. (2022). Simulation-based interactive multimedia to improve vocational students' learning outcomes. *World Journal on Educational Technology Current Issues*, 14(6), 1927–1942. <https://doi.org/10.18844/wjet.v14i6.8363>
- Wijayanti, N. W., Roemintoyo, R., & Murwaningsih, T. (2017). The Impact of Numbered Heads Together Model on the Learning Outcomes of Science Viewed from Students' Self

Regulated Learning. *Journal of Education and Learning (EduLearn)*, 11(3), 257–261.  
<https://doi.org/10.11591/edulearn.v11i3.5838>

Wiratman, A., & Putri. (2023). Transformasi keterampilan proses sains melalui kooperatif numbered Head Together. *Didaktika: Jurnal Kependidikan*, 12(4), 1041–1050.  
<https://doi.org/10.58230/27454312.257>

## Unveiling the Creative Teacher’s Secret: A Systematic Review of Learning Variations for Active Classrooms

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### ABSTRACT

The changing times require teachers to be more creative in creating learning that is not monotonous in order to increase student motivation and participation. This research aims to explain the meaning of learning variation and its role in building an active and interesting classroom atmosphere, identify variation skills such as teaching style, media, and interaction, and analyze the principles of their use. This research uses a qualitative approach with a library research method, where data is collected through document analysis from relevant books and journals. This research synthesizes contemporary pedagogical innovations, including AI integration and play-based strategies, to provide a comprehensive framework for creative teaching in the post-pandemic era. The results show that learning variations have a significant influence in overcoming learning boredom, improving understanding, and adjusting the learning process to students' diverse learning styles. Teachers who are able to creatively combine methods, media, and interactions prove more successful in creating a dynamic and meaningful learning atmosphere. In conclusion, learning variation is not only a teaching strategy, but also the key to creating a classroom that is inclusive, adaptive and supports the development of 21st century skills in students.

**Keywords:** *creative teacher, learning motivation, student engagement, teaching strategy, variation of learning*



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### INTRODUCTION

The changing times require teachers to be more creative in creating learning that is not monotonous, especially with the significant impact of artificial intelligence (AI) technology on modern classroom instruction (Starko, 2021; Steele & Whitaker, 2019). While creativity is increasingly emphasized in global curricula, the journey to systematically support its promotion in the classroom remains a complex challenge (Anderson et al., 2021; Patston et al., 2021; Zielińska et al., 2024). Teachers are required to create learning experiences that excite and actively involve students. Creativity in a variety of methods, media and interactions is the key to bringing the classroom to life. Varied learning activities build motivation, a sense of being valued, and encourage critical thinking skills and cooperation. Educators need to innovate, read classroom dynamics, and dare to try new approaches. By optimizing existing potential, the learning atmosphere becomes more enjoyable and meaningful. Through variety, students more easily understand the material, develop skills, and find their own learning style. The classroom

turns into an inclusive and empowering space where ideas grow and flourish (Julrissani et al., 2020). Creativity in education is not merely a teaching technique but an organic philosophy that must be nurtured to allow students' intuition and academic potential to flourish (Piirto, 2021).

In many parts of the world, the challenge of maintaining student interest in learning is increasingly evident. Data from the UNESCO Institute for Statistics (2024) recorded a 12% decline in active student participation in developing countries in the last five years. This condition shows that the monotonous conventional approach is not able to accommodate the needs of today's students.

The rigid learning atmosphere often makes students feel bored and uninterested. The results of the OECD study (2023) found that 47% of students who were not actively involved in learning had lower academic achievement compared to those who actively participated. This situation is a serious concern for the world of education that is oriented towards developing student potential (li & Belajar, 2021). Therefore, self-belief and professional teacher development are the main foundations in integrating creativity organically in the classroom (Akbar, 2021; Vorontsov & Vorontsova, 2015).

Variations in learning methods are developing as a strategic step to bring about changes in classroom dynamics. A teacher who is able to combine various techniques, media and approaches will find it easier to build a dynamic and fun learning atmosphere (Liu et al., 2024; Zhao et al., 2017). Through creative combinations, the learning process can be aligned with the diverse characteristics and individual needs of students. This opens up opportunities for a more in-depth, personalized, and lasting learning experience. Technology integration is also a form of variation that has a real impact on the learning atmosphere.

Creative teachers always try to explore a variety of approaches to arouse students' enthusiasm for learning. Project-based approaches, educational games, experiments, and the application of gamification elements are part of a series of strategies to bring a more lively, interactive and memorable classroom atmosphere. Each method applied provides its own color in the learning process, encourages active student involvement, and fosters curiosity that continues to grow (Rahma et al., 2024). An adaptive and inclusive learning environment also affects student development, A classroom atmosphere that respects various learning styles encourages wider involvement from all students.

Efforts to create variety in learning cannot be separated from the need for teachers to continue to develop themselves. Participating in training, workshops and sharing good practices among teachers are ways to enrich insights and skills in managing an active and creative classroom.

Through the application of learning variations, teachers not only create enjoyable learning experiences, but also foster 21st century skills in students, such as critical thinking, communication and collaboration. Teacher creativity is key in shaping a classroom atmosphere that supports students' intellectual and emotional growth amidst the challenges of the times.

Based on the above background, this study aims to explain the meaning of variation in teaching and learning and its role in creating an active and interesting classroom atmosphere, describe aspects of skills in making variations including variations in teaching styles, variations in teaching media and materials, and variations in interaction, analyze variations in learning activities through the use of diverse methods and providing examples and illustrations that support student learning motivation, describe the purpose and benefits of learning variations in building a dynamic learning environment and encouraging the development of critical thinking skills and collaboration, and examine the principles of using variations in learning activities so that teachers can choose and apply approaches that are in accordance with the characteristics and needs of students.

## METHODS

This study employs a qualitative approach with a systematic library research method. Qualitative research is an assessment that presents data in descriptive form such as written words, writings, and even the behavior of the individuals studied (Sundari et al., 2024). This type of research falls into the category of *library research*, where the main sources are books and various literature relevant to the topic of discussion. The data that researchers get comes from non-human sources. Non-human data sources are obtained from analyzing documents related to the material discussed in this article, such as: books and journals. The collection procedure is done by document analysis. Document analysis is carried out by studying book literature and journal articles related to the material discussed in this article.

To ensure the validity of the findings, a systematic selection process was implemented based on specific inclusion and exclusion criteria. The inclusion criteria involved: (1) peer-reviewed articles published within the last five to ten years (2014–2024) to ensure contemporary relevance; (2) studies focusing on K-12 or higher education settings; and (3) research specifically discussing teaching variations, classroom engagement, or creative pedagogy. The exclusion criteria removed documents that did not provide full-text access, non-English or non-Indonesian languages, and articles that lacked empirical or theoretical depth regarding classroom interactions.

## RESULTS AND DISCUSSION

### *Definition of variation in teaching and learning*

Changes that teachers make to learning activities to overcome student boredom and increase student engagement and attention during the learning process are known as variations in teaching and learning. To create a dynamic, interesting and effective learning atmosphere, teachers must master these basic skills in teaching.

Educators' skills to make variations are needed to attract students' attention and motivation in the learning process and to reduce the boredom and saturation felt by students when receiving material delivered by the teacher. Variation is also intended to apply differences that are made consciously to create different learning experiences (Trisnawati Trisnawati & Diena San Fauziya, 2024). Variation in the learning process aims to eliminate boredom and increase students' motivation and curiosity and encourage their active involvement in learning. The application of variation in the learning process is also able to strengthen the active participation of students.

This variation strategy makes it possible to achieve the set learning objectives. Students' enthusiasm for the subject is an important component that determines learning success. One way to increase interest in learning is to use various techniques and make adjustments to the content and characteristics of learning media (Anggrayani et al., 2023).

The use of teaching materials and educational media is very important for the success of the teaching and learning process in the classroom. Learning media are tools used and assist in the learning process, increasing the importance of the contact and communication process. One variation of learning media is the use of various forms of media to present subject matter. Learning media are usually divided into three categories: visual, audio, and audio-visual.

### *Aspects of developing variety skills in the teaching and learning process*

Variations in teaching style, use of learning tools, forms of interaction, and learning activities. organize variations in the learning process. This variation aims to prevent boredom, optimize students' interest in learning and create a more effective and supportive learning atmosphere. Teachers need to change voice intonation, body position, and combine lecture, discussion, and practice methods to keep learning dynamic. In addition, the use of media such

as pictures, videos, or props also plays a role in deepening students' understanding of the learning content taught.

1. Variety of teaching styles

Teaching style variation is a technique used by teachers or educators to deliver material to students in different ways so that the learning process becomes more effective and interesting (Yunus, 2022). Every teacher who is active in learning must have the ability to apply various learning approaches. In the learning process, teachers often carry out activities or routines such as entering the classroom, directing students, delivering subject matter, and then giving homework.

A change in the learning process is to apply many learning variations to achieve learning objectives. Students often feel bored and unfocused when learning, even though they have plenty of time. The role of teachers in implementing effective education, which is different, is to create a learning atmosphere that is able to arouse the interest of learners. Teachers can do this by creating learning approaches that encourage active interaction and create positive and enjoyable learning experiences (Peters & Heraud, 2019; Piirto, 2021; Subhan & Ningsih, 2024).

2. Variety of teaching media and materials

Learning media and teaching materials are two components in education that help teachers deliver lessons to students. Learning media can be visual, audio, or a combination of both that function as a means of transferring information or presenting teaching materials to students. Meanwhile, teaching materials refer to a collection of materials that are systematically designed to facilitate the learning process of both educators and students.

Types of Learning Resources: Print learning resources such as textbooks, modules, handouts, and student worksheets. The most common and most accessible form. Visual teaching materials, such as pictures, graphs, maps and diagrams, which provide more detailed explanations. Audiovisual teaching materials, such as learning videos or educational animations. Digital/interactive teaching materials, such as learning apps, e-modules and e-learning platforms.

Types of Learning Media: Different types of media are used in learning to match the different learning styles of students, such as visual, auditory, and kinesthetic. Some types of learning media are as follows: Visual media: whiteboards, drawings, photographs, or PowerPoint slides; Audio media: songs, stories, or recorded dialogs that help learning to hear; and Audiovisual media: learning videos or documentaries. Interactive Media: computers, learning apps and simulations that allow students to learn actively.

Benefits of Variation in Media and Teaching Materials: There are many benefits of using a variety of media and teaching materials. Attracts students' attention: Interesting media can prevent students from getting bored and keep them focused. Improves understanding: Explaining difficult topics becomes easier to understand with the help of certain visual or audio tools. Supports a variety of individual learning styles: Every student has unique learning characteristics. A variety of media can cater to this need. Encourage independent learning: Students can learn on their own at home with resources such as learning modules or videos (Dyftania et al., 2023). In the learning process, differences in the use of media and teaching materials are very important. By choosing the right media and teaching materials, teachers can increase students' interest in learning, help students understand the material better, and make learning fun and interactive (Wu et al., 2024; Veerasinghan et al., 2021; Yusriadi, 2021).

3. Variation of interaction

Interaction variation refers to the way individuals or groups interact with each other in various social, cultural and environmental contexts. This variation can occur in a variety

of ways, such as digital interaction, verbal or non-verbal communication (Cremin & Chappell, 2019; Isawi et al., 2024). Understanding these differences is important as they can affect relationships between individuals, group dynamics and interaction outcomes.

Different patterns of interaction between educators and students, which include two sides, namely:

- a) Students carry out the learning process independently without direct assistance from the teacher.
- b) Students demonstrate appropriate listening attitudes when teachers communicate with learners (Prasetyo & Putri, 2025).

Both of the above are possible possibilities. For example, an educator can communicate with a small group of learners by asking a few questions or queries while talking to individual learners. They can also create a situation where learners can exchange opinions with each other through demonstration, demonstration, or discussion. To ensure students' success in achieving the objectives, this interaction pattern is used to create an interesting and not boring classroom atmosphere.

#### *Variation in learning activities*

Variety in learning activities refers to the variety of methods, media and strategies used by teachers to create an interesting, non-monotonous learning atmosphere, and according to students' needs. The aim is to increase students' motivation, participation and understanding of the subject matter. By presenting variations such as group discussions, simulations, educational games, use of videos, or independent projects teachers can accommodate different learning styles and prevent boredom, so that the learning process becomes more effective and meaningful.

##### 1. Variation in the use of learning methods

An important skill that a teacher must have is a diversity of learning methods. Teachers can make lessons more interesting and effective by choosing the right approach, such as varied lectures, question and answer, discussions, presentations or role plays. In this way, students' interest and attention can increase and they are more engaged and motivated to learn. Therefore, teachers must be wise in selecting and choosing the right learning methods to achieve the desired learning objectives. In this way, students will have a better learning experience and achieve better results (RimahDani et al., 2023)

In addition, a variety of learning methods can also help teachers adapt learning to the diverse learning needs of students. Since each student has a different learning style, the application of various learning methods allows teachers to accommodate these differences. Thus, students can learn more effectively and achieve optimal learning outcomes.

Teachers can use a variety of learning methods to achieve learning objectives. For example, they can use lecture method to explain complex concepts, discussion method to encourage discussion and exchange of ideas, or presentation method to present students' work. By using various methods, teachers can make learning more interesting and effective, and improve students' understanding of what they are learning.

##### 2. Variation in examples and illustrations

In learning, examples and illustrations are very important because they can make students more focused and motivated. Students can more easily understand the subject matter if they use direct examples that are around them and that happen actually. Direct examples such as pictures, magazines, newspapers, radio news, TV, or events that occur in the school environment and society can also increase students' motivation and enthusiasm for learning (Ningsih et al., 2025).

Thus, teachers can use relevant and actual examples to make learning more interesting and effective. This can help learners to understand the subject matter better and increase their learning motivation.

#### *Purpose and benefits of learning variation*

Learning variations have several purposes and benefits, among others:

1. Increase students' attention and interest: By making learning variations, teachers can make the learning process more interesting and fun, thus increasing students' attention and interest in learning.
2. Meet the different learning needs of students: Learning variations can meet the different learning needs of students, so that each student can learn better.
3. Increase student participation: By making learning variations, teachers can increase student participation in learning activities, so that students are more involved and active.
4. Eliminate boredom and boredom: Learning variations can eliminate boredom and boredom in the learning process, so that students are more excited and motivated to learn.
5. Increase student motivation: Learning variations can increase students' desire to learn and explore, enhance their passion for learning and increase their motivation to learn.
6. Forming positive student attitudes: By making learning variations, teachers can make students have a positive view of educators and schools, so that learners appreciate and like the learning process more.
7. Students learn individually: Learning variations can enable students to learn independently and more effectively. each student can obtain better learning outcomes (Tinggi et al., 2024).

Diverse learning is essential to produce a more efficient, enjoyable and meaningful learning process. By using a variety of approaches, teachers can not only attract students' attention and increase motivation, but they can also accept different learning styles, encourage active participation, and foster a positive perspective on learning. Learning variation becomes an important strategy to improve students' learning process and outcomes.

#### *Principles of using variety in learning activities*

The Principles of Using Learning Variations are as follows:

1. Using different types of variation: Teachers should use different types of learning variations to achieve the desired learning objectives
2. Use variation in learning smoothly and continuously: Variations should be used smoothly and continuously so as not to disrupt the learning process and students' attention.
3. Structured planning: Teachers should plan the use of learning variations in a structured and flexible manner, so as to adjust to the needs of students.
4. Has a planned direction and purpose: Variations in learning need to be designed with clear aims and objectives, aligned with learning outcomes and considering the characteristics of students (Sufiati & Afifah, 2019).

The principles of using learning variation emphasize that diversity, continuity, structured planning and clear objectives for each strategy applied are essential. In order to keep the learning process focused and not confuse students, teachers must combine various variations in a smooth and planned manner. In addition, each variation should have goals that are aligned with learning achievements and student characteristics, so that the overall learning process is more effective and better.

Overall, the synthesis of recent literature suggests that the secret of creative teachers in bringing the classroom to life lies in seven interrelated features of creative pedagogy: exploration of ideas, granting autonomy, playfulness, problem solving, risk taking, collaboration, and the teacher's own creativity.

## CONCLUSION

Variation in learning is an important strategy that teachers master to create an active, interesting and meaningful classroom atmosphere. Through the use of various methods, media, interactions, and appropriate examples, teachers can provide motivation, participation, and understanding of students and accommodate different learning styles. The implementation of planned and sustainable variations helps overcome learning boredom and shape students' positive attitudes towards learning. Therefore, learning variation is key in providing an effective, enjoyable learning process that equips students with 21st century skills.

This study provides a theoretical contribution by synthesizing seven key features of creative pedagogy, such as idea exploration, student autonomy, playfulness, problem solving, risk taking, collaboration, and teacher creativity as a practical framework for educators. Furthermore, the study emphasizes that the integration of future technologies such as artificial intelligence (AI) is not merely a tool but an essential element in modern learning variations to enhance digital literacy and active student engagement.

## CONFLICT OF INTEREST

No conflict of interest for this study.

## REFERENCES

- Akbar, A. (2021). Pentingnya kompetensi pedagogik guru. *JPG Jurnal Pendidikan Guru*, 2(1), 23. <https://doi.org/10.32832/jpg.v2i1.4099>
- Anderson, R. C., Katz-Buonincontro, J., Bousselot, T., Mattson, D., Beard, N., Land, J., & Livie, M. (2021). How am I a creative teacher? Beliefs, values, and affect for integrating creativity in the classroom. *Teaching and Teacher Education*, 110, 103583. <https://doi.org/10.1016/j.tate.2021.103583>
- Anggrayani, A., Iriani, T., & Handoyo, S. S. (2023). Ragam Variasi Dalam Keterampilan Dasar Mengajar. *Jurnal Pendidikan West Science*, 1(08), 481–494. <https://doi.org/10.58812/jpdws.v1i08.440>
- Cremin, T., & Chappell, K. (2019). Creative pedagogies: a systematic review. *Research Papers in Education*, 36(3), 299–331. <https://doi.org/10.1080/02671522.2019.1677757>
- Dyftania, D., Simanjuntak, A., Petra, D., & Sitorus, M. (2023). Pengaruh Media Pembelajaran Audio Visual Dan Variasi Mengajar Guru Terhadap Hasil Belajar Siswa Kelas IX Mata Pelajaran IPS SMP Negeri 11 Pematangsiantar. 1(2), 708–718.
- Ii, B. A. B., & Belajar, P. K. (2021). *Mufied Fauziah, Usaha Pemberian Layanan Optimal Bagi Guru BK (Yogyakarta: UAD PRESS, 2021).Hal.26 1 14. 14–50.*
- Isawi, D., Schoonover, T. T., Davis, E., & Gomez-Torres, B. (2024). Creative Pedagogy in Counselor Education: The use of play Strategies. *Journal of Creativity in Mental Health*, 20(4), 615–628. <https://doi.org/10.1080/15401383.2024.2432251>
- Julrissani, J., Parid, M., & Kusainun, N. (2020). Membangun Kreativitas Guru Dalam Pembelajaran Tematik Di Sd Muhammadiyah Karangbendo. *El Midad*, 12(1), 1–17. <https://doi.org/10.20414/elmidad.v12i1.1757>
- Liu, S., Yin, H., Wang, Y., & Lu, J. (2024). Teacher innovation: Conceptualizations, methodologies, and theoretical framework. *Teaching and Teacher Education*, 145, 104611. <https://doi.org/10.1016/j.tate.2024.104611>
- Ningsih, J., Nur, K., Fadilah, N., & Hidayah, R. (2025). *Analisis Keterampilan Mengadakan Variasi dalam Meningkatkan Efektivitas Pembelajaran pada Anak Usia Dini.*

- Patston, T. J., Kaufman, J. C., Copley, A. J., & Marrone, R. (2021). What is creativity in Education? A qualitative study of international curricula. *Journal of Advanced Academics*, 32(2), 207–230. <https://doi.org/10.1177/1932202x20978356>
- Peters, M. A., & Heraud, R. (2019). *Encyclopedia of Educational Innovation*. <https://doi.org/10.1007/978-981-13-2262-4>
- Piirto, J. (2021). *Organic creativity in the classroom: Teaching to Intuition in Academics and the Arts*. Routledge.
- Prasetyo, F. A., & Putri, L. D. (2025). *Hubungan Lingkungan Masyarakat Dengan Perilaku Sosial Remaja Di Kawasan Wisata Pantai Kota Padang*. 1, 141–151.
- Rahma, M. A., Nabilla, I., Khasanah, K., Asri, N. S., Nadia, I. A., & Khumaedy, A. (2024). Transformasi Dinamika Metode Konvensional ke Digital pada Pembelajaran di MA Pembangunan Jakarta. *Jurnal Pendidikan Transformatif (JPT)*, 3(3), 1–14.
- RimahDani, D. E., Shaleh, S., & Nurlaeli, N. (2023). Variasi Metode Dan Media Pembelajaran Dalam Kegiatan Belajar Mengajar. *Al-Madrasah: Jurnal Pendidikan Madrasah Ibtidaiyah*, 7(1), 372. <https://doi.org/10.35931/am.v7i1.1829>
- Starko, A. J. (2021). *Creativity in the classroom: Schools of Curious Delight*. Routledge.
- Steele, D., & Whitaker, T. (2019). Good lesson plans don't redeem poor relationships. get to know your students . . . then it becomes much easier to teach them. In *Good lesson plans don't redeem poor relationships* (pp. 11–12). <https://doi.org/10.4324/9780429022029-7>
- Subhan, N. S., & Ningsih, N. F. (2024). Teachers ability to provide learning variations in thematic learning in elementary schools. *Council Education Journal of Social Studies*, 2(1), 37–46. <https://doi.org/10.59923/council.v2i1.61>
- Sufiati, V., & Afifah, S. N. (2019). Peran perencanaan pembelajaran untuk performance mengajar guru pendidikan anak usia dini. *Jurnal Pendidikan Anak*, 8(1), 48–53. <https://doi.org/10.21831/jpa.v8i1.26609>
- Sundari, D., Anshari, K., Al, U., Medan, W., Islam, U., & Batu, L. (2024). *Pendekatan Dalam Penelitian Kuantitatif dan Kualitatif*. 6(1), 83–90.
- Tinggi, S., Islam, A., Sangatta, S., Tinggi, S., Islam, A., & Sangatta, S. (2024). *Analisis Keterampilan Guru dalam Mengadakan Variasi pada Pembelajaran PAI di SDIT 1 Daarussalaam Sangatta Nur Aidila Fitria tentu dipengaruhi oleh kesiapan peserta didik dalam menerima ilmu (Rukhaiyah et al., 2023)*. 3, 124–140.
- Trisnawati Trisnawati, & Diena San Fauziya. (2024). Faktor Penyebab Kejenuhan Belajar Siswa SMP Kelas VIII Pada Pembelajaran Bahasa Indonesia. *Aliansi: Jurnal Hukum, Pendidikan Dan Sosial Humaniora*, 1(5), 214–226. <https://doi.org/10.62383/aliansi.v1i5.407>
- Veerasinghan, K., Balakrishnan, B., Damanhuri, M. I. M., & Gengatharan, K. (2021). Design thinking for creative teaching of chemistry. *International Journal of Academic Research in Business and Social Sciences*, 11(3). <https://doi.org/10.6007/ijarbss/v11-i3/8979>
- Vorontsov, A., & Vorontsova, E. (2015). Innovative Education in Russia: The Basic Tendencies Analysis. *Procedia - Social and Behavioral Sciences*, 214, 1147–1155. <https://doi.org/10.1016/j.sbspro.2015.11.731>
- Wu, D., Chen, M., Chen, X., & Liu, X. (2024). Analyzing K-12 AI education: A large language model study of classroom instruction on learning theories, pedagogy, tools, and AI literacy. *Computers and Education Artificial Intelligence*, 7, 100295. <https://doi.org/10.1016/j.caeai.2024.100295>
- Yunus, W. P. (2022). Keterampilan Guru Mengadakan Variasi Pada Pembelajaran Matematika Siswa Kelas V SD Inpres Pakkolompo Kecamatan Parangloe. *Journal of Social Studies Arts and Humanities (JSSAH)*, 2(1), 25–31. <https://doi.org/10.33751/jssah.v2i1.6087>

- Yusriadi, Y. (2021). Create Teaching Creativity through Training Management, Effectiveness Training, and Teacher Quality in the Covid-19 Pandemic. *Journal of Ethnic and Cultural Studies*, 8(4), 18–35. <https://doi.org/10.29333/ejecs/800>
- Zhao, P., Zhou, J., & Li, Q. (2017). Teacher education. In *Edward Elgar Publishing eBooks*. <https://doi.org/10.4337/9781783470662.00017>
- Zielińska, A., Lebuda, I., Gop, A., & Karwowski, M. (2024). Teachers as creative agents: How self-beliefs and self-regulation drive teachers' creative activity. *Contemporary Educational Psychology*, 77, 102267. <https://doi.org/10.1016/j.cedpsych.2024.102267>

## Theoretical Analysis of the Use of Manipulative Media in Improving Mathematical Concepts Understanding in Elementary Schools

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### ABSTRACT

Mathematical concepts understanding at the elementary school level is often hampered by the abstract and lack of contextual nature of the material. This study aims to theoretically analyze the role of manipulative media in improving mathematical concept understanding and active student engagement. The method used is a literature study with a descriptive analysis approach to various academic sources from the last ten years (2015-2025). The findings indicate that manipulative media functions as a cognitive bridge that transforms abstract concepts into concrete experiences through tactile and motor interactions. The integration of manipulative media with the Problem-Based Learning (PBL) model has been shown to improve memory retention, reduce mathematical anxiety, and strengthen students' problem-solving skills. This study also highlights the transformation of manipulative media from physical to digital forms, such as GeoGebra and AI-based simulations, which offer greater flexibility in modern learning. The novelty of this article lies in the complementary synthesis of physical and digital media within the framework of Piaget's and Vygotsky's constructivist theories. The conclusion of this study emphasizes that the use of adaptive and innovative manipulative media is a primary prerequisite for creating meaningful mathematics learning at the elementary school level.

**Keywords:** concepts understanding, elementary schools, manipulative media, mathematics learning, Problem-Based Learning



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### INTRODUCTION

From a theoretical perspective, the use of manipulative media in learning aligns closely with constructivist theories, as proposed by Piaget and Vygotsky, which emphasize the importance of direct experience and social interaction in children's learning. Practically, the application of manipulative media, especially when combined with learning models such as Problem-Based Learning (PBL), can create a more active and collaborative classroom atmosphere (Dewanti et al., 2025; Muhamad et al., 2021; Setyawati et al., 2023). This is crucial considering that mathematics is a core subject taught in elementary school (SD) and Islamic elementary school (MI). The goal is to equip students with the ability to think logically, critically, analytically, and systematically in dealing with various problems (Raziana & Wibawanto, 2025; Siyamsih, 2024). However, many students still experience difficulties in understanding

mathematics due to its abstract nature. This is a big challenge for teachers in delivering material so that it is easier to understand and interesting for students (Ayyubi et al., 2025; Siregar, 2025).

One of the main factors that causes students to struggle to understand mathematical concepts is a learning approach that is too teacher-centered and lacks active student involvement (Muhamad et al., 2021; Siyamsih, 2024). Generally, learning is still conducted through theoretical or symbolic explanations without providing meaningful, hands-on experiences for students. As a result, students tend to simply memorize problem-solving steps without understanding the underlying concepts (Ayyubi et al., 2025; Nugroho et al., 2022). This clearly contradicts the goal of mathematics learning, which should be to develop thinking and reasoning skills. The weakness of this conventional method is often caused by the use of media that is not yet integrated with an appropriate learning model. However, the use of manipulative media and interactive multimedia has been proven to significantly improve students' conceptual mastery and cognitive learning outcomes (Efendi et al., 2020; Nugroho et al., 2022).

To address the challenges of thinking and reasoning skills, more interactive and concrete learning methods are needed. One approach is to utilize manipulative media. Manipulative media are learning aids that students can touch, move, and manipulate to help them understand abstract concepts more concretely (Ayyubi et al., 2025; Nugroho et al., 2022). Examples include aids such as number blocks, geometric objects, beads, and various other props relevant to the material being taught.

Keberadaan media manipulatif dalam pembelajaran matematika terbukti memberikan banyak manfaat. Selain menjadikan materi lebih mudah dipahami, media ini juga meningkatkan keterlibatan dan motivasi belajar siswa (Dewanti et al., 2025; Raziana & Wibawanto, 2025). Dengan berinteraksi langsung dengan objek konkret, siswa lebih terdorong untuk berpikir aktif, mencoba berbagai pendekatan pemecahan masalah, dan terlibat dalam diskusi kelompok. Hal ini menjadikan proses pembelajaran lebih bermakna dan menyenangkan bagi mereka.

The use of manipulative media in mathematics learning has been proven to provide numerous benefits. In addition to making the material easier to understand, this media also increases student engagement and motivation (Dewanti et al., 2025; Raziana & Wibawanto, 2025). By interacting directly with concrete objects, students are more encouraged to think actively, try various problem-solving approaches, and engage in group discussions. This makes the learning process more meaningful and enjoyable for them.

The integration of the Problem-Based Learning (PBL) model with the aid of manipulative media has proven effective in increasing active student engagement, with both independent and group participation rates reaching above 91% (Dewanti et al., 2025; Muhamad et al., 2021; Setyawati et al., 2023). Furthermore, the use of this media also plays a significant role in improving students' arithmetic operations and concrete visual understanding (Ayyubi et al., 2025; Listrianti et al., 2021; Siregar, 2025).

However, the use of manipulative media must be carried out with careful planning. Teachers need to adapt the type of media to the material being presented, pay attention to the students' developmental levels, and design activities that allow students to explore and discover concepts independently. Inappropriate or excessive use of media can actually disrupt student focus and hinder student understanding. Therefore, it is crucial for teachers to understand strategies for using media effectively (Tjandra, 2023; Siregar, 2025).

Through this study, the author aims to provide a theoretical and practical review of the use of manipulative media in mathematics learning in elementary schools. The study will cover the theoretical basis underlying the use of this media, the types of media that can be used, and effective implementation strategies in the classroom. It is hoped that this paper can serve as a reference and guide for teachers, prospective educators, and educational researchers in improving the quality of mathematics learning in elementary schools.

## **METHODS**

This study uses a Narrative Literature Review approach to synthesize theory and empirical findings regarding the use of manipulative media in mathematics learning in elementary schools. Unlike a traditional literature review, this approach involves a critical analysis of selected literature to develop a new framework or strengthen existing theory (Siregar, 2025; Raziana & Wibawanto, 2025).

The data analyzed is secondary data collected through a systematic search of digital academic databases. The literature search strategy focused on journal articles published within the last five years (2020–2025) to ensure the relevance of the data reviewed. Articles were selected based on their direct relevance to the understanding of mathematical concepts, the Problem-Based Learning (PBL) model, and the effectiveness of manipulative media in elementary schools.

The data analysis process was conducted qualitatively using Content Analysis techniques. The analysis stages included: (1) thematic mapping based on the study focus; (2) critical comparison between empirical study results; and (3) synthesis of the results to formulate a strategy for implementing effective manipulative media in darjah rooms. The validity of the analysis is guaranteed through consistent comparisons between various literary sources that have varying contexts but have the same substantive focus.

## **RESULTS AND DISCUSSION**

The results of a descriptive analysis of the collected literature indicate that the integration of media and learning models is key to transforming mathematics education at the elementary level. The following discussion outlines a synthesis of findings from various empirical studies to provide a comprehensive overview of the effectiveness of manipulative media.

### *Theory and Basic Concepts of Manipulative Media*

Manipulative media are learning tools that can be directly experienced through touch, sight, and hearing, and can be utilized in the learning process. These media can be derived from simple tools or recycled materials. The use of these media allows students to construct understanding through direct sensory-motor experiences, thus facilitating the transition from abstract thinking to clear visual representations (Ayyubi et al., 2025; Nugroho et al., 2022). These media are not limited to manufactured tools but also include various objects in the surrounding environment that can be modified to suit the instructional needs of the class.

The use of manipulative media requires an appropriate approach and in-depth understanding from the teacher. The teacher's role is not only to explain but also to be able to demonstrate the use of these media effectively. Furthermore, it is important to consider the students' developmental level to ensure that the media used is truly appropriate for their thinking stage (Sucahyo et al., 2024).

These concrete media can stimulate students' thinking processes according to their ability level, thereby increasing the effectiveness of mathematics learning. The use of manipulatives also helps students build understanding through direct experience, rather than simply memorizing or abstract theories. Thus, manipulative media can bridge the gap in overcoming mathematics learning difficulties and support gradual and meaningful concept formation.

Similarly, Santrock (2022) emphasized that manipulative media must be tailored to students' knowledge levels and delivered through a concrete approach, particularly in elementary school, to facilitate student comprehension. Implementing these media has also proven effective in improving students' gross and fine motor skills through structured manipulative play activities (Dewi & Verawati, 2021).

#### *The Influence of Manipulative Media on Mathematical Concept Understanding*

Conceptual understanding is a fundamental aspect of quality mathematics learning. A student is said to have understood a concept if they can explain, apply, and illustrate the concept in various situations (Kirana & Nur, 2022). However, many elementary school students experience difficulty understanding mathematics because their understanding is too abstract and lacks context. In this case, the use of manipulative media can be an effective approach to address these difficulties and improve students' understanding of mathematical concepts through concrete, active, and enjoyable learning experiences (Akmalia et al., 2021; Ayyubi et al., 2025).

Manipulative media refers to concrete learning aids that can be used directly by students to explore mathematical concepts. By directly touching, moving, and manipulating objects, students can build understanding through real-world experiences. This approach aligns with the constructivist view, which states that students construct knowledge through active interaction with their surroundings. Manipulative media bridges the gap between abstract concepts and concrete learning experiences, making learning easier to understand, more meaningful, and more relevant to the real world students experience in their daily lives (Cahyono et al., 2024).

Various studies have shown that mathematics learning supported by manipulative media significantly improves conceptual understanding. Students who learn using concrete tools tend to more easily understand the relationships between concepts and are able to relate the material to everyday life (Sundari, 2016). Furthermore, student retention or memory of the material also improves, as concepts are acquired through a process involving the senses and motor skills. The use of interactive animation media such as Powtoon can also be combined to strengthen the visualization of concepts learned through physical media (Akmalia et al., 2021). The use of this media can also reduce anxiety in math lessons, as students feel more confident exploring concepts through hands-on activities involving the senses and movement. This allows them to focus more on the process of understanding rather than fearing mistakes. Ultimately, they are able to gradually build conceptual mastery and increase their motivation to learn in a more enjoyable and less boring environment.

The use of manipulative media has also been shown to increase students' active participation in the learning process. By engaging directly, students are encouraged to ask questions, discuss, and solve problems with their peers. In this process, the teacher acts as a facilitator, guiding and guiding students so that the concrete experiences they gain can be processed into a comprehensive understanding. Therefore, teachers need to be skilled in selecting appropriate media and adapting them to the students' cognitive developmental stage (Rahmawati et al., 2023).

Overall, manipulative media plays a significant role in helping students understand mathematics more deeply. These media not only present material in a concrete form but also foster logistical and analytical thinking skills, which are crucial in mathematics learning (Bangkirai, 2016). Therefore, the use of manipulative media should be an integral part of innovative, enjoyable, and student-centered learning strategies, particularly at the elementary/Islamic elementary school level. At this stage, students are in the concrete operational cognitive development phase, according to Piaget's theory, which requires extensive direct experience in understanding abstract concepts such as those in mathematics lessons (Noverita, 2019).

### *Student Engagement and Problem-Solving Skills Development*

Student engagement plays a crucial role in developing critical thinking, the ability to evaluate information, and problem-solving skills. When students are actively involved in the learning process, they tend to demonstrate greater responsibility for their learning, are better able to understand context and formulate problems, and can effectively apply various problem-solving strategies. According to Fredricks, Blumenfeld, and Paris (2024), student engagement can be viewed across three main dimensions: behavioral, emotional, and cognitive engagement. Behavioral engagement is characterized by students' active participation in learning activities (Musa'ad et al., 2024). Meanwhile, emotional engagement refers to students' affective responses to teachers, classmates, and learning materials. Cognitive engagement describes students' intellectual efforts in deep thinking and the use of higher-order learning strategies. These three dimensions synergistically support the development of higher-order thinking skills, including problem-solving.

To increase student engagement while developing their problem-solving abilities, a number of learning approaches can be implemented. One approach is Problem-Based Learning (PBL), which involves students working in groups to analyze and solve real-life problems relevant to their lives (Adolph, 2016). Furthermore, the Active Learning approach is also effective because it encourages students to engage in interactive activities such as discussions, experiments, simulations, and case studies that stimulate critical thinking and problem-solving skills (Putri et al., 2024). Another approach is Project-Based Learning, which challenges students to complete real-life projects collaboratively, creatively, and innovatively, while simultaneously seeking solutions to complex problems. Cooperative learning models such as mind mapping can also be integrated with manipulative media to help students organize their conceptual understanding systematically (Rahmawati et al., 2023). Overall, these approaches not only increase student engagement in the learning process but also strengthen problem-solving skills, which are crucial for facing real-world challenges.

### *Analysis of Problem-Based Learning with Manipulative Media*

Problem-Based Learning (PBL) is an instructional approach that emphasizes student active participation in solving real-life problems. In this model, students act as the primary subjects of learning, exploring, investigating, and discussing to find solutions. PBL encourages collaboration among students and fosters critical and analytical thinking skills, as students not only receive material but also construct their knowledge through the problem-solving process (Hidayat, 2022).

Meanwhile, Manipulative media refers to learning aids that students can touch and operate directly, such as blocks, concrete objects, or three-dimensional visual models. These media serve to facilitate the understanding of abstract concepts in a more tangible way, especially for elementary to secondary students.

When the PBL approach is implemented with manipulative media, the learning process becomes more lively and effective. Through physical and visual activities with aids, students not only utilize cognitive abilities to solve problems but also develop their motor and sensory aspects. The use of this media also increases student engagement from an emotional, behavioral, and mental perspective, as they actively interact, experiment, and evaluate various alternative problem-solving approaches. Collaboration and reflection are also important parts of their learning experience.

Addressing the need for practical guidance, the following is a concrete example of teaching the concept of "Fractions" using PBL and Manipulative Media (Dewanti et al., 2025; Nugroho et al., 2022): (1) Problem Orientation: The teacher presents a problem involving dividing martabak (a type of pancake) into four equal parts; (2) Learning Organization: Students are given a

manipulative media, a "fraction plate" or circular origami paper; (3) Investigation: Students physically cut the media into four equal parts to find the value of  $\frac{1}{4}$ ; (4) Result Development: Students attach the pieces to the board and explain their relationship to the numerator and denominator; and (5) Evaluation: The teacher reinforces the concept that fractions are part of a whole, based on the students' physical experiences.

However, implementing PBL with manipulative media presents several challenges. Structured planning, adequate tools, and teacher competence in managing open and flexible learning are required. Furthermore, because these activities often require more time, efficient time management is crucial. Nevertheless, numerous studies have shown that the combination of PBL and manipulative media has a positive impact on students' conceptual understanding, critical thinking skills, and learning motivation (Adar Bakhsh Baloch, 2017).

### *The Role of Technology in the Use of Manipulative Media*

Technology plays a significant role in developing and enhancing the use of manipulative media in learning activities. With the advancement of the digital world, manipulative media now takes the form of not only physical tools such as blocks or real objects, but has also evolved into virtual manipulative media that can be operated through digital devices such as computers, tablets, and smartphones (Utami, 2022).

Technological advancements have transformed manipulative media from physical to digital, enabling students to learn abstract concepts in a more interactive and flexible way (Aboraya, 2021). In mathematics learning, for example, students can utilize platforms like GeoGebra or the Math Learning Center to dynamically explore topics such as geometry, algebra, and statistics (Widianita, 2023). These digital manipulative media not only mimic the experience of using physical tools but also include additional features such as animation, visual changes, and simulations, making learning more engaging. The use of software like GeoGebra has proven effective in transforming abstract objects into interactive visual representations (Siregar, 2025). Students can freely set parameters, observe results directly, and explore various solutions, thus increasing their engagement and motivation to learn.

On the other hand, digital manipulative media excels in accessibility and flexibility. Students can access them anytime and anywhere, supporting both online and blended learning. Features such as screen readers, display magnification, and touch controls also help students with special needs learn more inclusively (Tjandra, 2023). This technology also supports collaborative learning; students can collaborate online on problem-based tasks using digital manipulatives, even from different locations.

It is important to note that physical and digital manipulative media are complementary in the context of PBL. Physical media build students' early sensory intuition through tactile manipulation, while digital media expands these physical boundaries through dynamic simulations that enable limitless exploration (Siregar, 2025). However, in rural elementary schools in Indonesia, infrastructure challenges such as weak internet signals and limited device availability remain major barriers to the implementation of digital media (Tjandra, 2023). Therefore, teachers in rural areas are encouraged to be more creative in developing manipulative media from natural or recycled materials as a practical solution.

For educators, the use of digital manipulative media is very helpful in the learning planning and evaluation process. Many applications already provide automatic data on student activity, such as recordings of interactions, levels of difficulty encountered, and student-chosen problem-solving strategies (Hutauruk et al., 2022). Furthermore, the development of artificial intelligence (AI)-based manipulative tools in the future (2024-2025) is predicted to provide more personalized, adaptive feedback tailored to each student's learning patterns (Raziana & Wibawanto, 2025; Siregar, 2025).

The novelty of this study lies in the integrative synthesis of the PBL model, the use of physical manipulative media, and the transformation to AI-based digital media within a unified theoretical framework. Unlike previous studies that focused solely on one aspect, this article emphasizes the complementary relationship between physical tactile experiences and digital exploration to address the cognitive challenges of elementary school students. Furthermore, this study provides specific solutions to educational challenges in rural areas by emphasizing the adaptation of local media, supported by robust theoretical analysis (Levitskaya & Fedorov, 2021).

Future research should further explore the effectiveness of using Augmented Reality (AR) as a bridge between physical and digital manipulative media in real-time in the classroom. Furthermore, broader field experiments are needed to test the adaptation model of manipulative media in areas with technological limitations to ensure equitable distribution of the quality of mathematics learning across Indonesia. Evaluating teachers' digital competence in operating AI-based manipulative media is also a crucial area that requires further in-depth study.

## CONCLUSION

The use of manipulative media in mathematics learning at the elementary school level has been proven to significantly improve student conceptual understanding, engagement, and critical thinking and problem-solving skills. The abstract nature of mathematics often presents a barrier for students, especially when conventional learning methods are used with minimal interaction. Manipulative media, both physical and digital, bridge this gap by providing concrete, contextual, and enjoyable learning experiences. The use of technology also expands access and effectiveness of manipulative media, particularly in the context of digital and inclusive learning.

However, the effectiveness of manipulative media utilization depends heavily on careful planning, appropriate media selection, and the teacher's ability to facilitate the learning process. Therefore, teachers need to have a good understanding of student characteristics, learning materials, and innovative learning strategies. With the support of the right approach and optimal use of technology, manipulative media can be a strategic solution to improve the quality of mathematics learning in elementary schools in a holistic and sustainable manner.

## CONFLICT OF INTEREST

No conflict of interest for this study.

## REFERENCES

- Aboraya, W. (2021). Assessing students' learning of abstract mathematical concepts in a blended learning environment enhanced with a web-based virtual laboratory. *Journal of E-Learning and Knowledge Society*, 17(3), 50–58. <https://doi.org/10.20368/1971-8829/1135520>
- adar BakhshBaloch, Q. (2017). Analysis of the covariance structure of health-related indicators in elderly people living at home, with a focus on subjective sense of health. 11(1), 92–105.
- Adolph, R. (2016). Hubungan Pemahaman Kompetensi Pedagogik Guru dengan Kreativitas Mengajar. 3(2), 1–23.
- Akmalia, R., Fajriana, F., Rohantizani, R., Nufus, H., & Wulandari, W. (2021). Development of powtoon animation learning media in improving understanding of mathematical concept. *Malikussaleh Journal of Mathematics Learning (MJML)*, 4(2), 105. <https://doi.org/10.29103/mjml.v4i2.5710>
- Ayyubi, I. I. A., Nurhikmah, N., Rahmawati, S., Trimulyati, S. H., & Setiawati, T. (2025). The influence of manipulative media usage on students' understanding of fraction operations in elementary schools. *Noumerico Journal of Technology in Mathematics Education*, 3(1), 11–25. <https://doi.org/10.33367/jtme.v3i1.6700>

- Cahyono, B., Karoso, S., Sugito, & Baso, R. S. (2024). Implementasi Media Manipulatif Untuk Pemahaman Siswa Dalam Pembelajaran Matematika. *Indonesian Journal of Learning and Instructional Innovation*, 2(01), 1–6. <https://doi.org/10.20961/ijolii.v2i01.1303>
- Dewanti, S. S., Rahmawati, N., & Sumardi, N. (2025). Problem-Based Learning with Manipulative Media: Enhancing Elementary Students' Conceptual Understanding in Area and Volume. *Jurnal Ilmiah Sekolah Dasar*, 8(3), 487–499. <https://doi.org/10.23887/jisd.v8i3.80221>
- Dewi, R., & Verawati, I. (2021). The effect of manipulative games to improve fundamental motor skills in elementary school students. *International Journal of Education in Mathematics Science and Technology*, 10(1), 24–37. <https://doi.org/10.46328/ijemst.2163>
- Efendi, A., Budiarto, M., Wibawanto, H., & Budiarto, M. K. (2020). The effect of interactive multimedia to improve the cognitive learning outcome in senior high school's student. *International Journal of Education and Knowledge Management*. <https://doi.org/10.37227/ijekm-2021-01-34>
- Hidayat, R. (2022). Jurnal Ilmiah Wahana Pendidikan. *Jurnal Ilmiah Wahana Pendidikan* 8(3), 178–183. <https://doi.org/10.5281/zenodo.6466588>
- Hutauruk, A., Subakti, H., Simarmata, D., Lestari, H., Al Haddar, G., Da'i, M., Purba, S., Khalik, M., & Cahyaningrum, V. (2022). Media Pembelajaran dan TIK. *Yayasan Kita Menulis*, 5(3).
- Khumaidi. (2021). Upaya Meningkatkan Pemahaman Konsep Bangun Ruang Sisi Datar Dengan Menggunakan Media Manipulatif. *Jurnal Pendidikan*.
- Kirana, A., & Nur, I. R. D. (2022). Analisis Kemampuan Pemahaman Konsep Matematika Ditinjau dari Minat Belajar Siswa. *Jurnal Educatio FKIP UNMA*, 8(1), 374–385. <https://doi.org/10.31949/educatio.v8i1.1992>
- Levitskaya, A., & Fedorov, A. (2021). Theoretical model of media competence's development of teachers-to-be in the process of the analysis of manipulative media influences. *Mediaobrazovanie*, 17(1). <https://doi.org/10.13187/me.2021.2.323>
- Listrianti, F., Baharun, H., Sugiannoor, & Wati, N. I. (2021). Using Manipulative Media in Improving Students' Abilities in Operations to Calculate The Addition of Integers In Madrasah. *ZAHRA: Research and Thought Elementary School of Islam Journal*, 3(2), 114–128. <https://doi.org/10.37812/zahra.v3i2.700>
- Muhamad, A., Murtono, Suad, & Gui, Y. (2021). The effect of manipulative PBL model on the understanding mathematic concepts for elementary students. *Asian Pendidikan*, 1(2), 17–22. <https://doi.org/10.53797/aspem.v1i2.3.2021>
- Musa'ad, F., Ahmad, R. E., Sundari, S., & Hidayani, H. (2024). Pembelajaran Berbasis Proyek untuk Meningkatkan Kemampuan Berpikir Kritis Siswa. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 8(2), 1481–1487. <https://doi.org/10.31004/cendekia.v8i2.3361>
- Noverita, W. A. (2019). Pengembangan Media Pembelajaran Replika Peta Budaya Pada Pembelajaran Tematik Terpadu Untuk Kelas IV SD/MI di Bandar. <http://repository.radenintan.ac.id/7638/1/SKRIPSI.pdf>
- Nugroho, S., Putri, L. I., & Husna, A. (2022). The Effectiveness of Manipulative Media on Understanding The Concept of Multipling in Grade II Madrasah Ibtidaiyah. *PrimaryEdu - Journal of Primary Education*, 6(1), 44–53. <https://doi.org/10.22460/pej.v6i1.2857>
- Rahmawati, R. B., Ardianti, S. D., & Rondli, W. S. (2023). Model pembelajaran kooperatif tipe mind mapping berbantuan media manipulatif untuk meningkatkan pemahaman konsep siswa. *Jurnal Educatio FKIP UNMA*, 9(2), 560–566. <https://doi.org/10.31949/educatio.v9i2.4713>
- Raziana, E., & Wibawanto, H. (2025). Pedagogical Innovation of Game-Based Learning for 21st Century Skills in Vocational Education: A Systematic Literature Review. *Indonesian Journal of Learning and Instructional Innovation*, 3(1), 19-30. <https://doi.org/10.20961/ijolii.v3i1.2494>

- Rika Widianita, D. R. (2023). Pengaruh Kepercayaan Dan Kemudahan Terhadap Keputusan Pembelian Menggunakan Shopee Paylater Pada Masyarakat Kota Mataram. *At-Tawassuth: Jurnal Ekonomi Islam*, 8(1), 1–19.
- Putri, A. E., Lizarni, N., & Yelni, S. (2024). Pengaruh Metode Pembelajaran Aktif terhadap Motivasi Belajar Pendidikan Agama Islam di SMPN 1 Lembah Gumanti. *EduSpirit: Jurnal Pendidikan Kolaboratif*, 1(1), 580–585. Retrieved from <https://journal.makwafoundation.org/index.php/eduspirit/article/view/1006>
- Setyawati, H., Wardani, K., & Indaryanti. (2023). Understanding mathematical concepts using manipulative media-based problem-based learning models in elementary schools. *Proceedings of International Conference on Teacher Profession Education*, 1(1), 2023. <https://seminar.ustjogja.ac.id/index.php/ICoTPE/article/view/1000>
- Siregar, T. (2025). Literature Review: The Use of GeoGebra Software on Mathematical Comprehension Ability. *Preprints.org*. <https://doi.org/10.20944/preprints202510.0925.v1>
- Siyamsih, D. (2024). The mathematics learning process in using counting media in Grade 1 elementary school students as an improvement in student understanding. *Aksioma Education Journal*, 1(2). <https://doi.org/10.62872/88zep303>
- Sucahyo, I. R., Ai, K., Syaifudin, M., Putri, E., Aini, N., Ayu, R., Ardianto, R. B., Isnaini, K., & Fatmawati, A. A. (2024). Penerapan Media Manipulatif dalam Pengajaran Matematika untuk Mendukung Pendidikan Berkualitas pada MI Anbaul Ulum, *Pakis Malang*. 8, 47287–47297.
- Sundari, R. (2016). Penerapan Model VAK (Visual, Auditory, Kinestetik) Terhadap Keberhasilan Belajar Siswa Pada Mata Pelajaran IPA (Ilmu Pengetahuan Alam) Kelas VA SDN 04 Curup Utara. *Skripsi*. Sekolah Tinggi Agama Islam Negeri (STAIN) Curup.
- Tjandra, C. (2023). Effectiveness of Using Manipulatives in Mathematics Teaching in Inclusive Education Programs in an Elementary School. *Dharmas Education Journal (DE\_Journal)*, 4(1), 168–178. <https://doi.org/10.56667/dejournal.v4i1.944>
- Utami, M. (2022). Pengaruh Media Interaktif Animasi Terhadap Minat Belajar Pada Mata Pelajaran Seni Budaya Dan Prakarya (SBDP) Materi Lagu Daerah Siswa Kelas IV SDN 1 Sawah Lama Bandar Lampung. *Skripsi*. Universitas Islam Negeri Raden Intan Lampung.

## The BERAKSI Learning Model: Optimizing the Holistic Development of Early Childhood

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### ABSTRACT

Early Childhood Education has a vital role in the holistic development of children, including cognitive, social, emotional and motoric aspects. However, traditional learning approaches are often less effective in accommodating these developmental needs. To overcome this problem, the BERAKSI (Playing, Creating, Discussing and Cheerful) Learning Model was developed as an innovation that aims to increase involvement and optimal development of young children. This research will discuss the implementation of the BERAKSI Learning Model which can optimize the development of early childhood in cognitive, social, emotional and motoric aspects. The aim is to develop and implement the BERAKSI Learning Model to optimize the holistic development of early childhood. This research uses a qualitative approach with a case study method. Data was collected through observation, interviews and document analysis in several early childhood schools. Data analysis was carried out thematically to identify patterns and effects from applying this model. The research results show that the BERAKSI Learning Model is successful in increasing children's involvement in the learning process, improving cognitive, social and emotional abilities, and creating a pleasant learning atmosphere. Teachers who have been trained are able to implement this model well, and the curriculum developed supports the success of the BERAKSI model. The implications of this research indicate that the BERAKSI approach can be adopted more widely in early childhood education in Indonesia. The proposed solutions include teacher training, development of appropriate curricula, provision of supporting facilities and resources, as well as ongoing evaluation to adjust learning strategies. With these steps, the BERAKSI Learning Model is expected to have a significant positive impact on the holistic development of early childhood.

**Keywords:** *early childhood, holistic, in action, learning model*



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### INTRODUCTION

Early Childhood Education (ECE) plays a crucial role in supporting children's holistic development, including cognitive, social, emotional and motoric aspects (Sahu & Kumar Singh, 2023; Ukamaka, 2023) In this phase, children experience rapid growth and are very sensitive to the environment and learning experiences provided (Baten et al., 2023) Therefore, an interactive and fun learning approach is essential to facilitate their exploration, creativity and learning. However, many traditional learning models tend to focus on theory-based teaching, which is often less effective in meeting children's overall development needs (Reed et al., 2023; Romito et al., 2021; Vinokur et al., 2023). Conventional learning models often cannot accommodate the various ways children learn and interact with the world around them (Mann et al., 2021; Smith

et al., 2022; Sukacké et al., 2022). This can result in dissatisfaction, boredom, and even a decrease in children's motivation to learn. This situation shows the importance of innovation in learning methods that can integrate various activities that support all aspects of children's development (Kwangmuang et al., 2021; F. Parker, 1999; R. Parker et al., 2022; Weber & Greiff, 2023). For example, approaches that involve play, art, discussion, and physical activity give children the opportunity to learn while having fun. The BERAKSI Learning Model offers solutions with an approach that includes play, creativity, discussion and fun. By involving children in relevant and interesting activities, early childhood education can create learning experiences that are not only educational but also fun (Keung & Fung, 2021; Pienimäki et al., 2021; Rahiem, 2021). This not only supports their optimal development but also builds a strong foundation for future learning. Through this innovative and comprehensive approach, ECE can play a more effective role in preparing children to face the challenges of later life.

The BERAKSI (Play, Create, Discuss and Cheerful) Learning Model is an innovative approach designed to meet the holistic development needs of early childhood. Given the importance of this developmental phase, this model focuses on four main activities that are believed to provide optimal stimulation for children. First, play activities are the core of this model. Playing is not only fun, but also serves as an effective learning tool (Zeng et al., 2020). Through play, children can develop fine and gross motor skills, while stimulating their cognitive abilities (Behnamnia, Kamsin, Ismail, et al., 2020a). They learn to solve problems, adapt to new situations, and understand basic concepts, such as numbers and colors, through hands-on experience (Cankaya et al., 2023; Shi et al., 2023). Games also teach children about cooperation and sharing, which are important foundations of social interaction. Second, creative activities, such as drawing, painting and making crafts, encourage children to explore their imagination and creativity (Kizilaslan et al., 2021; Rizzi et al., 2020). In this process, children learn to express ideas and emotions, while developing critical thinking skills. These activities not only support creativity, but also provide a sense of accomplishment when children see the results of their work, which contributes to increased self-confidence (Capron Puozzo & Audrin, 2021; Rizzi et al., 2020)

Third, discussion activities invite children to engage in conversation and collaboration with peers. Discussions help train children's social and communication skills, including the ability to listen and respect other people's opinions (Reith-Hall & Montgomery, 2023). It also gives them the opportunity to learn to think critically and convey their ideas with confidence (O'Flaherty & Costabile, 2020). This ability is very important in building positive social relationships in the learning environment and outside of school (Molina Roldán et al., 2021; Wang & Hofkens, 2020). Fourth, the cheerful aspect of this model ensures that children learn in a fun and stress-free atmosphere. A cheerful learning atmosphere increases children's motivation and enthusiasm for participating, and helps reduce any anxiety they may feel (Liu et al., 2022; Özhan & Kocadere, 2020; Printer, 2023). By creating positive learning experiences, this model not only supports academic development but also children's mental and emotional health.

The BERAKSI Learning Model integrates various activities that support each other, creating a holistic and effective learning environment, and giving children the tools they need to develop optimally in various aspects of life (Green et al., 2020; Koul & Nayar, 2021). With this approach, it is hoped that children can have an enjoyable educational experience, preparing them for future challenges. The BERAKSI approach not only provides a fun learning environment, but also integrates a variety of learning methods designed to increase children's engagement and maximize their potential (Behnamnia, Kamsin, Ismail, et al., 2020; van der Oord & Tripp, 2020). By utilizing various types of activities, this approach provides a comprehensive learning experience, allowing children to participate actively in the educational process (Wen, 2021). Through a combination of play, creativity and discussion, children not only gain academic knowledge, but also social and emotional skills that are important for their development.

One of the key aspects of this approach is its ability to adapt learning methods to different learning styles among children. Each child has his own uniqueness and way of absorbing information, therefore, the diversity in activities offered can meet the needs of each individual (Orson et al., 2020; Xia et al., 2022). For example, children who prefer to move can be more involved in play activities, while children who tend to think creatively will enjoy creative activities. In addition, a cheerful and positive learning environment contributes to reducing stress and anxiety, which often become obstacles for children in learning (Attanasio et al., 2022; Carlier et al., 2020) When children feel comfortable and happy, they are more open to learning and exploring new things. This supportive atmosphere helps children feel valued and accepted, creating a strong foundation for their self-confidence and independence.

The importance of this model is increasingly felt considering the crucial role of early childhood education in forming the basis of children's character and abilities in the future (Behnamnia, Kamsin, & Ismail, 2020) Education at an early age is not only about transferring knowledge, but also about building values, habits and skills that will equip children to face life's challenges (D'Angelo et al., 2022). With the BERAKSI approach, it is hoped that children can grow and develop optimally, both in terms of cognitive, emotional, social and physical (Kuzik et al., 2020). This is not only an investment for the present, but also for a better future, where children can become independent, creative individuals and able to contribute positively to society.

In this research, it is discussed that the implementation of the BERAKSI Learning Model can optimize the development of early childhood in cognitive, social, emotional and motoric aspects. The aim is to develop and implement the BERAKSI Learning Model to optimize the holistic development of early childhood, including cognitive, social, emotional and motoric aspects. The BERAKSI Learning Model offers an integrative and holistic approach that integrates play, creativity, discussion and cheerful activities, which has not been widely implemented in the context of early childhood education in Indonesia. This approach focuses on developing all aspects of the child, creating a learning experience that is not only fun but also educational. In an educational context that often still relies on traditional methods, the existence of this model becomes very relevant. Through play activities, children can learn in a natural and fun way, while being creative provides space for them to express their imagination and creativity. Discussions help hone communication and collaboration skills, which are important for their social development. Cheerful activities ensure the learning atmosphere remains positive, reduce stress and increase children's motivation.

Although there are several initiatives aimed at implementing interactive methods, the BERAKSI Learning Model promises more comprehensive integration. By combining various types of activities that complement each other, this approach can address children's diverse developmental needs. It is hoped that the implementation of this model can improve the quality of early childhood education in Indonesia, providing a strong foundation for their future development. Through wider implementation, the BERAKSI Learning Model has the potential to create a generation of children who are more creative, independent, and able to adapt to changes in the environment around them.

## **METHODS**

### *Types and Research Approaches*

This research uses a type of qualitative research with a case study approach (D'Angelo et al., 2022; Dawson R. Hancock, 2021; Farquhar et al., 2020; Kuzik et al., 2020). A qualitative approach was chosen because the main aim of the research was to understand in depth how the BERAKSI Learning Model was implemented and how it affected early childhood development. Through this method, researchers can explore nuances and context that cannot be measured with quantitative data. The case study was chosen because it allows researchers to conduct a detailed exploration of several early childhood education institutions that

implement the BERAKSI model. By selecting various locations and situations, this research can capture the dynamics and complexity that arise in the real context of early childhood education (Cleland et al., 2021). Each early childhood school has unique characteristics that influence the implementation of this model, including social, cultural, and economic background.

With this method, researchers can collect data through in-depth interviews with teachers, parents and early childhood education management, as well as direct observation of the learning process. The data obtained will provide insight into the effectiveness of the model in increasing children's engagement and supporting their development. In addition, this approach also allows researchers to identify challenges and solutions encountered in implementing the model, providing a valuable contribution to the development of early childhood education practices in Indonesia. Through this research, it is hoped that best practices will be revealed that can be applied more widely in the context of other early childhood education schools.

#### *Population or research Sample*

The population of this research is all early childhood education schools in Indonesia that implement the BERAKSI Learning Model. However, due to limited time and resources (Skivington et al., 2021). The research samples were taken by purposive sampling with the criteria, namely ECE that had implemented the BERAKSI Learning Model for at least one semester, PAUD that were willing to participate in this research, and ECE that had various socio-economic backgrounds to ensure data diversity. From these criteria, three were selected. ECE located in large cities, medium cities and rural areas, can provide a more comprehensive picture of the application of the BERAKSI model in various contexts.

#### *Method of collecting data*

The data in this research was collected through three main methods: observation, interviews, and document analysis (Dalglish et al., 2021; Morgan, n.d.). Observations were carried out to see directly how the BERAKSI Learning Model was implemented in the classroom. Researchers observed playing, creating, discussing and cheerful activities carried out by children as well as interactions between teachers and children during the activities. This observation was carried out systematically using an observation guide that had been prepared previously. Interviews were conducted with teachers, school principals and parents to obtain their perspectives regarding the implementation of the BERAKSI Learning Model and its impact on children's development. These interviews were semi-structured, allowing the researcher to explore topics that emerged during the interview as well as ask follow-up questions to obtain more in-depth information. And the documents analyzed include the curriculum, learning implementation plans, child development records, and evaluation reports. This document analysis aims to understand how the BERAKSI Learning Model was designed and implemented in writing as well as to verify the findings from observations and interviews.

#### *Data analysis*

Data analysis in this research was carried out thematically with the following steps, namely: Data from observations, interviews and document analysis were collected and categorized according to source and type (Dawson R. Hancock, 2021; Jain, 2021). Then the data that has been collected is then reduced by selecting, focusing, simplifying and abstracting the raw data. Data reduction is carried out to filter information that is relevant and significant to the research objectives. The reduced data is arranged in the form of matrices, tables and descriptive narratives to facilitate further analysis. Presenting this data helps researchers see patterns, relationships and findings that emerge from the data. After the data is presented, the researcher interprets and draws conclusions based on the findings that emerge. This process involves verifying findings by triangulating data from various sources to ensure the validity and reliability of research results (Surucu & Maslacki, 2020). Finally, the conclusions and research findings are

then compiled in the form of a systematic report, explaining how the BERAKSI Learning Model is implemented, its impact on children's development, and the implications and recommendations for further development. With this approach, it is hoped that research can provide a comprehensive and in-depth picture of the application and effectiveness of the BERAKSI Learning Model in early childhood education.

*Research Instrument*

In this research, various instruments were used to collect the necessary data. These instruments are designed to ensure the data obtained is complete, accurate and relevant to the research objectives (Bhat & Huang, 2021; Ly et al., 2020).The following are details of the instruments used:

*1. Observation Guide*

An observation guide is used to assist researchers in recording activities and interactions during the implementation of the BERAKSI Learning Model. This guide includes indicators related to the four components of BERAKSI (Playing, Creativity, Discussion and Cheerfulness), as well as aspects of child development that are observed (cognitive, social, emotional and motoric). This guide covers:

*Table 1. Observation guide indicators*

No	Activity			
	Play	Get creative	Discuss	Cheerful
1	Game type	Types of creative activities	Discussion topic	Class situation
2	Child participation	Child involvement	Communication skills	Children's happiness
3	Interaction with peers	Demonstrated innovation	Child participation	Positive interactions
4	Creativity in play	Children's work	How teachers facilitate children	Children's responses to fun activities

*2. Interview Guide*

The interview guide was designed to obtain in-depth information from teachers, school principals and parents regarding the implementation of the BERAKSI Learning Model and its impact on children. This guide includes semi-structured questions, allowing flexibility in exploring respondents' answers (Xiao, 2020; Zhang, 2019). Questions in this guide include:

*Table 2. Interview guide instruments*

No	Question	Teacher evaluation	Parental assessment
1	How do you implement the ACTION Learning Model in the classroom?		
2	What challenges did you face in implementing this model?		
3	How do you see children's development in cognitive, social, emotional and motoric aspects after implementing the BERAKASI model?		
4	What do teachers and parents think about this learning model?		

*3. Document Analysis Checklist*

The document analysis checklist is used to assess the curriculum, learning implementation plans, child development records, and evaluation reports related to the implementation of the BERAKSI Learning Model. This checklist includes elements that must be present in these documents, such as:

*Table 3. Document analysis guide*

No	Statement	Assessment	
		In accordance	It is not in accordance with
1	Curriculum alignment with the BERAKSI model.		
2	Details of play, creativity, discussion and fun activities in the lesson plan.		
3	Child development indicators in development records.		
4	Evaluation results of the implementation of the BERAKSI model.		

#### 4. Evaluation Questionnaire

Evaluation questionnaires are used to collect quantitative data from teachers and parents regarding the effectiveness of the BERAKSI Learning Model. This questionnaire contains statements that must be answered using a Likert scale (for example, strongly agree, agree, neutral, disagree, strongly disagree). statements in this questionnaire include:

*Table 4. Evaluation questionnaire guide*

No	Statement	Assessment				
		SS	S	N	TS	STS
1	My child showed an increase in abilities in aspects of child development after following the BERAKSI model					
2	My child is more active and creative in learning activities at school.					
3	Teachers are able to integrate play, creativity, discussion and cheerful activities in daily learning.					
4	I am satisfied with my child's social and emotional development since implementing the BERAKSI model.					

## RESULTS AND DISCUSSION

### Results

By using these various instruments, researchers can collect comprehensive and in-depth data regarding the implementation of the BERAKSI Learning Model and its impact on early childhood development. The combination of qualitative and quantitative data will provide a better and more comprehensive understanding of the effectiveness of this model. The results of research regarding the implementation of the BERAKSI Learning Model in the three ECEs studied showed a significant positive impact on early childhood development. These findings were obtained from analysis of data collected through observation, interviews and document analysis.

#### 1. Implementation of the BERAKASI learning Model

Field observations show that play, creativity, discussion and cheerful activities are implemented consistently in the three ECEs. Play activities, such as group games and creative games, encourage children to interact with each other, develop children's developmental abilities, and solve problems collaboratively. Creative activities, such as drawing and making crafts, give children the opportunity to express themselves and practice soft skills. In discussion activities, children are involved in group discussions which facilitate their communication skills. Teachers use open-ended questioning methods to stimulate critical thinking and collaboration among children. Playful activities, such as singing and dancing, create a fun learning atmosphere and reduce stress, allowing children to be more focused and engaged.

*Table 5. Observation results of model implementation*

<b>Activity</b>	<b>Assessment Indicators</b>	<b>Pembina Ujung Bulu State Kindergarten</b>	<b>Al Uswah State Kindergarten</b>	<b>Melati Private Kindergarten</b>
Play	Game type	includes simple puzzle activities, memory games, building blocks, role playing with dolls, and outdoor games such as jump rope and ball.	word guessing activities, group games such as snakes and ladders, drawing and painting, and physical games such as running and catching a ball.	story-based games, as well as group activities such as building together with blocks. outdoor games with hide and seek and playing slides and playing ball
	Child participation	active involvement in play activities Children participate enthusiastically, learn to share, work together	involvement in more complex physical play activities such as running and catching a ball.	involvement in activities inside and outside the classroom
	Interaction with peers	involves sharing toys, and working together in group activities, which helps develop children's social skills and empathy.	includes working together in group games, joint projects, which strengthen their communication and collaboration skills.	involves collaboration on strategy game projects, and activities that develop their social, problem-solving, and communication skills.
	Creativity in play	involves construction play, and simple experiments, which encourage imagination, problem solving, and innovation in children.	collaborative activities, and science experiments, which develop children's imagination, critical thinking skills, and innovation.	art project activities, which encourage children to imagine, collaborate and express themselves freely.
Get creative	Types of creative activities	drawing, coloring, making simple crafts, and role playing, all of which encourage children's imagination and creative exploration.	collage art, drawing with various media, making craft projects from recycled materials, and musical activities, which stimulate children's creativity and innovation.	group art projects, role-play creation, creative science experiments, and poster design, encouraging children's collaboration and self-expression.
	Child involvement	active participation in games, drawing, and group activities, where they interact, share, and learn to collaborate with friends.	participation in group projects, discussion of activities, as well as artistic exploration, which increases self-confidence and the ability to work together with friends.	collaboration on art projects, active participation in role-playing, and group discussions, which develop their social, communication, and creativity skills.
	Demonstrated innovation	using simple materials for crafts, creating imaginative play, and expressing	reflected in creative experimentation with art materials, incorporation of story	seen in the creation of original role plays, the incorporation of simple technologies in

Activity	Assessment Indicators	Pembina Ujung Bulu State Kindergarten	Al Uswah State Kindergarten	Melati Private Kindergarten
		new ideas while role-playing.	elements in play, and collaboration on unique and engaging group projects.	art projects, and the exploration of new concepts in collaborative activities.
	Children's work	colorful pictures, creative crafts using simple materials, and collages.	collaborative paintings, crafts from recycled materials, and art projects with imaginative themes, reflect creativity	includes creative posters, original scripted mini-theatres, and collaborative art projects, showcasing innovation, collaboration, and self-expression
	Discussion topic	favorite stories, pets, play experiences, and environmental themes, encouraging children to share their opinions	holiday experiences, hobbies, favorite book characters, and art activities, which stimulate children's communication skills.	covers environmental issues, fantasy stories, extracurricular activities, and learning experiences at school.
	Communication skills	They share stories, ask for help, and interact with friends while playing.	through group discussions, sharing opinions about activities, and explaining their ideas.	They express opinions, discuss in groups, and participate in role-playing.
Discuss	Child participation	active involvement in games where they interact, share and learn with friends enthusiastically.	group activities, such as art projects and team games, where they collaborate, share ideas, and actively engage in the learning process.	seen in group discussions, collaborative projects, and theater activities, where they actively contribute, share ideas, and work together to achieve common goals.
	How teachers facilitate children	ask open questions, allow time to talk, encourage all children to participate, and create a safe atmosphere for sharing opinions.	invite them to share experiences, ask thought-provoking questions, and create a supportive space for communication.	organizing small groups, using visual aids, encouraging critical questions, and providing opportunities for each child to speak and share ideas.
cheerful	Class situation	filled with fun, colorful decorations, sounds of laughter, and play activities, creating a warm and safe environment for children to learn and develop.	dynamic and creative, with children engaged in group projects, active discussions, and art activities, creating a learning environment that supports exploration and collaboration	interactive and collaborative, filled with group discussions, art projects, and theater activities, creating an environment that supports creativity, communication, and cooperation among children.

Activity	Assessment Indicators	Pembina Ujung Bulu State Kindergarten	Al Uswah State Kindergarten	Melati Private Kindergarten
	Children's happiness	This can be seen from cheerful laughter, enthusiasm in playing, and enthusiasm for learning, reflecting an environment that supports their exploration and curiosity.	visible from smiles, enthusiasm in participating in group activities, and enthusiasm in art projects, reflecting a learning environment that supports social interaction and creativity.	visible from active participation in discussions, joy when collaborating on art projects, and satisfaction when expressing oneself, creating a positive learning atmosphere.
	Positive interactions	This can be seen when they share toys, help friends, play roles together, and encourage each other, creating an environment that supports friendship and cooperation.	This can be seen when they work together on group projects, share ideas in discussions, help each other in activities, and show empathy and support for friends.	This can be seen when they collaborate on art projects, discuss respectfully, support each other in theater activities, and show empathy and appreciation for their friends' contributions.
	Children's responses to fun activities	Fun activities are demonstrated through cheerful laughter, high enthusiasm, active participation, and great curiosity, creating a positive and joyful learning atmosphere.	Fun activities are demonstrated through enthusiastic engagement, big smiles, enthusiasm for collaboration, and creative expression, creating an interactive and cheerful learning environment.	Fun activities can be seen from high enthusiasm, active participation, cheerful laughter, and creativity in collaboration, creating a dynamic and positive class atmosphere.

Children at various levels of preschool enjoy various types of play appropriate to their developmental stage. At the Pembina Ujung Bulu State Kindergarten, games such as simple puzzles, role-playing, and outdoor games such as skipping rope and ball increase their active involvement in learning. At Al Uswah Kindergarten, word charades, group games, and physical activities such as running and catching balls develop their motor and social skills. Meanwhile at Melati Topanda Kindergarten, story-based games, group activities and outdoor games such as hide and seek stimulate imagination and collaboration. Positive interactions with peers and teachers help strengthen their social skills, while creativity in play, including through art projects and science experiments, provides space for self-expression and the development of critical thinking skills. Overall, these play activities not only build technical skills, but also strengthen children's social, emotional, cognitive, and motor aspects, creating a solid foundation for their future growth.

Creative activities at the preschool level involve children in various activities to encourage imagination and creative exploration. At the Pembina Ujung Bulu State Kindergarten, things like drawing, coloring and making simple handicrafts, as well as role playing, provide the foundation for developing their creativity. Al Uswah Kindergarten, through the art of collage, drawing with various media, craft projects from recycled materials, and musical activities, stimulates innovation and collaboration. Melati Topanda Kindergarten, group art projects, role-playing, creative science experiments, and poster design, encourage self-expression and collaboration. Children's active participation in these activities improves their social, communication and

creativity skills. Innovation is demonstrated by the use of simple materials at the Pembina Ujung Bulu State Kindergarten, art experiments and collaborative projects at the Al Uswah Kindergarten, as well as original role playing and exploration of new concepts at the Melati Topanda Kindergarten. Children's work reflects their diverse creativity, including drawings, crafts, collages, collaborative paintings and imaginative concept art projects. These creative activities develop children's technical, social and emotional skills holistically, preparing them for future challenges with balanced skills between creativity, collaboration and problem solving.

Discussion is an effective way to develop children's communication skills at various levels of ECE. Discussion topics such as favorite stories, pets, play experiences, and environmental issues allow them to share opinions, hone their speaking skills, and learn to listen actively. At Pembina Ujung Bulu Kindergarten, children share stories and interact with friends while playing, while at Al Uswah Kindergarten, they engage in group discussions about hobbies and artistic activities, improving their communication skills. At Melati Topanda Kindergarten, discussions about fantasy stories and school experiences help them play a role in talking and sharing ideas. Children's active participation in discussions also shows the importance of their involvement in the learning process. The teacher at the kindergarten facilitated discussions by asking open questions, providing time to talk, and creating a supportive atmosphere for sharing opinions. At Pembina Ujung Bulu State Kindergarten, teachers encourage all children to actively participate, while at Al Uswah Kindergarten, they stimulate critical thinking with relevant questions. At Melati Topanda Kindergarten, teachers organize discussions in small groups, use visual aids, and provide opportunities for each child to speak and share ideas, strengthening their communication skills collectively.

The classroom atmosphere at various levels of ECE displays a variety of characters that reflect a child-centered educational approach. At the Pembina Ujung Bulu State Kindergarten, the atmosphere is full of joy with colorful decorations and the sound of children's laughter filling the room. Children engage in play activities that create a warm and safe environment for learning and developing. At Al Uswah Kindergarten, the classroom atmosphere is dynamic and creative, with children involved in group projects, active discussions and art activities. This creates a learning environment that supports exploration and collaboration, as well as stimulates their curiosity in a variety of fun activities. Meanwhile, at Melati Topanda Kindergarten, the interactive and collaborative atmosphere is strong, with classrooms filled with group discussions, art projects and theater activities. This creates an environment that not only supports creativity, communication, and cooperation among children, but also develops their social skills in a positive way.

Children's happiness is reflected in their cheerful laughter, enthusiasm for playing, and enthusiasm for learning at all levels of ECE. They demonstrate active participation in discussions, joy when collaborating on art projects, and satisfaction in expressing themselves, creating a positive and encouraging learning atmosphere. Positive interactions between children are reflected when they share toys, help friends, play roles together, and encourage each other. This creates an environment that supports friendship, cooperation and the development of empathy at the Pembina Ujung Bulu State Kindergarten. At Al Uswah Kindergarten, positive interactions are demonstrated through working together on group projects and providing mutual support in daily activities. Meanwhile, at Melati Topanda Kindergarten, children show empathy and appreciation for their friends' contributions in various collaborative activities. Children's positive responses to fun activities can be seen from their high enthusiasm, active participation, cheerful laughter and creative expression. This creates a dynamic, interactive and joyful classroom atmosphere in all these ECE environments, facilitating a fulfilling and meaningful learning experience for the holistic development of children.

## 2. Holistic Development of Children

The results of interviews with teachers and parents showed that there was a significant improvement in aspects of children's development. From a cognitive perspective, children show increased critical thinking and problem-solving abilities. Many teachers report that children are more active in asking questions and providing opinions in discussions.

*Table 6. Interview results on holistic child development*

No	Interview questions	Teacher	Parent
1	How do you implement the BERAKSI Learning Model in the classroom?	<ol style="list-style-type: none"> <li>1. Teachers provide educational game sessions that stimulate motor and cognitive skills, such as puzzles and role-playing games.</li> <li>2. Teachers carry out creative activities such as drawing and crafts to encourage creativity.</li> <li>3. Teachers hold group discussions to develop children's communication and social skills</li> <li>4. Teachers create a fun learning atmosphere with singing, dancing and outdoor games.</li> </ol>	Parents generally give positive responses to the implementation of the BERAKSI Learning Model in the classroom. They saw improvements in children's social skills and independence, becoming more open in communication, more creative, and more enthusiastic about learning. Parents also appreciate the fun and stress-free learning atmosphere, helping children feel more comfortable and motivated.
2	What challenges did you face in implementing this model?	<ol style="list-style-type: none"> <li>1. Integrating all model components in a tight daily schedule can be difficult.</li> <li>2. Minimal props and creative materials needed for play and creative activities.</li> <li>3. Different levels of abilities and interests of children in one class.</li> <li>4. Requires good cooperation with parents to strengthen learning at home.</li> </ol>	They realize the limitations of time and resources in schools and the importance of teacher readiness to adopt new methods. Many parents are willing to provide support, such as providing creative materials and teaching aids, as well as being more actively involved in their children's learning process at home.
3	How do you see children's development in cognitive, social, emotional and motoric aspects after implementing the BERAKASI model?	<ol style="list-style-type: none"> <li>1. Cognitive Aspect: Children show improvements in problem solving and creativity.</li> <li>2. Social Aspect: The ability to interact and work together in groups is getting better.</li> <li>3. Emotional Aspect: Children are better able to express and manage their emotions, appear happier and more confident.</li> <li>4. Motor Aspects: Improvement in fine and gross motor skills through play and physical activities.</li> </ol>	Parents see positive developments in various aspects after implementing the BERAKSI Learning Model. Children are more creative and show improvements in critical thinking skills. Children become more open, sociable and able to work together with friends. Children are better able to express their emotions in healthy ways and appear happier.
4	What do teachers and parents think about this learning model?	The BERAKSI Learning Model has been very positive, seeing significant improvements in children's engagement and holistic development. They appreciate this interactive and fun approach, despite the challenges, because it helps children learn more effectively and enjoy the learning process.	Parents provide positive feedback regarding the BERAKSI Learning Model, appreciating improvements in children's creativity, social, emotional and motor skills. They support this approach as it creates a fun and effective learning environment for the holistic development of children.

From a social aspect, children involved in the BERAKSI Learning Model show significant improvements in their interaction skills with peers. They become better able to work together in groups, which is seen in group activities involving games and creative projects. Children also show increased empathy, being able to understand and appreciate the feelings and perspectives of their friends, which is an important social skill for their future development. Parents report positive changes in their children's behavior at home. Children become more open in communicating, sharing experiences, and discussing the activities they do at school. They show greater interest in collaborating with friends and engaging in games that involve cooperation, thereby strengthening their social relationships. Apart from that, increased independence can also be seen in the way children take the initiative to play and be creative. They are more confident in choosing the activities they want to do, whether it's playing outside or exploring arts and crafts. This independence not only shows development in social aspects, but also increases children's self-confidence and ability to express themselves. Overall, this model not only contributes to children's academic development, but also facilitates social and emotional growth that is important in the formation of their character.

From an emotional perspective, the BERAKSI Learning Model has succeeded in creating a supportive environment for children to express their feelings. In this context, children appear happier and more confident, which is clearly visible from their active participation in all the activities held. They are not only physically engaged, but also emotionally, creating a more enjoyable and meaningful learning experience. The cheerful atmosphere created during learning contributes to increasing children's motivation and interest in learning. With an approach that prioritizes fun, children feel freer to experiment and take risks in learning. This encourages them to more actively explore new ideas and engage in constructive discussions, which further strengthens their understanding of the material studied. Furthermore, this positive environment helps children manage their emotions better. They learn to recognize and express feelings, both positive and negative, in a safe and supportive context. This is very important in building emotional intelligence, where children can understand and manage their own emotions, as well as empathize with the feelings of others. Thus, the BERAKSI Learning Model not only facilitates academic aspects, but also plays an important role in healthy emotional development for children, equipping them to face life's challenges in the future.

### 3. Evaluation and Documentation

Analysis of documents, such as the curriculum and Learning Implementation Plan (LIP), shows that the curriculum that supports the BERAKSI Learning Model is well designed. The LIP includes clear details about how each component of the model will be implemented in daily activities. This not only provides guidance for teachers in implementing the model effectively, but also ensures that every aspect of learning is well integrated in the child's educational process. Furthermore, the child's development records show clear progress.

*Table 7. Document availability analysis results*

No	Statement	Assessment	
		In accordance	It is not in accordance with
1	Curriculum alignment with the BERAKSI model.	✓	
2	Details of play, creative, discussion and cheerful activities in the lesson plan.	✓	
3	Child development indicators in development records.	✓	
4	Evaluation results of the implementation of the BERAKSI model.	✓	

The results of observations and assessments of established development indicators show that the majority of children have experienced significant improvement. They show progress in social, emotional, and cognitive skills, which is reflected in their active participation and ability to interact positively with peers. The teacher's response to children's improvement in the BERAKSI model is very positive. Teachers enjoy seeing children's active and creative development in learning activities. The integration of play, creativity, discussion and cheerful activities in daily learning is also something that is welcomed by teachers. Teachers are also happy to see children's social and emotional progress since implementing this model. Hopefully the child's positive development will continue and provide great benefits in his education.

*Table 8. Results of teacher opinion questionnaire on learning models*

<b>Descriptive Statistics teachers opinion</b>					
	<b>N</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Mean</b>	<b>Std. Deviation</b>
question 1	32	4	5	4.31	.471
question 2	32	4	5	4.69	.471
question 3	32	3	5	4.28	.634
question 4	32	4	5	4.62	.492
Valid N (listwise)	32				

Likewise, parents are very happy with their children's development after following the BERAKSI model. They see children more active, creative and enthusiastic in learning at school. The integration of play, creativity, discussion and cheerful activities in daily learning is also welcomed. Parents are satisfied with their children's social and emotional progress since implementing this model. They hope that children will continue to experience positive improvements and get maximum benefits from the education provided.

*Table 9. Results of parent opinion questionnaire on learning models*

<b>Descriptive Statistics parents opinion</b>					
	<b>N</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Mean</b>	<b>Std. Deviation</b>
question 1	40	1	5	4.08	.888
question 2	40	2	5	4.32	.859
question 3	40	2	5	4.17	.984
question 4	40	1	5	4.07	.971
Valid N (listwise)	40				

These records not only serve as an evaluation tool for teachers, but also as valuable feedback for parents regarding their child's development. With concrete evidence of progress made, parents can better understand and support their child's learning journey. Overall, this analysis provides confidence that the BERAKASI Learning Model is not only theoretical, but also has effective practical applications in the context of early childhood education, making it an approach worthy of wider application.

### *Discussion*

The results of this research show that the BERAKSI learning model (playing, creating, discussing and being cheerful) has a significant impact in improving the holistic development of early childhood. The following discussion will further explain the effectiveness of this model, the challenges faced, and the implications for early childhood education. This learning model has proven effective in stimulating children's involvement. Play activities, as the main component, provide opportunities for children to learn through direct experience (Grace D et al., 2025). In observations, children show high curiosity and active involvement when involved in games designed to support learning. Group games not only develop fine and gross motor skills, but also stimulate creativity and adaptability (Behnamnia, Kamsin, Ismail, et al., 2020; Pantaleo, 2025;

Tu & Lee, 2025). Children learn to solve problems and negotiate with peers, which are important social skills.

Creative activities, such as drawing, painting and making crafts, allow children to express their ideas and emotions visually and practically (Leigh, 2020; Leung et al., 2023). Research finds that children who engage in arts and crafts activities experience improvements in creative thinking abilities and fine motor skills. These activities provide opportunities for children to make choices and decisions, which are important in the development of their independence. Through creating, children not only learn about techniques and tools, but also hone their imagination skills which will be useful in the future (Bae et al., 2023; Kong & Yasmin, 2022; Sakti et al., 2024). Meanwhile, discussion activities encourage children to hone their communication and listening skills. Through discussion, children learn to respect other people's opinions, consider different perspectives, and express their ideas effectively (Bae et al., 2023; Grace D et al., 2025; Kong & Yasmin, 2022). This contributes to improved social and emotional skills, where children become more empathetic and able to work together in groups. Group discussions also provide a space for children to learn how to express opinions confidently, which is very important for future communication development.

Although positive results were found, this research also identified several challenges in implementing the BERAKSI Model. One of them is the need for more training and support for teachers. Some teachers report difficulty in implementing all components of this model in a balanced manner, especially in managing time and resources. Limited learning facilities and tools, such as creative materials or sufficient space for play activities, are also a challenge, especially in areas with fewer resources. Differences in children's readiness to engage in more active activities were also seen. Some children may feel uncomfortable in situations that require a high level of social interaction. Therefore, it is important for teachers to pay attention to the individual needs of each child and adapt the approach to each child's characteristics. This requires a deep understanding of group dynamics and sensitivity to differences in personalities and learning preferences.

The BERAKSI Learning Model has broad implications for early childhood education practice. With an interactive and fun approach, this model can create a positive learning environment and support children's holistic development (Leigh, 2020; Pantaleo, 2025; Tu & Lee, 2025). This leads to the development of skills necessary for the future, including creativity, adaptability, and social abilities. The importance of collaboration between teachers and parents is also highlighted in this research. Parental involvement in supporting learning activities at home can strengthen the learning experiences gained at school (Chan & Hu, 2023; Leung et al., 2023; Sedrakyan et al., 2020). Therefore, training for parents and effective communication programs between school and home are highly recommended. Educating parents about how to support learning at home will help reinforce concepts taught at school.

Seeing the success of this model, further research can examine the implementation of the BERAKSI Learning Model in a broader context, including elementary schools and communities. In addition, further research can be conducted to evaluate the long-term impact of implementing this model on children's development, including academic and social aspects in the future. This research can provide deeper insight into how the skills acquired during early childhood education can influence a child's life later in life. Overall, this research shows that the BERAKSI Learning Model can be an effective alternative in early childhood education, providing a fun and in-depth learning experience, and supporting children's overall development. It is hoped that the implementation of this model can be the first step towards broader innovation in the approach to early childhood education in Indonesia.

Although the research results showed positive impacts, several challenges were also identified. Some teachers expressed difficulty in managing time between activities and finding ways to interest all children. Therefore, further training on classroom management and use of

existing resources is highly recommended. Recommendations from this research include the need for support from schools in providing teaching materials that support creative activities, as well as ongoing training for teachers to deepen their understanding of the implementation of the BERAKSI model. Apart from that, parental involvement in the learning process also needs to be strengthened to support children's development at home.

Overall, the BERAKSI Learning Model shows great potential in improving the holistic development of early childhood. By encouraging a more interactive and fun approach to education, this model not only makes the learning process more interesting for children, but also ensures that all aspects of cognitive, social, emotional and physical development are well supported. The success of this model in creating a positive and supportive learning environment is very important, especially in the educational context in Indonesia, where the need for innovative and relevant approaches is increasingly urgent. This research is the first step for wider implementation in various early childhood education contexts in Indonesia. By implementing the findings and recommendations from this study, it is hoped that more ECE institutions will adopt the BERAKSI Learning Model, providing a richer and more beneficial learning experience for children. Furthermore, adoption of this model can inspire better curriculum development and provide necessary training for educators. With the right support, the BERAKSI Learning Model has the potential to become the standard in early childhood education, helping prepare future generations who are not only academically intelligent but also rich in important social and emotional skills.

## **CONCLUSION**

The BERAKSI learning model (playing, creating, discussing and being cheerful) has proven to be effective in improving the holistic development of early childhood. Research shows that the application of this model is successful in stimulating children's involvement, improving cognitive, social and emotional skills, and creating a positive and enjoyable learning environment. Although there are challenges in implementation, such as the need for teacher training and limited resources, the results of this research show the great potential of interactive approaches in children's education. Recommendations for collaboration between teachers and parents, as well as ongoing training, are critical to the success of this model. Thus, the BERAKSI Learning Model can be used as a useful alternative to improve the quality of early childhood education in Indonesia, with the hope of providing a sustainable positive impact on children's development.

## **CONFLICT OF INTEREST**

The authors declare that there is no conflict of interest regarding the publication of this article entitled "*The BERAKSI Learning Model: Optimizing the Holistic Development of Early Childhood.*" This research was conducted independently without any financial, institutional, or personal relationships that could inappropriately influence or bias the work reported. All findings, interpretations, and conclusions presented in this article solely reflect the authors' scholarly perspective and academic responsibility.

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## REFERENCES

- Attanasio, O., Cattan, S., & Meghir, C. (2022). Early Childhood Development, Human Capital, and Poverty. *Annual Review of Economics*, 14(Volume 14, 2022), 853–892. <https://doi.org/10.1146/ANNUREV-ECONOMICS-092821-053234/CITE/REFWORKS>
- Bae, S. S., Vanukuru, R., Yang, R., Gyory, P., Zhou, R., Do, E. Y. L., & Szafir, D. A. (2023). Cultivating Visualization Literacy for Children Through Curiosity and Play. *IEEE Transactions on Visualization and Computer Graphics*, 29(1), 257–267. <https://doi.org/10.1109/TVCG.2022.3209442>
- Baten, E., Vlaeminck, F., Mués, M., Valcke, M., Desoete, A., & Warreyn, P. (2023). The Impact of School Strategies and the Home Environment on Home Learning Experiences During the COVID-19 Pandemic in Children With and Without Developmental Disorders. *Journal of Autism and Developmental Disorders*, 53(4), 1642–1672. <https://doi.org/10.1007/s10803-021-05383-0>
- Behnamnia, N., Kamsin, A., & Ismail, M. A. B. (2020). The landscape of research on the use of digital game-based learning apps to nurture creativity among young children: A review. *Thinking Skills and Creativity*, 37, 100666. <https://doi.org/10.1016/J.TSC.2020.100666>
- Behnamnia, N., Kamsin, A., Ismail, M. A. B., & Hayati, A. (2020). The effective components of creativity in digital game-based learning among young children: A case study. *Children and Youth Services Review*, 116, 105227. <https://doi.org/10.1016/J.CHILDYOUTH.2020.105227>
- Bhat, S. A., & Huang, N. F. (2021). Big Data and AI Revolution in Precision Agriculture: Survey and Challenges. *IEEE Access*, 9, 110209–110222. <https://doi.org/10.1109/ACCESS.2021.3102227>
- Cankaya, O., Rohatyn-Martin, N., Leach, J., Taylor, K., & Bulut, O. (2023). Preschool Children's Loose Parts Play and the Relationship to Cognitive Development: A Review of the Literature. *Journal of Intelligence* 2023, Vol. 11, Page 151, 11(8), 151. <https://doi.org/10.3390/JINTELLIGENCE11080151>
- Capron Puozzo, I., & Audrin, C. (2021). Improving self-efficacy and creative self-efficacy to foster creativity and learning in schools. *Thinking Skills and Creativity*, 42, 100966. <https://doi.org/10.1016/J.TSC.2021.100966>
- Carlier, S., Van der Paelt, S., Ongenaes, F., De Backere, F., & De Turck, F. (2020). Empowering Children with ASD and Their Parents: Design of a Serious Game for Anxiety and Stress Reduction. *Sensors* 2020, Vol. 20, Page 966, 20(4), 966. <https://doi.org/10.3390/S20040966>
- Chan, C. K. Y., & Hu, W. (2023). Students' voices on generative AI: perceptions, benefits, and challenges in higher education. *International Journal of Educational Technology in Higher Education*, 20(1), 1–18. <https://doi.org/10.1186/S41239-023-00411-8/TABLES/5>
- Cleland, J., MacLeod, A., & Ellaway, R. H. (2021). The curious case of case study research. *Medical Education*, 55(10), 1131–1141. <https://doi.org/10.1111/MEDU.14544;WGROU:STRING:PUBLICATION>
- Dalglish, S. L., Khalid, H., & McMahon, S. A. (2021). Document analysis in health policy research: the READ approach. *Health Policy and Planning*, 35(10), 1424–1431. <https://doi.org/10.1093/HEAPOL/CZAA064>
- D'Angelo, S., Marcus, R., & Ngabonzima, E. (2022). Teaching and learning for life skills development: Insights from Rwanda's 12+ programme for adolescent girls. *Development Policy Review*, 40(S2), e12622. <https://doi.org/10.1111/DPR.12622>
- Dawson R. Hancock. (2021). *Doing Case Study Research: A Practical Guide for Beginning Researchers*

- Farquhar, J., Michels, N., & Robson, J. (2020). Triangulation in industrial qualitative case study research: Widening the scope. *Industrial Marketing Management*, 87, 160–170. <https://doi.org/10.1016/J.INDMARMAN.2020.02.001>
- Grace D, T., Abel, C., & Salen Tekinbaş, K. (2025). Learning Curiosity through Play: Exploring the Role of Games and Interactive Design in Museums. *Conference on Human Factors in Computing Systems - Proceedings*. [https://doi.org/10.1145/3706598.3713164/SUPPL\\_FILE/PN4625-TALK-VIDEO-CAPTION.VTT](https://doi.org/10.1145/3706598.3713164/SUPPL_FILE/PN4625-TALK-VIDEO-CAPTION.VTT)
- Green, S. E., Rees, J. P., Stephens, P. A., Hill, R. A., & Giordano, A. J. (2020). Innovations in Camera Trapping Technology and Approaches: The Integration of Citizen Science and Artificial Intelligence. *Animals* 2020, Vol. 10, Page 132, 10(1), 132. <https://doi.org/10.3390/ANI10010132>
- Jain, N. (2021). Survey Versus Interviews: Comparing Data Collection Tools for Exploratory Research. *The Qualitative Report*, 26(2), 541–554. <https://doi.org/10.46743/2160-3715/2021.4492>
- Keung, C. P. C., & Fung, C. K. H. (2021). Pursuing quality learning experiences for young children through learning in play: how do children perceive play? *Early Child Development and Care*, 191(4), 583–597. <https://doi.org/10.1080/03004430.2019.1633313>
- Kizilaslan, A., Zorluoglu, S. L., & Sozibilir, M. (2021). Improve learning with hands-on classroom activities: science instruction for students with visual impairments. *European Journal of Special Needs Education*, 36(3), 371–392. <https://doi.org/10.1080/08856257.2020.1732110>
- Kong, C., & Yasmin, F. (2022). Impact of Parenting Style on Early Childhood Learning: Mediating Role of Parental Self-Efficacy. *Frontiers in Psychology*, 13, 928629. <https://doi.org/10.3389/FPSYG.2022.928629/BIBTEX>
- Koul, S., & Nayar, B. (2021). The holistic learning educational ecosystem: A classroom 4.0 perspective. *Higher Education Quarterly*, 75(1), 98–112. <https://doi.org/10.1111/HEQU.12271;REQUESTEDJOURNAL:JOURNAL:14682273;JOURNAL:JOURNAL:14682273;WGROU:STRING:PUBLICATION>
- Kuzik, N., Naylor, P. J., Spence, J. C., & Carson, V. (2020). Movement behaviours and physical, cognitive, and social-emotional development in preschool-aged children: Cross-sectional associations using compositional analyses. *PLOS ONE*, 15(8), e0237945. <https://doi.org/10.1371/JOURNAL.PONE.0237945>
- Kwangmuang, P., Jarutkamolpong, S., Sangboonraung, W., & Daungtod, S. (2021). The development of learning innovation to enhance higher order thinking skills for students in Thailand junior high schools. *Heliyon*, 7(6), e07309. <https://doi.org/10.1016/j.heliyon.2021.e07309>
- Leigh, J. (2020). Using creative research methods and movement to encourage reflection in children. *Journal of Early Childhood Research*, 18(2), 130–142. <https://doi.org/10.1177/1476718X19885992>
- Leung, S. K. Y., Wu, J., Lam, Y., & Ho, T. H. (2023). An explanatory study of kindergarten teachers' teaching behaviours in their visual arts classrooms. *Teaching and Teacher Education*, 124, 104018. <https://doi.org/10.1016/J.TATE.2023.104018>
- Liu, Y. J., Zhou, Y. G., Li, Q. L., & Ye, X. D. (2022). Impact Study of the Learning Effects and Motivation of Competitive Modes in Gamified Learning. *Sustainability* 2022, Vol. 14, Page 6626, 14(11), 6626. <https://doi.org/10.3390/SU14116626>
- Ly, B. C. K., Dyer, E. B., Feig, J. L., Chien, A. L., & Del Bino, S. (2020). Research Techniques Made Simple: Cutaneous Colorimetry: A Reliable Technique for Objective Skin Color Measurement. *Journal of Investigative Dermatology*, 140(1), 3-12.e1. <https://doi.org/10.1016/J.JID.2019.11.003>

- Mann, L., Chang, R., Chandrasekaran, S., Coddington, A., Daniel, S., Cook, E., Crossin, E., Cosson, B., Turner, J., Mazzurco, A., Dohaney, J., O'Hanlon, T., Pickering, J., Walker, S., Maclean, F., & Smith, T. D. (2021). From problem-based learning to practice-based education: a framework for shaping future engineers. *European Journal of Engineering Education*, 46(1), 27–47. <https://doi.org/10.1080/03043797.2019.1708867>
- Molina Roldán, S., Marauri, J., Aubert, A., & Flecha, R. (2021). How Inclusive Interactive Learning Environments Benefit Students Without Special Needs. *Frontiers in Psychology*, 12, 661427. <https://doi.org/10.3389/FPSYG.2021.661427/BIBTEX>
- Morgan, H. (n.d.). The Qualitative Report The Qualitative Report Conducting a Qualitative Document Analysis Conducting a Qualitative Document Analysis. *Number 1 How To Article*, 27, 1–3. <https://doi.org/10.46743/2160-3715/2022.5044>
- O'Flaherty, J., & Costabile, M. (2020). Using a science simulation-based learning tool to develop students' active learning, self-confidence and critical thinking in academic writing. *Nurse Education in Practice*, 47, 102839. <https://doi.org/10.1016/J.NEPR.2020.102839>
- Orson, C. N., McGovern, G., & Larson, R. W. (2020). How challenges and peers contribute to social-emotional learning in outdoor adventure education programs. *Journal of Adolescence*, 81, 7–18. <https://doi.org/10.1016/J.ADOLESCENCE.2020.02.014>
- Özhan, Ş. Ç., & Kocadere, S. A. (2020). The Effects of Flow, Emotional Engagement, and Motivation on Success in a Gamified Online Learning Environment. *Journal of Educational Computing Research*, 57(8), 2006–2031. <https://doi.org/10.1177/0735633118823159>
- Pantaleo, S. (2025). The meaning-making in kindergarten children's visual narrative compositions. *Journal of Early Childhood Literacy*, 25(2), 336–366. [https://doi.org/10.1177/14687984231161114/ASSET/E78F10F1-5339-423D-AEB7-7ABB1ACD97C0/ASSETS/IMAGES/LARGE/10.1177\\_14687984231161114-FIG3.JPG](https://doi.org/10.1177/14687984231161114/ASSET/E78F10F1-5339-423D-AEB7-7ABB1ACD97C0/ASSETS/IMAGES/LARGE/10.1177_14687984231161114-FIG3.JPG)
- Parker, F. (1999). Parent-child relationship, home learning environment, and school readiness. *School Psychology Review*, 28(3), 413–425. [https://api.elsevier.com/content/abstract/scopus\\_id/0033465713](https://api.elsevier.com/content/abstract/scopus_id/0033465713)
- Parker, R., Thomsen, B. S., & Berry, A. (2022). Learning Through Play at School – A Framework for Policy and Practice. *Frontiers in Education*, 7. <https://doi.org/10.3389/feduc.2022.751801>
- Pienimäki, M., Kinnula, M., & Iivari, N. (2021). Finding fun in non-formal technology education. *International Journal of Child-Computer Interaction*, 29, 100283. <https://doi.org/10.1016/J.IJCCI.2021.100283>
- Printer, L. (2023). Positive emotions and intrinsic motivation: A self-determination theory perspective on using co-created stories in the language acquisition classroom. *Language Teaching Research*. [https://doi.org/10.1177/13621688231204443/SUPPL\\_FILE/SJ-DOCX-1-LTR-10.1177\\_13621688231204443.DOCX](https://doi.org/10.1177/13621688231204443/SUPPL_FILE/SJ-DOCX-1-LTR-10.1177_13621688231204443.DOCX)
- Rahiem, M. D. H. (2021). Storytelling in early childhood education: Time to go digital. *International Journal of Child Care and Education Policy*, 15(1), 1–20. <https://doi.org/10.1186/S40723-021-00081-X/FIGURES/3>
- Reed, R. S., Van Wagoner, H. P., Cropanzano, R., & Jennings, T. M. (2023). Assessing the Efficacy of Online Learning in Disparate Business Subjects: Lessons from Distributed Practice and Social Learning Theory. *Journal of Management Education*, 47(5), 505–547. <https://doi.org/10.1177/10525629231178916>
- Reith-Hall, E., & Montgomery, P. (2023). Communication skills training for improving the communicative abilities of student social workers: A systematic review. *Campbell Systematic Reviews*, 19(1), e1309. <https://doi.org/10.1002/CL2.1309;JOURNAL:JOURNAL:18911803>

- Rizzi, V., Pigeon, C., Rony, F., & Fort-Talabard, A. (2020). Designing a creative storytelling workshop to build self-confidence and trust among adolescents. *Thinking Skills and Creativity*, 38, 100704. <https://doi.org/10.1016/J.TSC.2020.100704>
- Romito, B., Jewell, J., Jackson, M., Ernst, K., Hill, V., Hsu, B., Lam, V., Mauro-Small, M., & Vinocur, C. (2021). Child Life Services. *Pediatrics*, 147(1). <https://doi.org/10.1542/peds.2020-040261>
- Sahu, B., & Kumar Singh, M. (2023). *Preschool Education and An Integrated Preschool Curriculum*.
- Sakti, S. A., Endraswara, S., & Rohman, A. (2024). Revitalizing local wisdom within character education through ethnopedagogy approach: A case study on a preschool in Yogyakarta. *Heliyon*, 10(10), 31370. <https://doi.org/10.1016/J.HELIYON.2024.E31370/ASSET/7250093D-994B-4E3B-B144-C9669D42FF7A/MAIN.ASSETS/GR5.JPG>
- Sedrakyan, G., Malmberg, J., Verbert, K., Järvelä, S., & Kirschner, P. A. (2020). Linking learning behavior analytics and learning science concepts: Designing a learning analytics dashboard for feedback to support learning regulation. *Computers in Human Behavior*, 107, 105512. <https://doi.org/10.1016/J.CHB.2018.05.004>
- Shi, L., Dong, L., Zhao, W., & Tan, D. (2023). Improving middle school students' geometry problem solving ability through hands-on experience: An fNIRS study. *Frontiers in Psychology*, 14, 1126047. <https://doi.org/10.3389/FPSYG.2023.1126047/BIBTEX>
- Skivington, K., Matthews, L., Simpson, S. A., Craig, P., Baird, J., Blazeby, J. M., Boyd, K. A., Craig, N., French, D. P., McIntosh, E., Petticrew, M., Rycroft-Malone, J., White, M., & Moore, L. (2021). A new framework for developing and evaluating complex interventions: update of Medical Research Council guidance. *BMJ*, 374. <https://doi.org/10.1136/BMJ.N2061>
- Smith, K., Maynard, N., Berry, A., Stephenson, T., Spiteri, T., Corrigan, D., Mansfield, J., Ellerton, P., & Smith, T. (2022). Principles of Problem-Based Learning (PBL) in STEM Education: Using Expert Wisdom and Research to Frame Educational Practice. *Education Sciences 2022, Vol. 12, Page 728*, 12(10), 728. <https://doi.org/10.3390/EDUCSCI12100728>
- Sukackè, V., Guerra, A. O. P. de C., Ellinger, D., Carlos, V., Petronienè, S., Gaižiūnienè, L., Blanch, S., Marbà-Tallada, A., & Brose, A. (2022). Towards Active Evidence-Based Learning in Engineering Education: A Systematic Literature Review of PBL, PjBL, and CBL. *Sustainability 2022, Vol. 14, Page 13955*, 14(21), 13955. <https://doi.org/10.3390/SU142113955>
- SÜRÜCÜ, L., & MASLAKÇI, A. (2020). VALIDITY AND RELIABILITY IN QUANTITATIVE RESEARCH. *Business & Management Studies: An International Journal*, 8(3), 2694–2726. <https://doi.org/10.15295/BMIJ.V8I3.1540>
- Tu, H. Y., & Lee, S. W. Y. (2025). Curiosity, Interest, and Engagement: Unpacking Their Roles in Students' Learning within a Virtual Game Environment. *Journal of Educational Computing Research*, 62(8), 1995–2019. <https://doi.org/10.1177/07356331241277904;PAGE:STRING:ARTICLE/CHAPTER>
- Ukamaka, E. J. (2023). *Early Childhood Education and Development: Innovations and Best Practices*. <https://rojournals.org/roj-art-and-management/>
- van der Oord, S., & Tripp, G. (2020). How to Improve Behavioral Parent and Teacher Training for Children with ADHD: Integrating Empirical Research on Learning and Motivation into Treatment. *Clinical Child and Family Psychology Review 2020 23:4*, 23(4), 577–604. <https://doi.org/10.1007/S10567-020-00327-Z>
- Vinokur, E., Yomtovian, A., Itzhakov, G., Shalev Marom, M., & Baron, L. (2023). Social-Based Learning and Leadership (SBL): Theory Development and a Qualitative Case Study. *Sustainability*, 15(22), 15800. <https://doi.org/10.3390/su152215800>
- Wang, M. Te, & Hofkens, T. L. (2020). Beyond Classroom Academics: A School-Wide and Multi-Contextual Perspective on Student Engagement in School. *Adolescent Research Review*, 5(4), 419–433. <https://doi.org/10.1007/S40894-019-00115-Z/METRIC>

- Weber, A. M., & Greiff, S. (2023). ICT Skills in the Deployment of 21st Century Skills: A (Cognitive) Developmental Perspective through Early Childhood. *Applied Sciences*, 13(7), 4615. <https://doi.org/10.3390/app13074615>
- Wen, Y. (2021). Augmented reality enhanced cognitive engagement: designing classroom-based collaborative learning activities for young language learners. *Educational Technology Research and Development*, 69(2), 843–860. <https://doi.org/10.1007/S11423-020-09893-Z/METRICS>
- Xia, Q., Chiu, T. K. F., Lee, M., Sanusi, I. T., Dai, Y., & Chai, C. S. (2022). A self-determination theory (SDT) design approach for inclusive and diverse artificial intelligence (AI) education. *Computers & Education*, 189, 104582. <https://doi.org/10.1016/J.COMPEDU.2022.104582>
- Xiao, M. (2020). A system active learning Kriging method for system reliability-based design optimization with a multiple response model. *Reliability Engineering and System Safety*, 199. <https://doi.org/10.1016/j.res.2020.106935>
- Zeng, J., Parks, S., & Shang, J. (2020). To learn scientifically, effectively, and enjoyably: A review of educational games. *Human Behavior and Emerging Technologies*, 2(2), 186–195. <https://doi.org/10.1002/HBE2.188>
- Zhang, C. (2019). Fuzzy multi-SVR learning model for reliability-based design optimization of turbine blades. *Materials*, 12(15). <https://doi.org/10.3390/ma12152341>

## Computational Thinking-Based Metacognitive Learning Assessment: Issues and Challenges

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### ABSTRACT

Metacognition is identified as the awareness and control of thinking for learning, which plays a crucial role in students' problem-solving performance. This urgency is further accentuated in the context of computational thinking, as practicing computational thinking through programming relies on problem-solvers' metacognition. However, the reality is that CT assessment is still in its infancy, particularly for formative assessment, and metacognitive strategies are often not explicitly taught. This study aims to identify critical issues and formulate further research challenges in CT-based metacognitive learning assessment. The method used is a systematic literature review to identify, evaluate, and synthesize all relevant scientific evidence. Four main issues were identified, including the need for rigorous experimental methods to validate CT assessments, Conceptual gaps regarding whether and how CT can support the development of metacognitive strategies, Challenges in implementing more nuanced scaffolding, and Limited intervention duration, even though improving metacognition requires long-term learning interventions. Furthermore, there are challenges in optimizing learning management systems as metacognitive tools. Metacognitive assessments should explicitly measure cognitive regulation (planning, monitoring, and evaluation) using authentic methods, such as think-aloud. This study's contribution is to provide a structured roadmap for further research, focusing on strengthening validity, clarifying causal relationships, and optimizing digital implementations to foster students' higher-order problem-solving skills.

**Keywords:** *computational thinking, learning assessment, learning management system, metacognition, metacognitive scaffolding*



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### INTRODUCTION

Metacognition is broadly defined as the awareness and control of thinking for learning (Stanton et al., 2021), and as a second-order or higher-order thinking process involving active control over cognitive processes (Zarouk & Khaldi, 2016). This central concept is structured into two main components: Metacognitive Knowledge and Metacognitive Regulation (Mahande et al., 2021). Metacognitive Knowledge encompasses self-understanding as a learner, encompassing declarative knowledge (learning about something), procedural knowledge (knowing how to do something), and conditional knowledge (knowing why and when) (Mahande et al., 2021). Meanwhile, Metacognitive Regulation, which focuses on actions for learning, is classified into three key processes: planning, monitoring, and evaluation (Stanton et al., 2021).

Through this regulation, metacognition enables effective control over ongoing cognition (Callaway et al., 2023) and is a self-directed process by which learners transform their mental abilities into academic skills (Bonner et al., 2021). Therefore, this ability is considered crucial because it plays a significant role in students' problem-solving performance (Zhou et al., 2023) and is essential for organizing thinking strategies to achieve learning goals.

Metacognition plays a crucial role in learning and problem solving, as it influences the acquisition, understanding, retention, and application of what is learned (Yadav et al., 2022). Metacognitive knowledge involves knowing when to use, how to coordinate, and how to monitor various skills in problem solving (Zhou et al., 2023). Metacognition, broadly defined as human awareness of mental operations such as perception, remembering, and thinking and the ability to control them (Sengul & Katranci, 2012), is a system that regulates individual learning and cognition, as metacognition refers to the process of becoming aware of one's cognitive structure and learning characteristics (Sengul & Katranci, 2012). According to Flavell, metacognition functions as a system that organizes information, experiences, goals, and strategies (Sengul & Katranci, 2012), and individuals with more developed metacognitive skills have been shown to be better problem solvers, decision makers, and critical thinkers than others (Sengul & Katranci, 2012). Essentially, the primary function of the metacognitive system is to enable effective control over ongoing cognition (Callaway et al., 2023), which is reflected in a model that describes how metacognitive monitoring (feeling of knowing) can dynamically inform metacognitive memory (direction of retrieval efforts) (Callaway et al., 2023). Within this framework, metacognition involves interactions between meta-level processes and object-level meta-processes, where meta-level processes integrate the state of object-level processes and their control (Callaway et al., 2023). Metamemory, as a higher-order process, refers to higher-order processes that integrate and control basic processes of recognition (Callaway et al., 2023), thus enabling meta-level agents to optimally control how long these processes continue (Callaway et al., 2023). This component of mental behavior is also emphasized by Schoenfeld who divides it into information about one's thought processes, action control or self-regulation, beliefs and attitudes (Sengul & Katranci, 2012).

The importance of metacognition lies in the awareness and control of thinking for learning (Stanton et al., 2021), which allows students to actively monitor and regulate their cognitive processes in achieving goals (Flavell, 2024). Metacognition is an important thinking skill that must be mastered by students (Agung et al., 2023), because strong metacognitive skills have the power to influence student learning and performance. Historically, Flavell (1979) defined metacognition as the active monitoring and consequent regulation and orchestration of these processes in relation to the cognitive objects or data they carry, usually to achieve concrete goals or objectives (Flavell, 2024). Metacognition makes a significant contribution to academic success; for example, students with good metacognitive skills can identify concepts they do not understand and choose appropriate strategies to learn those concepts. They can also evaluate their strategies and adjust their plans based on the results (Stanton et al., 2021). This metacognitive function is very important in problem solving, where good metacognition will make students able to solve problems well, and metacognition is very important for every student to develop independence in learning (Agung et al., 2023). Furthermore, in an academic context, Metacognition influences the perception and processing of information in a way that influences students in improving learning outcomes (Agung et al., 2023), and the creative thinking process in students at a high metacognitive level consists of understanding problems, formulating problem-solving strategies, implementing problem-solving strategies, evaluating problem-solving solutions (Akmam et al., 2023). Therefore, metacognition is a strategy that facilitates students on how to learn, and explicit metacognitive training can significantly improve students' creative problem-solving abilities (Akmam et al., 2023).

Metacognitive thinking ability has a reality of varying metacognitive thinking ability among students, and in practice, self-regulation, which is important for problem solving and includes metacognitive strategies, is the ability of students to direct efforts to complete an academic task in class (Sengul & Katranci, 2012). However, this ability is often not fully applied or mastered, because research shows that students are often not explicitly taught metacognitive strategies. (Sengul & Katranci, 2012), whereas individuals with more developed metacognitive skills are also better problem solvers, decision makers, and critical thinkers than others (Sengul & Katranci, 2012). In fact, when faced with problems, different levels of metacognitive awareness influence problem-solving success; for example, students with reflective metacognitive awareness have the highest computational thinking ability because they meet three of the four CT indicators (Sudadi et al., 2023), while students with tacit metacognitive awareness do not meet the computational thinking indicators when solving problems (Sudadi et al., 2023). Furthermore, the reality is that most students do not consider important aspects such as time allocation; 70% of survey participants did not consider time constraints for solving problems (Sengul & Katranci, 2012), and some students were unable to solve any of the problems (Sengul & Katranci, 2012). Although metacognition has a direct and positive correlation with high school students' mathematical modeling skills (Zhang et al., 2024), the reality is that metacognitive experiences do not directly affect mathematical modeling skills (Zhang et al., 2024).

The urgency of metacognitive research is emphasized because there is still a lack of in-depth research on pre-programming metacognitive planning that needs to be addressed (Zhou et al., 2023), moreover, these important metacognitive strategies are often not taught explicitly to students, despite having a significant impact on academic outcomes (Yadav et al., 2022). Although Higher Order Thinking Skills (HOTS) learning is closely related to metacognition, studies that focus on metacognitive-based HOTS teaching module elements are still limited (Hamzah et al., 2022), along with the fact that little research has been conducted on systematic literature reviews of metacognitive elements. Further research is also needed to bridge theoretical insights by incorporating inquiry elements into metacognitive components (planning, monitoring, and evaluation) (Hamzah et al., 2022). Furthermore, further research is also needed to analyze the micro-process of seeking help in SRL (Bonner et al., 2021). Metacognition is key to successful learning and problem-solving because it regulates awareness, control, and optimization of one's own independent thought processes. Without metacognition, learning becomes passive, error detection is difficult, retention is weak, and problem-solving often fails or is inefficient.

Computational Thinking (CT) is widely identified as a way of thinking that helps individuals think like computer scientists in solving practical problems. This central concept refers to the processes involved in problem solving, system design, and understanding human behavior, utilizing fundamental concepts of computer science (Zhou et al., 2023). Therefore, CT is viewed as a set of essential concepts and thought processes that help learners formulate, analyze, and represent problems (Zhou et al., 2023), as the solutions to these problems can be represented as computational steps and algorithms. Furthermore, CT consists of three main dimensions: computational concepts, computational practices, and computational perspectives. In more detail, the core aspects of CT include abstraction, decomposition, algorithms, debugging, iteration, and generalization (Yadav et al., 2022). Meanwhile, Computational Practices, which are aspects used by thinkers in various environments, include processes such as being incremental and iterative, testing and debugging, reusing and mixing, and abstracting and modularizing (Bonner et al., 2021). Therefore, CT functions as a universal talent and skill (Bonner et al., 2021), which is essential for formulating problems so that their solutions can be implemented effectively by information processing agents, both human and machine (Lei et al., 2020), so that CT is a way of thinking about how to solve problems (Zhou et al., 2023).

Computational thinking is a way of thinking that helps people think like computer scientists to solve practical problems. (Zhou et al., 2023). According to Wing (2006), computational thinking refers to the thinking process of computer scientists involved in solving problems, designing systems, and understanding human behavior, by referring to the fundamental concepts of computer science (Wing, 2006). Computational thinking is a problem-solving method that combines computational elements to analyze and structure problems, and design solutions or systems (Shin et al., 2024). Computational thinking is a set of problem-solving skills that must be mastered and improved by today's students (Markandan et al., 2022). The spiritual core of the 21st-century skills framework is system learning and innovation skills including critical thinking and problem solving, communication and collaboration, creativity and innovation. Many of these skills are highly relevant to computational thinking (Wang et al., 2024). In his journal, Sudadi (2023) explains that computational thinking is undeniably closely related to divergent thinking, innovativeness, problem solving, conceptual thinking, repetition, collaboration, patterns, synthesis, and self-reflection (Sudadi et al., 2023). Yu Wang (2024) concludes that computational thinking is an important skill for students to succeed in the 21st-century digital society (Wang et al., 2024).

The importance of computational thinking (CT) stems from its core definition as a thinking process involved in formulating problems and expressing their solutions in such a way that computers—humans or machines—can carry them out effectively (Lei et al., 2020). A comprehensive meta-analysis revealed that computational thinking and academic achievement were positively correlated (0.288) among students, underscoring the view that studying CT significantly helps learning outcomes (Lei et al., 2020). Most importantly, CT helps in the interpretation, analysis, and solution of various problems through the application of abstraction, algorithms, and systemic thinking. Abstraction, a key component, identifies key features and their relationships while ignoring irrelevant distractions to accurately represent a problem. Furthermore, an algorithm is considered an abstraction of a process that uses input representations of a problem to execute a series of actions and produce an output solution (Lei et al., 2020). These computational thinking processes—specifically abstraction, algorithmic processing, and systemic thinking—are crucial because they can help students build complex systems of understanding across academic subjects such as mathematics, science, and language (Lei et al., 2020). For example, students apply computational reasoning in science when they abstract the elements of compounds and in mathematics when they apply arithmetic algorithms. Therefore, the moderate positive correlation found confirms that the abstract and systemic aspects of computation effectively support learning across academic domains (Lei et al., 2020).

Computational Thinking (CT) has gained significant traction as an approach to bringing computer science tools and practices into K-12 classrooms, since Jeannette M. Wing popularized it in 2006 as a skill every student should possess (Yadav et al., 2022). CT is understood as solving problems, designing systems, and understanding human behavior, utilizing fundamental computer science concepts (Yadav et al., 2022), thus embodying fundamental skills everyone should acquire (Markandan et al., 2022). However, despite CT's widespread recognition, the reality of its implementation in schools remains debated, with major questions remaining unanswered regarding whether and how children engage in computational thinking and how CT may impact their problem-solving behavior and academic achievement (Yadav et al., 2022). Furthermore, efforts to incorporate CT skills through programming in STEM curricula, such as in Malaysia, pose significant challenges, especially for educators (Markandan et al., 2022). Despite these challenges, a meta-analysis of 34 studies confirmed that CT learning was significantly positively associated with students' overall academic achievement ( $r = 0.288$ ). (Lei et al., 2020), even showing that this positive relationship is stronger in Eastern cultures, at the elementary school level, and among female students (Lei et al., 2020). This fact supports the view that CT

instruction can be a tool to explicitly teach metacognitive strategies that are important for academic outcomes (Yadav et al., 2022).

The urgency of computational thinking research is emphasized because key unanswered questions remain regarding whether and how children engage in computational thinking and how computational thinking may influence their problem-solving behavior and academic achievement (Yadav et al., 2022). Therefore, there is a need to better understand whether and how computational thinking can support the development of metacognitive strategies (Yadav et al., 2022). Furthermore, future research should expand on this research and examine how computational thinking can guide teachers to explicitly teach metacognitive strategies and influence students' problem-solving and learning outcomes (Yadav et al., 2022). Furthermore, because too few studies examined in this meta-analysis used controlled experimental designs to test moderating effects (Lei et al., 2020), further research is needed using rigorous experimental methods to ascertain whether the use of computational thinking formative assessment tasks can lead to improvements in student learning (Bonner et al., 2021). According to the authors, Computational thinking is a core 21st-century skill that solves complex problems creatively, systematically, and innovatively like computer scientists, supporting success in the digital age.

Scaffolding is a tool that helps teacher-student interactions (Wang et al., 2024). Metacognitive scaffolding helps learners monitor and regulate their problem-solving process by providing structured support (Shin et al., 2024). Scaffolding for metacognition, such as questioning and modeling strategies, can help learners reflect on their understanding (Zhou et al., 2023). The introduction of scaffolding in programming learning allows learners to independently identify their strengths with teacher assistance, become more aware of their current learning status, and identify problems in a timely manner (Wang et al., 2024). Yu Wang (2024) explains in detail that scaffolding Metacognitive scaffolding provides new ideas to address this problem by assisting students in four areas: self-planning, self-monitoring, self-reflection, and self-evaluation, to foster a deeper understanding of their own knowledge acquisition process and the problems encountered in completing tasks, as well as to encourage spontaneous reflection and analysis of deficiencies (Wang et al., 2024). Metacognitive scaffolding is crucial because metacognitive knowledge guides students in selecting, evaluating, and refining cognitive strategies, which are essential for creative thinking (Akmam et al., 2023), especially in problem solving. In an academic context, scaffolding elements such as the use of answer keys enhanced with reflection questions can support students in evaluating their learning (Stanton et al., 2021).

The reality of metacognitive abilities shows that novice learners often get stuck when one of these aspects goes wrong due to a lack of metacognitive abilities (Wang et al., 2024), therefore scaffolding interventions are very necessary. Studies confirm that metacognitive scaffolding helps students determine the current learning state, adopt self-questioning, and monitor cognitive processes to compensate for their deficiencies (Wang et al., 2024) ; furthermore, a simpler type of support (semi-scaffolding) was found to be sufficient and efficient for the development of students' computational thinking (Zhou et al., 2023). However, the reality is that metacognitive abilities as a whole do not significantly improve metacognitive abilities (Wang et al., 2024), because the improvement of metacognitive abilities requires long-term learning interventions (Wang et al., 2024).

The urgency of metacognitive scaffolding research is emphasized because novice programmers often get stuck when one of these aspects is wrong due to a lack of metacognitive skills (Wang et al., 2024), so this intervention offers new ideas to address this problem that is difficult to address with programming alone. Further research is urgently needed because few studies have clarified the effects of metacognitive scaffolding on CT and little research on CT development has focused on students' metacognitive processes (Wang et al., 2024).

Furthermore, there are still limitations, because research on the combined effects of metacognition and cognitive scaffolding is still limited, underscoring the need for further research (Shin et al., 2024). Moreover, studies are often short-term, whereas improving metacognitive skills requires long-term learning interventions (Wang et al., 2024). Research shows that when metacognitive elements are incorporated into a module or learning design, it can enhance the effectiveness of metacognitive learning and the efficacy of students' facts, objectives, materials, and learning activities—bringing a positive influence on student learning (Hamzah et al., 2022). Specifically, metacognitive scaffolding facilitates regulatory skills such as planning, monitoring, and evaluating (Stanton et al., 2021). Furthermore, explicit metacognitive training significantly improves students' creative problem-solving abilities (Akmam et al., 2023). Thus, metacognitive scaffolding enables students to become more adept at thinking and more effective and efficient in their learning (Stanton et al., 2021). Metacognitive scaffolding serves as a structured guide from the teacher that facilitates students' planning, monitoring, reflecting, and evaluating their own thinking processes, thereby gradually building metacognitive independence and deeper problem-solving.

Metacognitive assessment is currently identified as an important component that focuses on awareness and control of thinking for learning (Stanton et al., 2021) and is a higher-order thinking process that involves active control over cognitive processes (Zarouk & Khaldi, 2016). This assessment is divided into two main components: metacognitive knowledge (metacognitive knowledge) and metacognitive regulation (metacognitive regulation) (Stanton et al., 2021). Because metacognitive regulation includes planning, monitoring, and evaluation (Stanton et al., 2021), these aspects are often the focus of measurement, especially in the context of vocational education and Project-Based Learning (PBL) (Zarouk & Khaldi, 2016).

To comprehensively measure metacognition, various authentic assessment methods are used. One recommended method is think-alouds (concurrent verbal reports), which serve to test the substantive processes involved in performance (Bonner et al., 2021) and provide evidence of construct validity for test-based interpretations (Bonner et al., 2021), thereby helping to verify that the measured thinking processes are consistent with the desired construct. Furthermore, LMSs can be transformed into collaborative metacognitive tools and support Self-Regulated Learning (SRL) (Zarouk & Khaldi, 2016) to facilitate assessment.

In a digital environment, enhanced Learning Management Systems (BLEMS) enable the integration of assessment rubrics that measure planning, monitoring, and evaluation (Bonner et al., 2021), where the LMS helps students create planning documents, summarize project progress, and submit final project reports. Comprehensive assessments often adopt a Triad Assessment Approach that combines self-assessment, peer-assessment, and teacher-assessment (Mahande et al., 2021), so that students are actively involved in assessing their higher-order thinking skills, namely metacognitive thinking (Mahande et al., 2021). The importance of this assessment is emphasized because metacognitive abilities play a significant role in students' problem-solving performance (Zhou et al., 2023) and influence performance in Computational Thinking.

Metacognitive assessment, according to Bonner et al. (2021), aims to produce information that can be interpreted in terms of the targeted construct (Bonner et al., 2021). This assessment involves cognitive knowledge and cognitive regulation (Zhou et al., 2023). Sarah Bonner (2021) describes the use of think-alouds to examine the substantive processes involved in performance on a formative computational thinking assessment designed to support self-regulated learning. Our task design model includes three phases of working on a computational thinking problem: forethought, performance, and reflection (Bonner et al., 2021). Bonner (2021) also adds that this method relies on test takers' verbal reports of their thinking simultaneously with task performance (Bonner et al., 2021). In Ying Zhou's (2023) research instrument, metacognitive

planning is presented as written metacognitive planning assessed based on evaluation criteria (Zhou et al., 2023).

The importance of metacognitive assessment is emphasized because it facilitates improved student understanding and learning outcomes. Tools such as answer keys enhanced with reflection questions can support students in evaluating their learning after completing assignments (Stanton et al., 2021). Furthermore, these assessments play a role in a broader context, where metacognitive knowledge guides students in selecting, evaluating, and refining cognitive strategies, which are crucial for creative thinking (Akmam et al., 2023). By using metacognitive assessments, students can evaluate their strategies and adjust their plans based on the results, thus becoming more adept at thinking and more effective and efficient in their learning (Stanton et al., 2021). Bonner (2021) adds that assessment tasks are often designed based on the self-regulated learning (SRL) model, which involves three phases of the cycle: forethought, performance, and reflection (Bonner et al., 2021). CT assessment can also be done by analyzing students' code artifacts based on criteria such as syntax, semantics, efficiency, and complexity (Shin et al., 2024).

Metacognitive assessment in Learning Management Systems (LMS) is rooted in the need to measure and support students' Self-Regulated Learning (SRL), especially in the context of Project-Based Learning (PBL) and vocational education (Mahande et al., 2021). Although conventional LMS While LMSs typically do not operate interactively and personally for students (Zarouk & Khaldi, 2016), the basis for implementation is transforming the LMS into a metacognitive tool. This is achieved by integrating assessment instruments and rubrics that cover three key aspects of metacognitive regulation: planning, monitoring, and evaluation (Mahande et al., 2021). The assessment rubrics are then integrated into the BLEMS method to facilitate the Triad Assessment Approach that combines self-assessment, peer-assessment, and teacher assessment (Mahande et al., 2021). Through this integration, the LMS supports students' SRL processes in accordance with the Zimmerman cycle model, allowing students to create planning documents, monitor project progress, and evaluate final project reports online (Mahande et al., 2021), so that they actively involved in assessing their higher-order thinking skills, namely metacognitive thinking (Mahande et al., 2021).

Computational Thinking (CT) assessment shows that although CT has become a priority in computer science education in the US due to the high demand for technology workers, CT assessment is still in its infancy, particularly for formative assessment (FA) (Bonner et al., 2021). The lack of practical tools for high-quality FA at the secondary school level is evident, particularly for assessing complex cognitive constructs such as CT (Bonner et al., 2021). Furthermore, the reality of validation studies using think-aloud methods reveals that too few of the studies examined in this meta-analysis used controlled experimental designs to test for moderating effects, thus necessitating rigorous methods to substantiate their claims regarding the impact of FA on student learning (Bonner et al., 2021). Further research is needed to determine whether the use of CT formative assessment tasks can lead to improved student learning.

Computational Thinking (CT) assessment research is emphasized because, despite CT being recognized as an essential 21st-century skill, major questions remain unanswered regarding whether and how children engage in computational thinking and how CT may impact their problem-solving behavior and academic achievement (Yadav et al., 2022). Furthermore, too few studies examined in this meta-analysis used controlled experimental designs to test for moderating effects (Lei et al., 2020), so future research should use rigorous methods to test whether CT formative assessment tasks can lead to improved student learning (Bonner et al., 2021). Structured assessments of Computational Thinking (CT) currently examine the thinking processes involved in problem-solving, system design, and understanding human behavior, utilizing fundamental concepts of computer science (Zhou et al., 2023). Assessments encompass CT encompassing dimensions of computational concepts, computational practices, and

computational perspectives (Bonner et al., 2021). To ensure construct validity, a structural approach was used through authentic methods, such as think-aloud, which aim to examine the substantive processes involved in performance, as well as provide evidence of the construct validity of test-based interpretations (Bonner et al., 2021). Furthermore, CT was assessed based on student-generated artifacts, such as programming code, which were then analyzed using a rubric to measure CT concepts and practices.

LMS, particularly those designed to support project-based learning (PBL) such as Blended Learning Management Systems (BLEMS), can serve as environments that support key aspects underlying Computational Thinking, although sources do not explicitly use the term. These systems are built as collaborative metacognitive tools and support Self-Regulated Learning (SRL) (Zarouk & Khaldi, 2016), based on the Zimmerman cycle model. Furthermore, LMS are developed to support soft skills relevant to the workplace, such as analytical thinking, creativity, problem-solving, and leadership (Mahande et al., 2021), as these abilities are classified as critical thinking governed by reflective or metacognitive thinking. Metacognition serves as the foundation for controlling and regulating cognitive processes. Therefore, these LMS integrate assessment rubrics that measure metacognitive regulation (planning, monitoring, and evaluation) (Mahande et al., 2021), which are essential skills in structured problem-solving. Through the integration of these features, such as Mind Mapping (Zarouk & Khaldi, 2016), and Learning Analytics, the LMS creates a framework that supports cognitive regulation, problem solving, and in-depth strategic analysis, which are essential prerequisites for the development of higher-order computational thinking skills.

Computational Thinking -based metacognitive assessments do not simply measure code output, but rather capture students' thinking processes in a holistic and authentic way. By integrating think-aloud techniques, written planning, code artifact analysis, and self-regulated learning tasks (forethought–performance–reflection), these assessments are able to uncover metacognitive knowledge (about oneself and strategies) as well as cognitive regulation (planning, monitoring, and evaluation) in the context of programming or projects. Computational Thinking (CT)-based metacognitive assessments are activated in the awareness and control of thinking for learning, as metacognition refers to the active monitoring and consequent regulation and orchestration of these processes in relation to the cognitive objects or data they carry, usually to achieve some concrete goal or objective (Flavell, 2024). In the context of problem-solving through programming, this process is crucial, as practicing computational thinking through programming depends on the problem-solver's metacognition. (Zhou et al., 2023) and metacognitive abilities are very important for CT to guide students in choosing thinking strategies, planning and evaluating thinking processes (Zhou et al., 2023).

The urgency of further research in the application of metacognitive assessment based on Computational Thinking (CT) is crucial because Computational Thinking relies heavily on problem-solving metacognition, thus practicing computational thinking through programming relies on problem-solver metacognition (Sengul & Katranci, 2012). Metacognition is necessary because metacognitive abilities are crucial for CT to guide students in selecting thinking strategies, planning and evaluating thinking processes, and breaking down complex actions into conditional sequences (Yadav et al., 2022). Although metacognition is often not taught explicitly, the integration of CT in K-12 classrooms provides a mechanism for teachers to explicitly engage their students in developing and using metacognitive strategies (Yadav et al., 2022). Existing research suggests that metacognitive scaffolding has an effect on CT problem-solving performance, but these findings require further strengthening and verification, with larger sample sizes and perhaps more nuanced scaffolding for these two dimensions (Bonner et al., 2021). Furthermore, future studies should be implemented over a longer period of time and should further examine whether metacognitive planning will change students' computational concepts, practices, and perspectives with a larger number of participants (Bonner et al., 2021),

to ensure that the designed metacognitive interventions and assessments are able to improve all aspects of CT.

The link between metacognitive assessment and CT is emphasized by the finding that metacognition plays a significant role in students' problem-solving performance (Zhou et al., 2023), which is a crucial aspect of CT. Because metacognition is a higher-order process that monitors and controls basic memory processes (Callaway et al., 2023), its measurement should include processes that reflect computational thinking. For example, one study found that metacognitive planning performance related to problem description and program comprehension significantly interfered with problem-solving performance, suggesting specific elements that should be emphasized in assessment (Zhou et al., 2023). Furthermore, CT elements such as testing and debugging are often synonymous with metacognitive monitoring, defined as the informal mental tracking of one's performance processes and outcomes (Bonner et al., 2021). Concrete studies show that metacognition has a direct and positive correlation with middle school students' mathematical modeling skills (Zhang et al., 2024), and critical thinking (critical thinking), which is a dimension of CT, mediates the relationship between metacognitive knowledge, experience, monitoring, and mathematical modeling skills (Zhang et al., 2024), indicating that adequate metacognition can enhance middle school students' critical thinking computational thinking and improve their mathematical modeling skills (Zhang et al., 2024). This approach provides valid and rich evidence on how students recognize problems, design solutions, detect errors, and reflect on their own processes, so that teachers can provide targeted feedback to develop independent learning in the digital era.

The interrelationship between metacognition, Computational Thinking (CT), and Learning Management Systems (LMS) forms a pedagogical framework that leverages technology to support the development of higher-order thinking skills essential for problem solving. Metacognition is the ability to monitor and control cognitive processes (Yadav et al., 2022), which refers to awareness of one's own cognitive processes and the ability to control and integrate those processes (Yadav et al., 2022). Metacognition plays a crucial role in students' problem-solving performance (Zhou et al., 2023), and specifically, practicing computational thinking through programming relies on the problem solver's metacognition. (Zhou et al., 2023). Computational Thinking (CT) is defined as the process of solving problems, designing systems, and understanding human behavior, by utilizing basic concepts of computer science (Zhou et al., 2023). Because metacognition functions to monitor and control cognitive processes (Yadav et al., 2022), metacognition is very important for CT to guide students in choosing thinking strategies, planning and evaluating thinking processes, and breaking down complex actions into conditional sequences (Zhou et al., 2023).

Metacognition has two components, namely metacognitive knowledge and metacognitive skills (Zarouk & Khaldi, 2016), where metacognitive skills include the planning phase (Planning Phase), the control phase (Control Phase), and the evaluation phase (Evaluation Phase) (Zarouk & Khaldi, 2016). These phases align with CT practices: for example, planning in metacognition is related to CT such as decomposition (breaking down a complex problem into sub-problems) and algorithmic thinking (designing a sequence of solution steps), while monitoring and evaluation align with debugging practices in CT. In fact, it was found that metacognitive planning performance related to 'problem description' and 'program understanding' correlates significantly with programming problem-solving performance (Zhou et al., 2023).

Meanwhile, Learning Management Systems (LMS) can be transformed into collaborative metacognitive tools and support Self-regulated Learning (SRL) (Zarouk & Khaldi, 2016) to support metacognition and CT. Although traditional LMSs typically do not operate in an interactive and personalized manner for students (Zarouk & Khaldi, 2016), enhanced LMSs (such as Blended Learning Management Systems or BLEMS) support students' SRL development based on the Zimmerman cycle model. This model organizes learning activities into three phases: the

Forethink phase (planning), the Performance phase (monitoring/control), and the Reflection phase (evaluation). LMSs facilitate metacognitive assessment rubrics that measure the three aspects of metacognitive regulation (planning, monitoring, and evaluation) (Mahande et al., 2021). In the context of PBL, LMSs enable students to create planning documents, summarize project progress, and produce final project reports (Mahande et al., 2021), and encourage active student engagement in learning. assess their Higher-Order Thinking Skills, namely metacognitive thinking (Mahande et al., 2021), which in turn supports CT skill training in programming problem solving.

The urgency of further research in the application of metacognition, Computational Thinking (CT), and Learning Management Systems (LMS) lies in the fact that the success of CT problem solving is highly dependent on problem-solving metacognition, as practicing computational thinking through programming relies on problem-solver metacognition (Zhou et al., 2023). Therefore, research is needed to optimize how LMS can function as a metacognitive tool. Although semi-scaffolding, which focuses on problem description and program understanding, has been shown to be efficient in supporting CT, this finding requires further verification, so further research should be further verified with a larger sample size and perhaps with more nuanced scaffolding for these two dimensions (Zhou et al., 2023). In addition, more in-depth and continuous studies are needed, which may need to be conducted for a longer period of time (Zhou et al., 2023), and researchers should develop more specific metacognitive planning measures and build more types of scaffolding with different characteristics to meet the needs of different students (Zhou et al., 2023), to ensure that scaffolding interventions in the LMS environment can effectively and efficiently foster students' computational thinking abilities.

## **METHODS**

Research in the field of metacognition and Computational Thinking (CT) shows that the Systematic Literature Review (SLR) method still has urgency, because little research has been done on systematic literature reviews on metacognitive elements. Although sources emphasize the need for further reviews, other relevant types of research designs found in the reviewed literature include the use of controlled experimental designs to test moderating effects in meta-analyses, and the need to apply rigorous methods in follow-up studies.

The author used the Systematic Literature Review (SLR) method to identify, evaluate, and synthesize all relevant and published scientific evidence on the topic of "Computational Thinking-Based Metacognitive Learning Assessment: Issues and Challenges" in a transparent, systematic, and reproducible manner. To ensure the scientific quality and relevance of the study, the methodology was executed through the following structured phases:

- 1) **Sampling and Selection Criteria:** The literature was retrieved from high-impact international and national databases (e.g., Scopus, Web of Science, and Sinta) to ensure the inclusion of high-quality sources. The selection was restricted to peer-reviewed articles published between 2019 and 2024, focusing on educational technology integration and pedagogical practices.
- 2) **Data Collection Procedures:** The search strategy employed specific keywords, including "Computational Thinking," "Metacognitive Assessment," and "Instructional Technology," to ensure alignment with the journal's focus and scope.
- 3) **Thematic Analysis:** The identified literature was synthesized to categorize issues and challenges into three domains: technological barriers, curriculum design gaps, and instructional innovation needs.

This rigorous approach ensures that the results provide a comprehensive "Section-by-Section Evaluation" of the current state of CT-based metacognitive assessment, offering significant contributions to knowledge in the field.

## RESULTS AND DISCUSSION

### *Issue Contribution*

The main issues that can be raised regarding metacognitive learning assessment based on Computational Thinking (CT):

#### A. Methodological Issues and Validity of CT Assessment

1. **Limitations of Formative Assessment Tools:** Reality shows that CT assessment is still in its infancy, especially for formative assessment (FA), and there is a lack of practical tools for high-quality FA at the secondary school level, especially for assessing complex cognitive constructs. Current CT assessment instruments still have difficulty covering all age groups of students and often lack adequate scientific documentation and validation (Poulakis & Politis, 2021).
2. **Need for Rigorous Experimental Designs:** There are validity issues in the existing research because too few of the studies examined in this meta-analysis used controlled experimental designs to test moderation effects, so future research should use rigorous methods to test claims and determine whether CT formative assessment tasks can result in increased student learning. In line with this, it is necessary to integrate various contexts, problem types, and item formats using competency-based assessment methods to measure CT comprehensively beyond just programming skills (Lai, 2021).
3. **Higher-Order Cognition Measurement Gap:** Current digital assessments often tend to use multiple-choice-based questions that only tap into lower-order cognitive thinking, so there is a need for forms of evaluation and questioning that allow students to explore their reflective and metacognitive thinking, both subjective and objective. To address this gap, CT-based assessments must involve components of decomposition, abstraction, pattern recognition, algorithms, and generalization that are capable of revealing students' deep thinking processes contextually (Amarulloh et al., 2025).
4. **Qualitative Data Integration:** Further research is needed that can be conducted by combining quantitative and qualitative data to obtain more in-depth teacher assessments regarding the effectiveness of students' metacognitive assessments.

#### B. The Issue of Conceptual Gap and the Relationship between CT and Metacognition

1. **CT Understanding Gaps in Students:** There are still major unanswered questions about whether and how children engage in computational thinking and how CT may impact their problem-solving behavior and academic achievement. Recent research shows a significant positive correlation between CT skills and self-efficacy and metacognitive self-regulation in student teachers (Şen, 2023).
2. **The Role of Metacognition in CT Development:** There is an urgent need to better understand whether and how CT can support the development of metacognitive strategies, and to examine how CT can guide teachers to explicitly teach metacognitive strategies. Empirical evidence suggests that metacognitive sub-dimensions such as planning, debugging, and procedural knowledge can explain up to 47% of the variance in students' CT abilities (Üzümcü, 2023). Furthermore, systematically applied metacognition has been shown to promote CT development through a functional architecture that differentiates content and skills (Silva et al., 2023).
3. **Focus on Pre-Programming:** There is a lack of in-depth research on pre-programming metacognitive planning, although metacognition (especially planning) is very

important because practicing computational thinking through programming depends on the problem solver's metacognition. This relationship is strengthened by correlation analysis which shows that metacognition components are key factors influencing problem solving in software education (Joo & Park, 2023).

C. Learning Implementation and Scaffolding Issues

1. Limitations of Explicit Teaching: The reality is that metacognitive strategies that are important for academic outcomes are often not taught explicitly to students, necessitating research on effective interventions. Using metacognitive techniques alone is not enough; instructors need to integrate problem-solving and metacognitive techniques simultaneously to help students develop strong CT sub-skills (Ubaidullah et al., 2021).
2. Lack of Metacognitive Focus in CT: There is an issue that little research on CT development focuses on students' metacognitive processes, and few studies have clarified the effects of metacognitive scaffolding on CT. The integration of metacognitive scaffolding in the aspects of planning, monitoring, reflection, and evaluation has been shown to facilitate increased CT and learning achievement (Gu et al., 2025).
3. Combined Effects of Scaffolding: Research on the combined effects of metacognitive and cognitive scaffolding is limited, although comprehensive interventions may be more effective. Synergistic strategies such as the combination of Project-Based Learning with Pair Programming Instructional Strategy (PBL-PPIS) have been shown to significantly improve students' five core CT competencies and metacognitive abilities (Zhang et al., 2025). Furthermore, learning modules such as ME-CoT have also demonstrated strong reliability in fostering metacognitive awareness in STEM curricula (Wang et al., 2022).

D. Context and Duration of Intervention Issues

1. Duration of Intervention: The reality is that improving metacognitive abilities requires long-term learning interventions, so further studies need to address the limitations of short research durations.
2. Adaptation of Vocational/General Context Model: Further research is needed to be conducted using other learning models based on Vocational Education or General Education by adopting the model produced in this study, because the characteristics of assessment in vocational education are very specific, namely performance-based assessment.

E. The Issue of Utilizing Technology (LMS/BLEMS) as a Metacognitive Tool

1. Learning Management Systems generally don't operate in an interactive and personalized way for students, posting assignments and learning materials tailored to their characteristics, making it difficult to provide adaptive, tailored recommendations and visualizations. As a result, LMSs often simply provide the same pedagogical resources and content to all students, without considering their specific and individual needs.
2. Learning Management Systems need to be further exploited as metacognitive tools to support student self-directed learning, as many instructors use them only for information dissemination rather than in ways that engage students in meaningful, strategic, or self-regulated learning.
3. Learning Management Systems typically do not operate in an interactive and personalized manner for students, necessitating the integration of specific rubrics and features to support metacognitive regulation. This issue will highlight the technical and

pedagogical challenges in leveraging digital platforms to facilitate and measure CT-based metacognition

*Challenges in Computational Thinking -Based Metacognitive Learning Assessment: Future Research Directions*

Future Research Challenges are crucial steps to address the knowledge gaps arising from the identified issues, thereby strengthening the development of Computational Thinking (CT)-based metacognitive assessments. These challenges should focus on rigorous testing, explicit causal relationships, and optimization of digital implementation. The following are future research challenges based on the identified issues:

A. Methodological Issues and Validity of CT Assessment

Further research challenges focus on strengthening validity and methodology, including:

1. Using Rigorous Experimental Designs: Future research should use rigorous experimental methods to empirically test whether CT formative assessment tasks can lead to improvements in student learning. Integrating Qualitative and Quantitative Methods: Further research is needed that combines quantitative and qualitative data and uses think-alouds methods to examine the substantive processes involved in performance and provide evidence of the construct validity of test-based interpretations. Psychometric approaches and Rasch analysis need to be applied more widely to evaluate the quality of computerized CT assessment instruments to have strong convergent validity (Lai, 2021).
2. Developing Reflection-Based Assessment Tools: Evaluation forms and question forms are needed that allow students to explore their reflective and metacognitive thinking, subjective and objective, beyond multiple choice-based questions that only touch on low-order cognitive thinking. Future researchers must develop assessments that encourage deep learning and transdisciplinary skills to address the complex challenges of the modern world (Amarulloh et al., 2025).

B. The Issue of Conceptual Gap and the Relationship between CT and Metacognition

The next research challenge should be to bridge the conceptual gap and understand the interaction between CT and metacognition:

1. Understanding Causal Relationships: There is an urgent need to better understand whether and how CT can support the development of metacognitive strategies, as metacognition is crucial for CT to guide students in selecting thinking strategies. Future research should explore the predictive role of metacognition in the context of higher-order thinking skills more broadly across educational levels (Üzümcü, 2023).
2. Examining the Role of Explicit Instruction: Research should examine how CT can guide teachers to explicitly teach metacognitive strategies, given that metacognitive strategies are often not taught explicitly.
3. Focusing on Pre-Programming Planning: There is a need to address the lack of in-depth research on pre-programming metacognitive planning, although practicing computational thinking through programming depends on problem solvers' metacognition.

C. Learning Implementation and Scaffolding Issues

Challenges in the area of implementation center on optimizing learning support:

1. Verifying Scaffolding with a Large Sample: The findings on the effects of metacognitive scaffolding need to be further verified with a larger sample size, and perhaps with more nuanced scaffolding for these two dimensions. Further research is needed on the effectiveness of integrated learning modules (such as ME-CoT) on larger samples to

validate their reliability in creating an active and enjoyable learning atmosphere (Wang et al., 2022).

2. Exploring Students' Metacognitive Processes: Further research is needed because little research on CT development has focused on students' metacognitive processes, and there are still limitations regarding the combined effects of metacognitive and cognitive scaffolding.
3. Developing Specific and Diverse Scaffolding: Researchers should develop more specific metacognitive planning steps and build more types of scaffolding with different characteristics to meet the needs of different students. Special emphasis should be given to the design of metacognitive scaffolding in project-based learning environments to help novices overcome obstacles while programming (Gu et al., 2025).

#### D. Context and Duration of Intervention Issues

This challenge calls for expanding the duration and context of studies:

1. Conducting Long-Term Interventions: Future studies need to be implemented over a longer period of time, as improving metacognitive abilities requires long-term learning interventions.
2. Examining Changes in CT Aspects: Studies should further examine whether metacognitive planning will change students' computing concepts, practices, and perspectives, to ensure that metacognitive interventions are able to influence all dimensions of CT.
3. Adopting Models in Vocational/General Contexts: Further research is needed using other learning models based on Vocational Education or General Education, considering that the characteristics of assessment in vocational education are often performance-based assessments.

#### E. The Issue of Utilizing Technology (LMS/BLEMS) as a Metacognitive Tool

Further research challenges should focus on optimizing LMS as a self-regulation support tool:

1. Exploiting LMS as a Metacognitive Tool: LMS needs to be further exploited as a metacognitive tool to support Student Self-Learning, as many instructors only use it for information dissemination.
2. Optimizing Personalization and Interactivity: Research is needed to optimize how LMSs can function as metacognitive tools, by addressing the challenge that conventional LMSs typically do not operate in an interactive and personalized manner for students.

This research makes a significant scientific contribution by synthesizing the critical gap between Computational Thinking (CT) skills and metacognitive awareness, which have often been studied separately in the educational literature. Its novelty lies in its comprehensive mapping of barriers to digital assessment. It reveals that the limitations of current instruments lie not only in technical aspects, but also in the inability of traditional formats, such as multiple-choice assessments, to capture students' reflective thinking processes in real time. By integrating recent findings such as the effectiveness of the PBL-PPIS strategy (Zhang et al., 2025) and the use of the ME-CoT metacognitive empowerment module (Wang et al., 2022), this research offers a new framework linking psychometric validity with instructional technology innovations to deepen learning engagement (deep learning). This positioning of the study's findings provides strategic guidance for curriculum developers in designing assessments that measure not only the final programming outcomes but also students' cognitive evolution during the problem-solving process.

Based on the issues and challenges identified in this systematic analysis, future research should focus on three key developmental domains. First, there is an urgent need to explore the use of artificial intelligence (AI) to automate metacognitive feedback in programming environments, given the limitations of manual tasks in efficiently measuring high-level cognition. Second, more rigorous experimental studies with larger sample sizes are needed to verify the effectiveness of metacognitive scaffolding across educational levels, to strengthen the generalizability of existing findings (Gu et al., 2025; Üzümcü, 2023). Finally, future research should target contextual adaptation through the development of assessment rubrics specific to vocational and general education, taking into account the different performance characteristics of students in solving computational problems, both independently and collaboratively, in dynamic digital ecosystems.

## **CONCLUSION**

Metacognition, defined as the awareness and control of thinking for learning, is a crucial component that plays a significant role in students' problem-solving performance, and is essential for Computational Thinking (CT) because practicing computational thinking through programming relies on problem solvers' metacognition. CT-based metacognitive assessments should structurally measure cognitive regulation, including planning, monitoring, and evaluation, using authentic methods such as think-aloud to examine the substantive processes involved in performance, and providing evidence of the construct validity of test-based interpretations. The need outlined in the Introduction regarding the lack of formative assessment tools and explicit metacognitive instruction is confirmed and detailed as crucial issues in the Results and Discussion, which demonstrate a congruence between the urgency of the research and the findings obtained.

Key challenges lie in the need to use rigorous experimental methods to validate the impact of assessments, bridge the conceptual gap regarding whether and how CT can support the development of metacognitive strategies, and optimize Learning Management Systems (LMS) to function as metacognitive tools to support Student Self-Directed Learning. The impact of this study is to provide a structured and conceptual research agenda for academics and practitioners to develop assessments and interventions capable of fostering students' higher-order thinking skills in the digital age. As a development prospect, further research should focus on longer-term interventions and more nuanced scaffolding verification to ensure that metacognitive changes are effectively able to transform students' computing concepts, practices, and perspectives, thereby achieving comprehensive improvements in all dimensions of CT.

## **CONFLICT OF INTEREST**

The authors declare that they have no financial or non-financial conflicts of interest related to the publication of this manuscript. This research was conducted as a Systematic Literature Review (SLR), aiming to identify, evaluate, and synthesize all relevant scientific evidence regarding the issues and challenges of Computational Thinking-based metacognitive learning assessment.

Due to the nature of this research as a literature review, no data were collected from human or animal subjects, and no external financial support was provided by any party that could have influenced the results or interpretations presented. The authors guarantee that all findings and conclusions are based on a transparent and reproducible analysis of the literature. No personal or institutional relationships exist that could affect the scientific objectivity of the results reported in this manuscript. This statement summarizes all aspects of any potential conflicts of interest.

## REFERENCES

- Agung, G., Parwata, L., Laba, N., & Widiana, W. (2023). Improving Metacognitive Ability and Learning Outcomes with Problem-Based Revised Bloom's Taxonomy Oriented Learning Activities. *Emerging Science Journal*. <https://doi.org/10.28991/esj-2023-07-02-019>
- Akmam, A., Hidayat, R., Mufit, F., Anshari, R., & Jalinus, N. (2023). Effect of Generative Learning Models Based on Cognitive Conflict on Students' Creative Thinking Processes Based on Metacognitive. *Journal of Physics: Conference Series*, 2582. <https://doi.org/10.1088/1742-6596/2582/1/012058>
- Amarulloh, R. R., Iqbal, N. H. M., & Aswie, V. (2025). Enhancing Deep Learning Through Computational Thinking-Based Assessment. *JENTRE*, 6(1), 54-62. <https://doi.org/10.38075/jen.v6i1.539>
- Bonner, S., Chen, P., Jones, K., & Milonovich, B. (2021). Formative Assessment of Computational Thinking: Cognitive and Metacognitive Processes. *Applied Measurement in Education*, 34(1), 27-45. <https://doi.org/10.1080/08957347.2020.1835912>
- Callaway, F., Griffiths, T.L., Norman, K.A., & Zhang, Q. (2023). Optimal Metacognitive Control of Memory Recall. *Psychological Review*, 131(3), 781-811. <https://doi.org/10.1037/rev0000441>
- Flavell, J. H. (2024). Theories of Learning in Educational Psychology. *The Nature of Intelligence*, 1979, 231-235.
- Gu, P., Wu, J., Cheng, Z. Xia, Y., Cheng, M., & Dong, Y. (2025). Scaffolding self-regulation in project-based programming learning through online collaborative diaries to promote computational thinking. *Education and Information Technologies*, 30, 16243-16267. <https://doi.org/10.1007/s10639-025-13367-1>
- Hamzah, H., Hamzah, MI, & Zulkifli, H. (2022). Systematic Literature Review on the Elements of Metacognition-Based Higher Order Thinking Skills (HOTS) Teaching and Learning Modules. *Sustainability (Switzerland)*, 14(2). <https://doi.org/10.3390/SU14020813>
- Joo, K. H., & Park, N. H. (2023). Correlation Analysis Between Metacognition and Computational Thinking on Software Education. In: Ranganathan, G., EL Alloui, Y., Piramuthu, S. (eds) *Soft Computing for Security Applications. ICSCS 2023. Advances in Intelligent Systems and Computing*, 1449. Springer, Singapore. [https://doi.org/10.1007/978-981-99-3608-3\\_39](https://doi.org/10.1007/978-981-99-3608-3_39)
- Lai, R. P. Y. (2021). Beyond Programming: A Computer-Based Assessment of Computational Thinking Competency. *ACM Trans. Comput. Educ.* 22, 2, Article 14 (June 2022), 27 pages. <https://doi.org/10.1145/3486598>
- Lei, H., Chiu, M.M., Li, F., Wang, X., & Geng, Y.-J. jing. (2020). Computational Thinking and academic achievement: A meta-analysis among students. *Children and Youth Services Review*, 118, 105439. <https://doi.org/10.1016/j.childyouth.2020.105439>
- Mahande, R. D., Darmawan, F. A., & Malago, J. D. (2021). Metacognitive skill assessment model through the blended learning management system in vocational education. *Jurnal Pendidikan Vokasi*, 11(1), 1-13. <https://doi.org/10.21831/jpv.v11i1.36912>
- Markandan, N., Osman, K., & Halim, L. (2022). Integrating computational thinking and empowering Metacognitive awareness in stem education. *Frontiers in Psychology*, 13. <https://doi.org/10.3389/fpsyg.2022.872593>
- Poulakis, E., Politis, P. (2021). Computational Thinking Assessment: Literature Review. In: Tsiatsos, T., Demetriadis, S., Mikropoulos, A., Dagdilelis, V. (eds) *Research on E-Learning and ICT in Education*. Springer, Cham. [https://doi.org/10.1007/978-3-030-64363-8\\_7](https://doi.org/10.1007/978-3-030-64363-8_7)
- Şen, Ş. (2023). Relations between preservice teachers' self-efficacy, computational thinking skills and metacognitive self-regulation. *Eur J Psychol Educ* 38, 1251-1269. <https://doi.org/10.1007/s10212-022-00651-8>

- Sengul, S., & Katranci, Y. (2012). Metacognitive Aspects of Solving Function Problems. *Procedia - Social and Behavioral Sciences*, 46(507), 2178–2182. <https://doi.org/10.1016/j.sbspro.2012.05.450>
- Shin, Y., Jung, J., Choi, S., & Jung, B. (2024). The influence of scaffolding for Computational Thinking on cognitive load and problem-solving skills in collaborative programming. *Educ. Inf. Technol.*, 30(1), 583–606. <https://doi.org/10.1007/s10639-024-13104-0>
- Silva, D. R., Kurtz, F. D., & de Araújo, M. C. P. (2023). A Metacognição e o Pensamento Computacional na Perspectiva Histórico-Cultural de Vygotsky. *Revista Espaço Pedagógico*, 30, e15264. <https://doi.org/10.5335/rep.v30.15264>
- Stanton, J.D., Sebesta, A.J., & Dunlosky, J. (2021). Fostering metacognition to support student learning and performance. *CBE Life Sciences Education*, 20(2). <https://doi.org/10.1187/CBE.20-12-0289>
- Sudadi, S., Lolang, E., Ariawan, J., Kusnadi, IH, & Munir, M. (2023). The Effectiveness Analysis of Computational Thinking Patterns and Levels of Students' Meta-Cognitive Awareness in Solving Learning Problems. *Journal on Education*, 6(1), 2166–2171. <https://doi.org/10.31004/joe.v6i1.3217>
- Ubaidullah, N. H., Mohamed, Z., Hamid, J., Sulaiman, S., & Yussof, R. L. (2021). Improving novice students' computational thinking skills by problem-solving and Metacognitive techniques. *International Journal of Learning, Teaching and Educational Research*, 20(6), 88-108. <https://doi.org/10.26803/ijlter.20.6.5>
- ÜZÜMCÜ, Ö. (2023). Computational thinking scale: The predictive role of metacognition in the context of higher order thinking skills. *Journal for the Education of Gifted Young Scientists*, 11(3), 423-437. <https://doi.org/10.17478/jegys.1355722>
- Wang, C., Shen, J. & Chao, J. (2022). Integrating Computational Thinking in STEM Education: A Literature Review. *International Journal of Science and Mathematics Education*, 20, 1949–1972. <https://doi.org/10.1007/s10763-021-10227-5>
- Wang, C.Y., Gao, B.L., & Chen, S.J. (2024). The effects of metacognitive scaffolding of project-based learning environments on students' metacognitive abilities and Computational Thinking. *Education and Information Technologies*, 29(5), 5485–5508. <https://doi.org/10.1007/S10639-023-12022-X>
- Wing, J. M. (2006). Computational Thinking. *Communications of the ACM*, 49(3), 33–35. <https://doi.org/10.1145/1118178.1118215>
- Yadav, A., Ocak, C., & Oliver, A. (2022). Computational Thinking and Metacognition. *TechTrends*, 66, 405–411. <https://doi.org/10.1007/s11528-022-00695-z>
- Zarouk, M.Y., & Khaldi, M. (2016). Metacognitive learning management system supporting self-regulated learning. *Colloquium in Information Science and Technology, CIST, 0*, 929–934. <https://doi.org/10.1109/CIST.2016.7805021>
- Zhang, J., Zhou, Y., Jing, B., Pi, Z., & Ma, H. (2024). Metacognition and Mathematical Modeling Skills: The Mediating Roles of Computational Thinking in High School Students. *Journal of Intelligence*, 12(6). <https://doi.org/10.3390/JINTELLIGENCE12060055>
- Zhang, W., Guan, Y., Hu, Z. et al. (2025). Synergistic approaches in education: elevating computational thinking and metacognitive skills through combined project-based and pair programming learning in high schools. *Education Tech Research Dev.* <https://doi.org/10.1007/s11423-025-10555-1>
- Zhou, Y., Chai, C.S., Li, X., Ma, C., Li, B., Yu, D., & Liang, J.C. (2023). Application of Metacognitive Planning Scaffolding for the Cultivation of Computational Thinking. *Journal of Educational Computing Research*, 61(6), 1123–1142. <https://doi.org/10.1177/07356331231160294>

## Development of Flipbook-Based Learning Media Using the Dick & Carey Model and Its Impact on Elementary School Students' Creative Problem-Solving Skills

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### ABSTRACT

The development of educational technology encourages the use of interactive digital media capable of delivering multimodal and adaptive learning. This study aims to develop Flipbook Maker-based learning media with the Dick & Carey instructional design model and analysed its effectiveness in improving elementary school students' problem-solving creativity. The development was carried out through the stages of needs analysis, design, production, formative evaluation, revision, and summative evaluation. This study used a modified Research and Development (R&D) approach involving expert validation, individual trials, small group trials, and field tests. The problem-solving creativity instrument was compiled based on indicators of fluency, flexibility, originality, and elaboration. The results showed that the flipbook obtained a "very valid" category from the validators of materials, media, and learning design. The field trial showed that the media was easy to use, interesting, and increased student learning engagement. Pretest-post-test analysis showed a significant increase in all indicators of problem-solving creativity ( $p < .001$ ), with a large effect size ( $d = 1.21$ ). These findings confirm that flipbooks developed systematically and based on multimedia theory are able to support creative thinking processes effectively, making them relevant for use in 21st-century learning.

**Keywords:** *creativity, Dick & Carey, Flipbook Maker, multimedia learning, problem solving*



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### INTRODUCTION

Developments in educational technology over the past two decades have transformed the way teachers and students' access, process, and represent knowledge. Interactive digital media are beginning to replace traditional learning resources due to their ability to present information in a multimodal, adaptive, and personalized manner (Darmawan, 2024; He, 2022). One medium experiencing increasing use in schools is Flipbook Maker, a digital platform that enables the creation of interactive books by integrating text, images, audio, animation, and video into a single display (Rozanah & Pratiwi, 2025). Flipbooks are considered to have great potential in enhancing the learning experience, as their format resembles a printed book but is supported by multimedia features, making it easier for students to access material in a systematic and engaging manner (Chairunnisa, 2025; Fitri, 2024).

The development of digital learning media requires the use of a systematic and proven instructional design model. This aligns with Dick and Carey's (2001) argument that learning development is a system, not a series of spontaneous steps. Therefore, every component, from needs analysis and goal formulation to student characteristics and learning strategies, to formative and summative evaluation, must be designed in an integrated manner. The Dick & Carey model has been recommended in various multimedia development studies because it provides a rational framework and encourages continuous evaluation of media quality (Spatioti, 2022; Purnomo, 2024). Therefore, the development of a Flipbook Maker based on this model will not only produce a technically feasible product but also be pedagogically effective.

Besides media effectiveness, a crucial issue in 21st-century education is the development of creativity and problem-solving skills (Partnership for 21st Century Learning [P21], 2007). As the digital world of work and life demands higher-order thinking skills, students need to be engaged in learning processes that enable the exploration of ideas, the creation of digital products, and independent decision-making. Guilford (1950) stated that creativity is a divergent thinking ability that includes fluency, flexibility, originality, and elaboration, while Torrance (1974) added that creativity can be enhanced through activities that provide space for students to produce meaningful artifacts. Papert (1980) through constructionism theory emphasized that learning involving the creation of digital products allows students to build deeper understanding because of the connection between personal experiences and conceptual representations. In this context, Flipbook Maker is a highly relevant medium because it is not only used for information consumption but can also be a means for students to produce digital works that reflect their creativity.

Previous research has shown that digital flipbooks can improve learning motivation, active engagement, and cognitive learning outcomes (Rezeki, 2023; Ulfa, 2025; Nurramadhani, 2025). Several international and national studies have even found that integrating flipbooks with digital storytelling can enhance students' creativity and problem-solving (Chen et al., 2023; Fitri, 2024). However, a critical review of the literature shows that most previous research focuses on media feasibility and improving basic cognitive learning outcomes, rather than higher-order thinking skills such as creativity or problem-solving. Furthermore, few studies integrate flipbook development with robust instructional design models, such as Dick & Carey's, which ensure alignment between content, learning strategies, and evaluation.

On the other hand, the effectiveness of flipbooks must also be analysed through the perspectives of multimedia theory and cognitive load theory. Mayer (2001, 2005) emphasized that multimedia learning is effective when verbal and visual information is processed through different yet integrated cognitive pathways. The principles of coherence, modality, redundancy, and segmentation are crucial in structuring flipbook pages to avoid cognitive overload. Sweller (1988) and Paas & Sweller (2014) warn that media overloaded with decoration or excessive visual elements can increase extraneous load, which actually hinders comprehension. Therefore, flipbook development requires a systematic approach so that multimedia design maintains a balance between visual appeal and cognitive efficiency.

Theoretical studies also suggest that the use of flipbooks in the classroom should be viewed as part of a broader technology integration. The TPACK framework (Mishra & Koehler, 2006) emphasizes that the effectiveness of learning technology is determined not only by its technological features, but also by the alignment between content, pedagogy, and technology. Teachers who understand how to integrate flipbooks into learning strategies such as project-based or problem-based learning are able to maximize the potential of these media in developing students' creativity and problem-solving skills (Bell, 2010; Çetinkaya, 2014).

Based on the synthesis of theory and previous research results, it can be concluded that there is a significant research gap, namely:

1. Most flipbook research only assesses the feasibility of the media and the improvement of cognitive learning outcomes, but has not assessed creativity and problem solving as 21st-century competencies.
2. There is minimal research developing flipbooks using the Dick & Carey model, even though this model has been proven to improve the quality of media design systematically.
3. There has not been much research examining flipbooks as a medium for the production of digital works by students, not just information consumption.
4. There has been no theoretical synthesis that combines the perspectives of Multimedia Learning, Cognitive Load Theory, Constructionism, and TPACK in the development of flipbooks.

Thus, research developing a Flipbook Maker based on the Dick & Carey model and assessing its impact on problem-solving creativity is crucial to fill this scientific gap. This research is expected to provide theoretical contributions in the form of integrating instructional models with multimedia and creativity theory, as well as practical contributions in the form of recommendations for effective media to improve 21st-century competencies.

## METHODS

This study uses a Research and Development (R&D) approach with the Dick & Carey (2015) model as a systematic framework for developing Flipbook Maker-based learning media. The R&D approach was chosen because the research aims not only to find facts, but also to produce product-oriented outcomes in the form of learning media whose effectiveness has been tested (Branch, 2009; Plomp & Nieveen, 2013). The Dick & Carey model is relevant because it provides comprehensive and structured instructional steps (Dick et al., 2015), making it suitable for developing digital media aimed at enhancing students' problem-solving creativity.

This study applies R&D modifications by adjusting the formative and summative evaluation stages as recommended by Tessmer (1993) and Nieveen (2015), with adjustments to the number of trial cycles according to the elementary school context. The research design also accommodates the analysis of problem-solving creativity using creative thinking indicators according to Torrance (1974) and Silver (1997), so that media development can be tested not only for technical functionality but also for its pedagogical impact.

*Table 1. Stages of the Dick & Carey Development Model*

Stage	Main Components	Academic Description
1	Identify Learning Objectives	Determination of learning objectives based on needs analysis, curriculum, and targeted competencies.
2	Learning Analysis	Breaking down the competency structure into basic skills and sub-skills.
3	Analysis of Student Characteristics	Identify students' initial abilities, learning styles, and cognitive characteristics.
4	Formulation of Specific Instructional Objectives	The translation of learning objectives into measurable performative objectives.
5	Evaluation Instrument Development	Preparation of measuring instruments to test the achievement of objectives.
6	Learning Strategy Development	Formulation of strategies, learning activities, and teaching scenarios.
7	Development & Material Selection (Flipbook Maker)	Development of digital media and teaching materials according to multimedia principles.
8	Formative Evaluation	Expert validation, individual, small group, and field trials.
9	Product Revision	Product improvement based on formative evaluation results.
10	Summative Evaluation	Assessment of media effectiveness after full implementation.

The Dick & Carey model is an instructional design approach that views learning as a system with structured relationships between components (Dick & Carey, 2001). Table 1 explains several stages. The first stage, identifying learning objectives, aims to determine the final competencies to be achieved by students based on the curriculum, school needs, and a learning gap analysis. Dick and Carey (2009) emphasize that learning objectives must be determined first because all instructional components will be structured based on these objectives.

The second stage, learning analysis, is the step of mapping complex behaviour into structured sub-skills that students must master (Dick et al., 2015). This analysis not only breaks down tasks but also identifies prerequisites for students to achieve the main objectives. Therefore, this step is crucial for designing learning media such as flipbooks that present content hierarchically and sequentially.

The third stage, analysing initial student behaviour and characteristics, is particularly relevant when using digital media. According to Reigeluth (2012), student characteristics such as initial abilities, learning styles, and cognitive readiness significantly influence the success of multimedia-based learning. Therefore, in this study, student analysis served as the basis for determining the appropriate visuals, narrative, and navigation of flipbooks.

The fourth stage, formulating specific instructional objectives, is carried out to make learning goals more operational and measurable. Objectives are formulated in the form of observable performative behaviours, in accordance with Mager's (1997) principles. The formulation of these performative objectives also serves as a reference for developing the creativity rubric and problem-solving instruments.

In the fifth stage, assessment instrument development, Dick and Carey (2015) emphasized the importance of aligning measurement tools with instructional objectives. Instruments such as cognitive tests, creativity rubrics, and performance assessment sheets should be developed before designing learning strategies to ensure goal-oriented assessment (Nitko & Brookhart, 2014).

The sixth stage is developing a learning strategy, which includes the sequence of material presentation, the methods used, student activities, and the media selected. This strategy must consider Mayer's (2005) multimedia principles, such as coherence, signalling, redundancy, and modality. These principles ensure that the developed flipbook can optimize cognitive processing and minimize students' cognitive load, as stated by Sweller (1988).

The seventh stage, namely material development and selection, includes the production of flipbooks with appropriate visual design, narrative, segmentation, and text-image integration. Papert (1980) emphasized that students learn better when interacting with digital products; therefore, Flipbook Maker was chosen as a constructive medium that allows students to explore ideas and develop creative competencies. Media development also took into account the TPACK framework (Mishra & Koehler, 2006) so that technology integration is aligned with content and pedagogy.

The eighth stage, formative evaluation, consists of expert validation, individual trials, small group trials, and field trials. According to Tessmer (1993), formative evaluation provides crucial feedback for improving media quality before full-scale implementation. In this context, material experts assess the appropriateness of the content, while media experts assess the visual aspects, navigation, and interactivity of the flipbook.

The ninth stage is product revision. Based on expert advice and trial findings, revisions are made to correct errors in content, navigation, or visual appearance. Revision is an iterative process that ensures the media fully meets pedagogical and technical standards (Gustafson & Branch, 2002).

The final stage, summative evaluation, is conducted to assess the overall effectiveness of the flipbook after its actual use in learning. Summative evaluation can involve analysing improvements in creativity and problem-solving skills using standardized instruments such as

the TTCT (Torrance, 1974) or the CPS rubric. According to Fitzpatrick et al. (2011), summative evaluation ensures that the developed media has empirical impact and can be recommended for widespread use.

Overall, the table and narrative above show how the Dick & Carey development model provides a systematic, measurable, and evidence-based framework in designing Flipbook Maker as a medium that not only delivers material, but also enhances students' cognitive and creative processes.

In this case, the research procedure is carried out through three major phases: development, validation, and effectiveness testing.

### *1. Development Phase*

This stage follows Dick & Carey's sequence, starting with identifying learning needs (Reigeluth, 2012), curriculum analysis, and analysing elementary school mathematics competencies based on the Independent Curriculum. Student characteristics were analysed using a learner analysis approach (Gagné et al., 2005), encompassing cognitive developmental age (Piaget, 1972), digital learning preferences (Prensky, 2010), and initial mathematical abilities.

The development of learning strategies refers to Mayer's (2009) multimedia theory, the principles of digital interactivity (Clark & Mayer, 2016), and problem-solving theory (Polya, 1973). Flipbook Maker was developed with integrative features such as images, animations, hyperlinks, and interactive exercises.

### *2. Validation Phase (Formative Evaluation)*

Formative evaluation is carried out in three stages:

- a. Expert review by experts in content, instructional design, and educational technology. Expert validation refers to media quality standards according to Reeves (1992) and Nieveen (2015).
- b. One-to-One Try-out on 3 students to identify technical errors (Morrison et al., 2019).
- c. Small Group Evaluation on 9 students to see the clarity of instructions and digital navigation.
- d. Field Test on a full class, analysing student responses and potential impact (Tessmer, 1993).

Validation data was analysed quantitatively using Likert scale assessment and qualitative analysis based on content analysis (Miles et al., 2014).

### *3. Effectiveness Test Phase*

Media impact testing was conducted through a pretest–post-test design (Creswell & Creswell, 2018) by measuring problem-solving creativity based on indicators of fluency, flexibility, originality, and elaboration (Torrance, 1974; Silver, 1997). Data analysis includes:

- a. Normality & homogeneity tests to ensure the suitability of parametric statistics.
- b. Paired t-test to see before–after improvements (Field, 2018).
- c. Effect size (Cohen's *d*) to measure the strength of the intervention (Cohen, 1988).
- d. Qualitative analysis of student answers, referring to the creative solution analysis model (Kaufman & Beghetto, 2009).

In Table 2, the needs analysis stage is the foundation of the systems-based development model, as it is at this stage that researchers identify gaps between ideal learning conditions and actual practice in the field. Dick and Carey (2015) emphasized that needs analysis serves to determine whether new media or instruction is needed to improve learning performance. Similarly, Gagné et al. (2005) stated that needs identification must consider the applicable curriculum, core competencies, and student characteristics as the basis for instructional design.

Therefore, this stage not only maps competency demands but also explores students' initial abilities and cognitive profiles—forming the foundation for subsequent design stages.

*Table 2. Research Stages, Activities, and Theoretical Basis*

<b>Research Stage</b>	<b>Activity</b>	<b>Theoretical Basis / References</b>
Needs Analysis	Curriculum analysis; student characteristics analysis; learning gap identification	Dick & Carey (2015); Gagne et al. (2005)
Design	Developing learning strategies; formulating instructional objectives; developing assessment instruments	Mayer (2009); Polya (1973)
Product Development	Flipbook Maker creation and design; text–image–audio integration; application of multimedia principles	Clark & Mayer (2016)
Expert Validation	Formative evaluation by material experts and media experts	Nieveen (2015); Reeves (1992)
Trials	Individual (one-to-one) and small group trials	Tessmer (1993)
Field Test	Full-scale field testing in a real classroom	Plomp & Nieveen (2013)
Effectiveness	Pretest–post-test measurement; effectiveness analysis; effect size calculation	Creswell (2018); Cohen (1988)

The design stage is a strategic step that outlines learning objectives, teaching strategies, and assessment instruments used to measure goal achievement. Mayer (2009) emphasized that designing multimedia-based media must adhere to the principles of evidence-based multimedia learning so that material can be optimally processed in working memory. Furthermore, Polya (1973) explained that developing instructional objectives related to creativity and problem-solving requires accommodating heuristic steps such as understanding the problem, planning a strategy, implementing the plan, and evaluating the results. Thus, the design process ensures that flipbook media is not only informative but also supports higher-order thinking processes.

In the product development stage, Flipbook Maker was designed with an integration of text, images, animation, and audio that followed the principles of effective multimedia design. Clark and Mayer (2016) emphasized that good digital media should minimize extraneous cognitive load and maximize germane load through the application of principles such as coherence, signalling, and modality. At this stage, the flipbook storyboard was systematically compiled, followed by the technical process of creating content and user interfaces. This ensures that the flipbook is not only visually appealing but also effective as a learning tool.

Expert validation is an essential part of formative evaluation to ensure product quality before testing it on students. According to Nieveen (2015), validation by material experts, media experts, and instructional design experts is necessary to ensure three main aspects: validity, practicality, and initial effectiveness of the media. Reeves (1992) also emphasized that formative evaluation must be conducted iteratively, involving experts to provide feedback based on theory and empirical experience.

The pilot testing phase is conducted in two forms: one-to-one testing and small group testing. Tessmer (1993) explains that individual testing aims to identify technical barriers and errors in use by individual users, while small group testing aims to test the clarity of instructions, the understandability of content, and the smoothness of interface interactions when used by several students simultaneously. The findings at this stage provide an important basis for product revisions before testing on a larger scale.

A full-scale field test is the stage where flipbook media is implemented in a real classroom context. Plomp and Nieveen (2013) explain that field tests are conducted to assess the practicality of classroom implementation, the level of student engagement, and the consistency

of the media's effectiveness in learning. Field tests allow researchers to determine whether the media can be used sustainably by teachers without intensive guidance.

The effectiveness stage is the culmination of the entire development process, where the implementation of the media is tested through a quasi-experimental design using the pretest–post-test method. Creswell (2018) emphasized that this design is used to assess significant changes in learning outcomes before and after the intervention. Effect size calculations using Cohen's (1988) formula are used to measure the strength of the media's influence on students' creativity and problem-solving abilities. Thus, this stage ensures that Flipbook Maker is not only valid and practical but also has a significant instructional impact.

## RESULTS AND DISCUSSION

### Results

The research results are presented based on three main phases: (1) validation and formative evaluation of the flipbook product, (2) field trials, and (3) testing its effectiveness on problem-solving creativity. Quantitative and qualitative analyses were used to ensure the reliability of the findings.

#### 1. Expert Validation Results

Media and material validation was conducted by three experts using a 4-point Likert scale instrument. The validation results are summarized in Table 3.

*Table 3. Results of Expert Validation of Media, Materials, and Learning*

Validator	Rated aspect	Average Score	Category
Subject Matter Expert	content accuracy, coherence, relevance	3.78	Very Valid
Media Expert	visual design, navigation, interactivity	3.65	Very Valid
Learning Expert	alignment of goals–instruments–materials	3.82	Very Valid

Validation results showed that the flipbook met validity criteria, with an overall mean of 3.75, indicating that the product was suitable for use during the trial phase. The validators emphasized that the design adhered to effective multimedia principles and that instructional alignment supported quality learning.

#### 2. Results of One-to-One and Small Group Trials

The initial pilot test involved three students (one-to-one) and nine students (small group). Qualitative findings indicated that students were able to navigate the flipbook without significant difficulty. They also demonstrated increased learning interest in the animation features and interactive exercises. Minor revisions to text size, background colour, and instruction clarity were made prior to the field test.

#### 3. Field Test Results

Field trials were conducted on 30 fifth-grade students. Data showed an increase in learning activity and digital participation scores. Most students rated flipbooks as “easier to understand than textbooks” and “facilitate independent learning.” Participants were selected using a purposive sampling technique, targeting students who had not previously used interactive flipbook media in their science lessons.

#### 4. Results of Media Effectiveness on Problem-Solving Creativity

A pretest–post-test design was used to measure problem-solving creativity based on four indicators: fluency, flexibility, originality, and elaboration. The results of the statistical analysis are summarized in Table 4. The paired t-test results showed a significant increase in all indicators ( $p < .001$ ). The effect size calculation yielded a Cohen's  $d$  value of 1.21, which falls into the large effect category, indicating that flipbooks have a strong influence on problem-solving creativity.

Table 4. Pretest–Post-test Results of Problem-Solving Creativity

Indicator	Pretest (M)	Post-test (M)	Gain	Significance (p)
Fluency	58.2	78.6	+20.4	p < .001
Flexibility	55.1	76.3	+21.2	p < .001
Originality	52.6	71.8	+19.2	p < .001
Elaboration	54.8	80.1	+25.3	p < .001

### Discussion

The discussion section interprets the findings and relates them to relevant research, without repeating references in the introduction.

#### 1. Media Validity and Instructional Quality

The expert validation findings, which indicated a "very valid" category, confirmed that the flipbook successfully met the principles of instructional design. The alignment between objectives, content, and instruments reinforces the assumption that systematically developed products tend to be highly effective. This aligns with the findings of Aydin and Usta (2020), which demonstrated that instructional model-based design improves consistency between learning components and the effectiveness of digital media.

Furthermore, the application of multimedia principles such as segmentation, visual simplification, and audio integration supports cognitive efficiency. A study by Alqahtani and Alhumaidi (2021) reported that digital media that appropriately integrates text, visuals, and animations improves students' conceptual understanding and learning attention.

#### 2. Student Response and Quality of Learning Interactions

Findings from initial trials and field tests indicate that students are highly responsive to the use of flipbooks. This medium has been shown to increase digital engagement and learning motivation. This is consistent with research findings by Kuswandi and Riyana (2020), which found that digital books increase student interaction and facilitate independent learning.

In the field test, students demonstrated the ability to understand instructions and complete interactive exercises, indicating that flipbook navigation aligns with the cognitive characteristics of elementary school-aged children. Visual support and interactive features appear to provide students with the freedom to explore information, a prerequisite for developing creative behaviour, according to research by Lee and Chen (2021).

#### 3. Effectiveness on Problem Solving Creativity

Significant improvements in fluency, flexibility, originality, and elaboration indicators indicate that flipbooks not only improve content comprehension but also divergent thinking skills. This finding is supported by research by Rahmawati and Wibowo (2022), who found that visual narrative-based digital media improves the ability to generate more ideas and a variety of solutions.

The very large effect size ( $d = 1.21$ ) confirms the strength of the intervention. A study by Ferdiansyah and Haryono (2021) showed that interactive media based on systematic design significantly contributed to problem-solving skills, particularly when students engaged in independent exploration of digital environments.

These findings also support the idea that interactive digital media can activate higher-order thinking skills through organizing information, providing challenges, and opportunities to construct one's own representations. This is reinforced by international studies such as those by Jamaludin and Osman (2020), which found that interactive media provides a conducive environment for fostering creative reasoning and complex problem-solving.

#### 4. *The Relationship between Instructional Design, Multimedia, and Creativity*

The research results show that the combination of systematic instructional design and multimedia design has a significant pedagogical impact. This combination supports the theory that creativity thrives in a structured yet flexible learning environment. This finding aligns with Kokotsaki's (2020) study, which showed that creativity increases when learning provides measured direction but allows for exploration.

Instructional integration, such as open-ended problem presentations, interactive exercises, and digital scaffolding in flipbooks, provides a learning experience that allows students to construct creative solutions. A study by Han and Lim (2022) corroborates these findings, stating that open-ended task-based digital media significantly enhances creative problem solving.

#### **CONCLUSION**

This study shows that the development of Flipbook Maker-based learning media using the Dick & Carey instructional development model is proven effective in improving elementary school students' problem-solving creativity. The development process, which follows systematic stages including needs analysis, design, development, and formative and summative evaluation, is able to produce digital media that is valid, practical, and has a significant pedagogical impact. Validation by material experts, media experts, and learning experts provides a very valid category, indicating that the alignment between learning objectives, digital content, and instructional strategies has been well established.

The results of individual trials, small group trials, and field trials showed that Flipbook Maker was easy to use, visually appealing, and able to increase student motivation and engagement. These findings reinforce the view that appropriate multimedia integration can create a more interactive and meaningful learning experience. Furthermore, the results of effectiveness measurements using a pretest–post-test design showed a significant increase in four indicators of problem-solving creativity: fluency, flexibility, originality, and elaboration, with a large effect size. This proves that flipbooks function not only as an information medium but also as a means of cognitive stimulation that supports higher-order thinking skills.

In addition to producing effective media, this research also provides a theoretical contribution in the form of integrating four main perspectives of Multimedia Learning, Cognitive Load Theory, Constructionism, and TPACK—in a single digital media development framework. This synthesis shows that the effectiveness of learning technology is not only determined by the quality of the technology, but also by the suitability of the media to the content, pedagogical strategies, and characteristics of the learners. The practical contribution of this research is seen in the provision of flipbooks that can be used by teachers as an alternative interactive learning media that encourages creativity, problem-solving, and independent learning.

Thus, this study confirms that Flipbook Maker developed through Dick & Carey's systematic approach is capable of being an innovative solution in 21st-century learning. This product is worthy of widespread implementation and can be a reference for further research related to multimedia integration with other instructional models and the development of higher-order thinking competencies at various levels of education.

#### **CONFLICT OF INTEREST**

No conflict of interest for this study.

#### **REFERENCES**

Alqahtani, M., & Alhumaidi, F. (2021). Effects of multimedia-based learning on students' cognitive processing and engagement. *Journal of Educational Technology, 18*(2), 45–60.

- Aydın, A., & Usta, E. (2020). Instructional design model-based digital media development: Impacts on learning consistency and performance. *International Journal of Instructional Media*, 47(1), 55–70.
- Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. *The Clearing House*, 83(2), 39–43.
- Branch, R. M. (2009). *Instructional design: The ADDIE approach*. Springer.
- Çetinkaya, L. (2014). Teacher perspectives on integrating digital tools in problem-based learning. *Educational Sciences: Theory & Practice*, 14(2), 879–886.
- Chairunnisa, S. (2025). Digital flipbook as an interactive learning resource in elementary education. *Journal of Digital Pedagogy*, 7(1), 22–34.
- Chen, L., Wang, H., & Xu, Y. (2023). Digital storytelling–flipbook integration to enhance creativity in elementary classrooms. *Computers & Education*, 194, 104672.
- Clark, R.C., & Mayer, R.E. (2016). *E-learning and the science of instruction (4th ed.)*. Wiley.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences (2nd ed.)*. Lawrence Erlbaum.
- Creswell, J. W. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches (5th ed.)*. SAGE.
- Creswell, J. W., & Creswell, J. D. (2018). *Research design (5th ed.)*. SAGE.
- Darmawan, D. (2024). *Digital-based educational technology*. Bandung: Alfabeta.
- Dick, W., & Carey, L. (2001). *The systematic design of instruction (5th ed.)*. Longman.
- Dick, W., Carey, L., & Carey, J. O. (2009). *The systematic design of instruction (6th ed.)*. Pearson.
- Dick, W., Carey, L., & Carey, J. O. (2015). *The systematic design of instruction (8th ed.)*. Pearson.
- Field, A. (2018). *Discovering statistics using SPSS (5th ed.)*. SAGE.
- Fitri, R. (2024). The effect of digital flipbook multimedia on students' creative problem solving. *Journal of Educational Technology*, 12(1), 45–59.
- Fitzpatrick, J., Sanders, J.R., & Worthen, B.R. (2011). *Program evaluation: Alternative approaches and practical guidelines (4th ed.)*. Pearson.
- Gagné, R.M., Wager, W.W., Golas, K.C., & Keller, J.M. (2005). *Principles of instructional design (5th ed.)*. Wadsworth.
- Guilford, J. P. (1950). Creativity. *American Psychologist*, 5(9), 444–454.
- Gustafson, K., & Branch, R. (2002). *Survey of instructional development models (4th ed.)*. ERIC Clearinghouse.
- He, X. (2022). Digital learning transformation in K–12 education. *Journal of Educational Technology Research*, 5(2), 15–29.
- Kaufman, J. C., & Beghetto, R. A. (2009). Beyond big-C and little-C: The Four C Model of Creativity. *Review of General Psychology*, 13(1), 1–12.
- Mager, R.F. (1997). *Preparing instructional objectives (3rd ed.)*. Center for Effective Performance.
- Mayer, R.E. (2001). *Multimedia learning*. Cambridge University Press.
- Mayer, R.E. (2005). *The Cambridge handbook of multimedia learning*. Cambridge University Press.
- Mayer, R.E. (2009). *Multimedia learning (2nd ed.)*. Cambridge University Press.
- Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis (3rd ed.)*. SAGE.

- Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge. *Teachers College Record*, 108(6), 1017–1054.
- Morrison, G.R., Ross, S.M., Morrison, J.R., & Kalman, H. (2019). *Designing effective instruction (8th ed.)*. Wiley.
- Nieveen, N. (2015). Formative evaluation in educational design research. In T. Plomp & N. Nieveen (Eds.), *Educational design research* (pp. 152–170). SLO.
- Nurramadhani, F. (2025). The effect of interactive flipbooks on elementary school students' learning outcomes. *Journal of Learning Innovation*, 6(1), 12–24.
- P21. (2007). *Framework for 21st century learning*. Partnership for 21st Century Skills.
- Paas, F., & Sweller, J. (2014). Implications of cognitive load theory for multimedia learning. *Multimedia Learning Review*, 22(3), 115–121.
- Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas*. Basic Books.
- Piaget, J. (1972). *The psychology of the child*. Basic Books.
- Plomp, T., & Nieveen, N. (2013). *Educational design research: Introduction*. SLO.
- Polya, G. (1973). *How to solve it (2nd ed.)*. Princeton University Press.
- Prensky, M. (2010). *Teaching digital natives: Partnering for real learning*. Corwin.
- Purnomo, A. (2024). Implementation of the Dick & Carey model in developing interactive multimedia for mathematics learning. *Journal of Modern Educational Technology*, 8(1), 33–47.
- Reeves, T. C. (1992). Effective dimensions of interactive learning systems. *Journal of Computer-Based Instruction*, 19(1), 1–6.
- Reigeluth, C. M. (2012). Instructional theory and technology for the new paradigm of education. *Journal of Instructional Theory*, 2(1), 1–10.
- Rezeki, A. (2023). The effect of digital flipbooks on motivation and learning outcomes. *Journal of Elementary Education*, 14(2), 77–89.
- Rozanah, A., & Pratiwi, N. (2025). Implementation of Flipbook Maker in thematic learning. *Journal of Digital Learning Media*, 6(1), 10–20.
- Silver, E. A. (1997). Fostering creativity through problem solving. *Mathematics Teacher*, 90(5), 348–355.
- Spatioti, A. (2022). Instructional design models in digital media development. *International Journal of E-Learning & Instructional Design*, 5(2), 99–118.
- Sweller, J. (1988). Cognitive load during problem solving. *Cognitive Science*, 12(2), 257–285.
- Tessmer, M. (1993). *Planning and conducting formative evaluations*. Kogan Page.
- Torrance, E. P. (1974). *Torrance Tests of Creative Thinking: Norms-technical manual*. Scholastic Testing Service.
- Ulfa, A. (2025). Using flipbooks to improve elementary school students' learning activities. *Journal of Innovative Education*, 9(1), 41–53.

## Socio-Scientific Issues (SSI) Approach Implementation to Enhance Students' Creative Thinking Skills: Literature Review

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### ABSTRACT

Creative thinking skills are one of the 21st-century skills that students must possess. This study aims to analyze the implementation of the Socio-Scientific Issues (SSI) approach to improve students' creative thinking skills. The study identified gaps between textbook content and actual student misconceptions in the Indonesian context. The research method used a literature review of scientific articles that align with the research objectives. Scientific articles were sorted using the Publish or Perish (PoP) application version 8 and selected based on the publication period between January 2021 and December 2025, published in journals indexed by Sinta 1 and Sinta 5 and not as a literature review. Three articles were obtained that met the selection criteria and met the article quality assessment. The results of the study indicate that there is a positive impact of implementing the SSI approach on improving students' creative thinking skills. The subject matter taught includes environmental change and conservation as well as green chemistry. The SSI approach can be applied to various learning models, namely Interactive Socio-Scientific Inquiry (ISSI), Problem-Based Learning (PBL), and Project-Based Learning (PjBL).

**Keywords:** *creative thinking skills, literature review, socio scientific issues*



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### INTRODUCTION

Creative thinking skills are one of the main foundations of modern education. Progressiveness in various sectors demands educational transformation to develop 21st-century skills including creative thinking, creative thinking, collaboration, innovation, and communication (Andaresta & Irawan, 2025; Mulyono et al., 2023; Tang et al., 2020), as well as developing the ability to apply knowledge in real-world forms (Dewra & Singh, 2025). PISA classifies adolescents' creative thinking skills as encompassing three main elements: creative manifestation, knowledge construction, and innovative problem solving (Karunarathne & Calma, 2024).

Creative thinking skills help build superior human resources (Sakdiah et al., 2023). Academically, creative thinking helps individuals develop fluency, flexibility, originality, and elaboration skills (Santoso et al., 2020). Furthermore, improving creative thinking skills is a factor in shaping progressive and adaptive technology and culture (Beaty et al., 2018; Foster & Schleicher, 2022). As a non-innate ability (Ritter & Mostert, 2017), creativity is seen as a complex phenomenon that is invaluable to human thought (Zhang et al., 2020). Each individual's creative

potential is inherent in cognitive functions, which can be developed through scientific learning and training (Sun et al., 2020).

The results of the 2022 PISA study show that the basic literacy skills of students in Indonesia lag behind those of several OECD (Organization for Economic Co-operation and Development) countries. Reading literacy scores reached only 359 (OECD average 476), mathematics 366 (OECD 472), and science 383 (OECD 485) (Alfaruqi & Nurwahidah, 2025). The OECD 2022 (2023) study showed that only 66% of students in Indonesia lack scientific literacy proficiency. This illustrates students' limitations in understanding and implementing scientific concepts analytically and applicatively. Furthermore, the low level of efforts to develop creative thinking skills can be seen in the results of the 2025 Global Innovation Index (GII), where Indonesia ranked 55th out of 139 countries globally and 12th out of 17 countries in Southeast Asia, East Asia, and Oceania. Indonesia's innovation performance in education has also declined in terms of input innovation, with human capital and research being the worst (WIPO, 2025). These findings indicate low innovation and creativity capabilities among Indonesian students. Therefore, developing learning that is in line with current trends is increasingly urgent.

Students develop an understanding of scientific thinking concepts through science learning (Vosniadou, 2019). Science learning plays a crucial role in building a sustainable society (Yunita & Mandasari, 2025). Science learning teaches students to develop an understanding of scientific thinking concepts, encouraging each individual to reflect on sustainable issues scientifically through scientific inquiry, fact-based learning, and involvement in socio-scientific discussions (Fernández-Huetos et al., 2025; Hogan & O'Flaherty, 2021). The Socio-Scientific Issue (SSI) approach integrates social and scientific factors to address relevant issues (Arthamena et al., 2024; Ke et al., 2021; Zatdni & Mashfufah, 2025) in students' lives, which has implications for creative thinking skills (Sa'diah et al., 2025).

Science and creativity are interrelated. Learning science requires individuals to think creatively (Mulyono et al., 2023). Furthermore, the primary goal of science education is to facilitate the development of creativity (Akram & Rana, 2025). The SSI approach has become essential and integral to science education curricula, pedagogy, and research in various countries over the past few decades (Högström et al., 2025). This approach encourages students to connect learning materials to real-life contexts, including environmental, social, and cultural issues (Andaresta & Irawan, 2025; Arifin & Nyet, 2024; Fujinami et al., 2025). While global studies emphasize the importance of SSI, the implementation in developing countries, particularly within Indonesian science textbooks, remains under-explored. Through the SSI approach, students can build a bridge of understanding between theory and contextual life, as well as develop scientific reasoning and social responsibility (Dusturia et al., 2024), and are closely related to morals and ethics (Andaresta & Irawan, 2025; Anwar & Ali, 2020; Desstya et al., 2024).

However, not many have discussed what learning models can be combined with SSI to improve students' creative thinking skills, what instruments to measure creative thinking after implementing SSI-based learning, what subjects/learning materials are appropriate to be taught using SSI, and the impact of the SSI approach on students' creative thinking skills, so it is necessary to conduct a literature review to analyze the application of the SSI approach in learning.

## **METHODS**

The research method applied in this study is a literature review. This review was conducted by examining scientific articles to uncover several aspects, including substantive findings, methodology on the research topic, and theoretical contributions to the research. The steps of the literature review in this study are outlined in Figure 1 below (Dusturia et al., 2024).

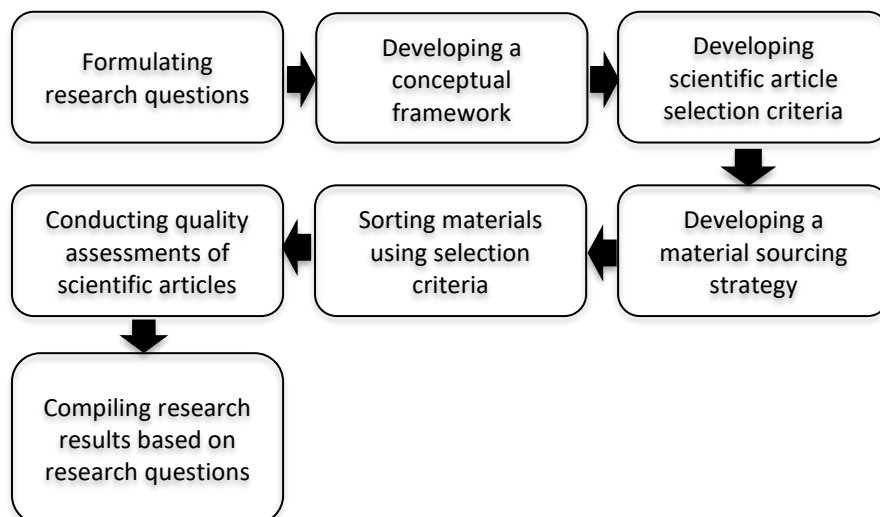


Figure 1. Literature review steps

The following is an explanation of each step in the flow:

*Formulating research questions*

This research question was formulated with the aim of making it easier for researchers to answer the objectives of the research being conducted.

Table 1. Research Questions and Objectives

Research Questions	Objective
Can the application of the Socio-Scientific Issues (SSI) approach improve students' creative thinking skills?	Determining the influence of the application of the SSI approach in learning on students' creative thinking abilities.
What are the results of students' creative thinking abilities after receiving learning by applying the SSI approach?	Revealing the results regarding students' creative thinking abilities after participating in learning by applying the SSI approach.
What type of instrument is used to measure students' creative thinking abilities?	What type of instrument is used to measure students' creative thinking abilities?

*Developing a conceptual framework*

A conceptual framework design was developed at this stage to explain the variables in this study. The conceptual framework in this study can be seen in the diagram below.

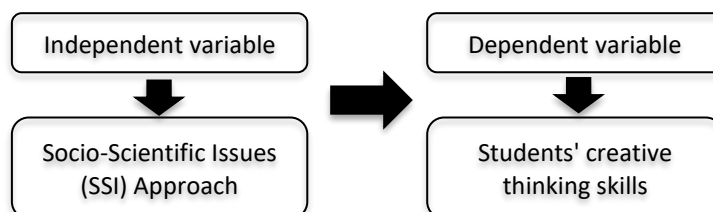


Figure 2. Conceptual framework design

*Developing scientific article selection criteria*

In this third stage, researchers develop criteria for selecting scientific articles to be reviewed. The selection criteria include acceptance and rejection criteria, as outlined below:

*Table 2. Acceptance and Rejection Criteria for Scientific Articles*

<b>Acceptance Criteria</b>	<b>Rejection Criteria</b>
Scientific articles were published between 2021 and 2025.	Scientific articles published before 2021.
Contains the application of the SSI approach which is implemented through a learning model and has an impact on students' creative thinking abilities.	Does not include the application of the SSI approach which has an impact on students' creative thinking abilities.
Scientific articles are published in Sinta 1-5 journals.	Articles are not published in journals accredited by Sinta 1-5.
Not a literature review	The article is a literature review

*Developing a material sourcing strategy*

In this fourth stage, steps were developed to search for scientific articles as material for review. Scientific articles were searched using the Publish or Perish application version 8 by entering several keywords, namely "Socio-Scientific Issue," "SocioScientific Issue," "Socio-Scientific Issue," "SSI," "creative thinking," "creative thinking skills," "creative thinking," "creative thinking skills," with a year limit between 2021 and 2025.

*Sorting materials using selection criteria*

In this fifth stage, the scientific articles obtained are sorted using the selection criteria as previously determined in the third stage.

*Conducting article quality assessments*

Scientific articles that have passed the selection criteria are reviewed based on quality criteria by answering the following questions.(Dusturia et al., 2024):

- a. Does the article title include the SSI approach and learning model used?
- b. Is the research method used appropriate to the purpose of writing this article?

The answers to the two questions above are to determine the learning model applied in the research and also the research methodology used by the researcher.

*Synthesis of research results*

In this seventh stage, scientific articles that pass the selection criteria are reviewed. The review is conducted to answer the previously established research questions

**RESULTS AND DISCUSSION**

*Sorting materials using selection criteria*

Referring to the article search results using the publish or perish application version 8 and applying the keywords "Socio-Scientific Issue", "SocioScientific Issue", "Socio Scientific Issue", "SSI", "creative thinking", "creative thinking skills", "creative thinking", "creative thinking skills" with a publication year range between 2021 and 2025, the results were 95 articles. Furthermore, all articles were reviewed based on predetermined criteria, namely containing the application of the SSI approach in learning and impacting students' creative thinking skills, and scientific articles published in Sinta 1-5 journals. Of the 95 articles, there are six articles containing the SSI approach that impacts students' creative thinking skills. Furthermore, of the six articles, four articles were published in Sinta 1-5 journals.

*Conducting article quality assessments*

*Socio-Scientific Issues (SSI)* is a learning approach and requires a learning model to implement it. Of the four articles accepted based on the previous selection criteria, the SSI approach and learning model are listed in the article titles, as shown in the following table:

Table 3. Learning approaches and learning models

Article Code	Approach	Learning model
A1	SSI	Interactive Socio-Scientific Inquiry (ISSI)
A2	SSI	Problem Based Learning (PBL)
A3	SSI	Project Based Learning (PjBL)
A4	SSI	Project Based Learning (PjBL)

The quality assessment of the articles continued by reviewing the research methods applied in each article. Referring to the conceptual framework, the study included SSI as the independent variable with creative thinking skills as the dependent variable with the aim of determining how the application of the SSI approach in learning impacts students' creative thinking skills. The four articles were analyzed and one article did not meet the purpose of this article. This was because the study did not observe the impact of SSI implementation on students' critical thinking skills, but rather conducted a survey of physics teachers' perceptions of the implementation of SSI integrated with STEM based on PjBL used to improve students' creative thinking skills on the topic of renewable energy. The study was not directly applied in classroom learning but rather a survey of teachers' perceptions.

The following three articles align with the purpose of this article. The research methods applied in each article are shown in the table below:

Table 4. Research Methods Applied

Article Code	Research methods
A1	Quasi Experiment
A2	Quasi Experiment
A4	Quasi Experiment

As seen in the table, all articles used a quasi-experimental research method with a pretest-posttest control group design to collect data to determine students' learning outcomes in the form of creative thinking skills. Based on the quality assessment of the articles used in this study, as determined in the writing of this article, namely by answering two questions related to the title and the suitability of the research method, three articles met the criteria. These three articles will then be analyzed in the next stage, namely the synthesis of research results.

#### Synthesis of research results

This stage is completed by answering the previously formulated research questions. This stage is conducted on three articles that have been sorted using selection criteria and article quality assessments. The list of articles to be analyzed at this stage is listed in Table 5.

Table 5. List of Analyzed Articles

Article Code	Article Title	Publisher Journal	Publication Year	Syntax Index
A1	Interactive Socio-Scientific Inquiry: The Effects on Creative Thinking Skills	Journal of Mathematics and Natural Sciences Education	2022	Sinta 2
A2	The Effectiveness of the Problem Based Learning Model Based on Socio-Scientific Issues on Students' Creative Thinking Skills in Green Chemistry Material	Journal of Chemical Education Research	2024	Sinta 4
A4	The Effectiveness of PjBL-Socio Scientific Issues-Based Student Worksheets on Environmental Change and Conservation Material on the Creative Thinking Skills of High School/Islamic Senior High School Students	Al-Alam: Islamic Natural Science Journal	2025	Sinta 5

Article A1 written by Tasya Indriani & Ummi Nur Afinni Dwi Jayanti (2022). The study was conducted using a control group and an experimental group at the high school level. The control group received the application of conventional learning activities according to the previous teacher's teaching method, while the experimental class carried out learning activities using the Interactive Socio Scientific Inquiry (ISSI) model. The subject taught was biology with the material of environmental changes. Evaluation of creative thinking skills was carried out using a question instrument containing five fill-in-the-blank questions. The fill-in-the-blank question instrument used refers to five indicators of creative thinking skills, namely fluent thinking, flexible thinking, original thinking, detailed thinking, and judgmental thinking. The assessment results showed that the creative thinking skills of the experimental class were higher than those of the control class. The pretest/posttest results of the experimental class were 66.80/91.40 while those of the control class were 64.63/80.93. The effectiveness test used the N-Gain Test with the results of the experimental class compared to the control class being 0.78:0.45 which showed that the application of ISSI was more effective in improving students' creative thinking skills. Furthermore, the hypothesis test using ANCOVA test with a significance level  $<0.05$  shows that  $H_0$  is accepted so that the implementation of the ISSI model has an impact on improving students' creative thinking skills. The ISSI learning model helps students to use a scientific approach in analyzing problems and making decisions regarding issues related to social and scientific issues around them. Socio-Scientific Issues (SSI) can create meaningful learning through the exploration of social problems and their implementation in the school environment.

Article A2 written by Putri Nadlifah Tiara Nita & Ella Izzatin Nada (2024). In the learning of green chemistry material for grade X of high school, the researcher aimed to measure the effectiveness of the application of the SSI-based PBL learning model on creative thinking skills in different class groups, namely the experimental class and the control class. The experimental class applied the SSI-based PBL model in learning, while the control class used conventional methods. The test instrument was in the form of 8 open-ended questions adjusted to four indicators of creative thinking skills, namely fluency, flexibility, originality, and elaboration. The pretest/posttest results for the experimental and control classes were 59.87/72.17 and 55.25/64.68, respectively. The effectiveness test used an independent sample t-test while to determine the increase in students' creative thinking skills, an effect size test (Cohend's  $d$ ) was used. Based on the test results, it shows that the application of PBL-SSI is effective in improving creative thinking skills (t-test  $0.001 < 0.05$ ) in the moderate category (effect test 0.708). The application of SSI supports PBL, especially in improving divergent thinking and mutual opinion. Divergent and argumentative thinking will stimulate fluency, flexibility, originality, and elaboration in the creative thinking process.

Article A4 written by Messy Naitul & Fitri Arsih (2025). The study was conducted on high school students in phase E (grade 10) for the material of environmental change and preservation. There was one control class and one experimental class. The control class implemented PjBL-based LKPD while the experimental class used PjBL-Socio Scientific Issues (SSI)-based LKPD. The analysis in this study used hypothesis testing and N-Gain testing. The test instrument consisted of 10 questions but the form of the instrument used for the pretest and posttest was not mentioned in this article. The indicators of creative thinking skills measured were fluency, flexibility, originality, and elaboration. The comparison of pretest results between the control class and the experimental class was 33.83: 40.97 and the comparison of posttest results between the control and experimental classes was 58.35: 73.89. The N-Gain test for the control class was 37% while the experimental class was 55% with both in the moderate category. Judging from the increase in students' creative thinking abilities in both the control and experimental classes, it shows that learning that applies LKPD based on PjBL-Socio Scientific Issues (SSI) provides a better impact on improvement compared to LKPD without using the SSI approach. The obstacles faced in this study were that students were not yet accustomed to

answering creative thinking questions, students were shy and not yet accustomed to expressing their creative opinions so that it requires teacher efforts in providing triggers in the form of relevant and meaningful real-world issues to further motivate students in learning.

*Socio-Scientific Issues* (SSI) emphasizes the implementation of science in life (Ke et al., 2020) where contextual problems are integrated into learning (Viehmann et al., 2024) which is based on scientific concepts but requires reasoning related to its social dimensions so that it can be responded to appropriately (Owens & Sadler, 2023) so that the integration will increase the relevance of learning (Suryani & Anggraini, 2025). SSI encourages students to face challenges in society through critical, interdisciplinary, and inquiry-based thinking that will impact their conceptual insight and environmental literacy (Lubis et al., 2022; Viehmann et al., 2024). By applying knowledge in a social context and reasoning about the relationship between scientific and social factors, it will influence their position on the complex issues discussed. (Ke et al., 2021). The existence of social conflict that is closely related to science in this approach will require scientific thinking in its presentation. (Arthamena et al., 2024) With these characteristics, the SSI approach can develop problem-solving skills. (Nugroho et al., 2025), in-depth contextual understanding, improving problem-solving skills, critical reasoning, creative thinking, argumentative abilities, motivation, and concern for the environment (Arthamena et al., 2024; Dewi & Yahdi, 2025; Suryani & Anggraini, 2025). Thus, the position of SSI in forming students with scientific insight is no longer debated. (Durak & Topçu, 2021). Its characteristics as an approach are flexible to be applied through various learning models, especially having dominant relevance in problem-based models such as inquiry, PBL, and PjBL (Dewi & Yahdi, 2025). Based on this, the SSI approach can positively correlate with the development of 21st-century skills in students. One important 21st-century skill is creative thinking, alongside critical reasoning, problem-solving, and collaboration. (Dilekçi & Karatay, 2023) The level of creative thinking skills can be measured from four aspects, namely fluency, flexibility, originality, and elaboration (Naitul et al., 2025). These four aspects can be stimulated through the application of SSI in learning activities. (Nadlifah et al., 2024). The characteristics of SSI approach learning activities are open and broad, ultimately developing critical thinking skills optimally (Astari et al., 2025). Finally, SSI-based learning deserves further optimization to foster students' creative thinking skills in the future.

## **CONCLUSION**

Based on the research results referring to three articles obtained from the selection results using several criteria, the implementation of the SSI approach in learning can encourage the improvement of students' creative thinking skills. The assessment of creative thinking skills applies a pretest and posttest design with essay-based questions developed according to creative thinking skill indicators. The material taught to students using the SSI approach includes environmental change and conservation as well as green chemistry for the science grass subject. This study contributes to instructional technology by providing a framework for digitizing SSI-based content that aligns with student conceptions, ultimately enhancing pedagogical practices in 21st-century science education. The SSI approach is implemented using several learning models, namely Interactive Socio-Scientific Inquiry (ISSI), Problem Based Learning (PBL), and Project Based Learning (PjBL).

## **CONFLICT OF INTEREST**

There are no conflicts of interest in the writing of this article.

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## REFERENCES

- Akram, T. M., & Rana, R. A. (2025). Assessing Prospective Science Teachers' Creative Thinking Ability to Solve Environmental Issues in Higher Education. *Qlantic Journal of Social Sciences and Humanities*, 6(1), 254–265. <https://doi.org/10.55737/qjssh.vi-i.25314>
- Alfaruqi, AZ & Nurwahidah. (2025). Reflection on Indonesia's PISA Scores and the 2024 Madrasah Teacher Competency Assessment Results: Challenges in Enhancing Teacher Competence. *Jurnal Pendidikan IPS*, 15(1), 11–19. <https://doi.org/10.37630/jpi.v15i1.2559>
- Andaresta, DA, & Irawan, E. (2025). Study of Students' Creative Thinking Ability in Socio-Scientific Issues Integrated Science Learning. *Jurnal Pendidikan Dan Pembelajaran IPA Indonesia*, 15(1), 13–24. <https://doi.org/10.23887/jppii.v15i1.90153>
- Anwar, NP, & Ali, MA (2020). The effect of socio-scientific issue (SSI) based discussion: A student-centred approach to the teaching of argumentation. *Scholarship of Teaching and Learning in the South*, 4(2), 35–62. <https://doi.org/10.36615/sotls.v4i2.76>
- Arifin, S., & Nyet, MS (2024). The Effect of Socioscientific Issues Approach and Design Thinking on Entrepreneurial Creative Thinking Among Secondary School Students. *International Journal of Modern Education*, 6(21), 611–631. <https://doi.org/10.35631/IJMOE.621045>
- Arthamena, V.D., Ayubi, M., Atun, S., & Suyanta, S. (2024). Use of Socio-Scientific Issues in Chemistry Learning. *Journal of Science Education Research*, 10(1), 38–46. <https://doi.org/10.29303/jppipa.v10i1.6285>
- Astari, WY, Redhana, IW, & Tika, IN (2025). Implications of the Socio-Scientific Issues Approach on Students' Creative Thinking Skills in Science Learning: A Systematic Literature Review. *Journal of Science Education Research*, 11(10), 98–106. <https://doi.org/10.29303/jppipa.v11i10.12071>
- Beaty, R.E., Kenett, Y.N., Christensen, A.P., Rosenberg, M.D., Benedek, M., Chen, Q., Fink, A., Qiu, J., Kwapil, T.R., Kane, MJ, & Silvia, P.J. (2018). Robust prediction of individual creative ability from brain functional connectivity. *Proceedings of the National Academy of Sciences*, 115(5), 1087–1092. <https://doi.org/10.1073/pnas.1713532115>
- Desstya, A., Sayekti, IC, Rahmawati, FP, Hidayati, YM, Kaltsum, HU, Mahya, YMZ, Kamila, SJP, Khotimah, NA, Fidyastuti, N., & Diaz, AM (2024). Development of a Natural and Social Sciences Learning Model Based on Socio Scientific Issues to Strengthen Scientific Literacy of Islamic Elementary School Students. *Journal of Science Education Research*, 10(11), 8703–8711. <https://doi.org/10.29303/jppipa.v10i11.9094>
- Dewi, CA, & Yahdi, Y. (2025). Research Trends on Socio-Scientific Issues in Chemistry Learning: A Systematic Review. *Jurnal Pendidikan MIPA*. <https://doi.org/10.23960/jpmipa.v26i1.pp457-475>
- Dewra, Dr. S. D., & Singh, J. (2025). Innovative Approaches in Modern Education: Bridging Theory and Practice. *International Journal of Scientific Research in Engineering And Management*, 09(05), 1–9. <https://doi.org/10.55041/IJSREM46731>
- Dilekçi, A., & Karatay, H. (2023). The Effects Of The 21st Century Skills Curriculum On The Development Of Students' Creative Thinking Skills. *Thinking Skills and Creativity*. <https://doi.org/10.1016/j.tsc.2022.101229>
- Durak, B., & Topçu, M. (2021). Socio-Scientific Issues and Model-Based Learning. *IGI Global Scientific Publishing*. 279–297. <https://doi.org/10.4018/978-1-7998-4558-4.ch010>
- Dusturia, N., Nurohman, S., & Wilujeng, I. (2024). Socio-Scientific Issues (SSI) Approach Implementation in Science Learning to Improve Students' Critical Thinking Skills: Systematic Literature Review. *Journal of Science Education Research*, 10(3), 149–157. <https://doi.org/10.29303/jppipa.v10i3.6012>
- Fernández-Huetos, N., Pérez-Martín, J.M., Guevara-Herrero, I., & Esquivel-Martín, T. (2025). Primary-Education Students' Performance in Arguing About a Socioscientific Issue: The Case

- of Pharmaceuticals in Surface Water. *Sustainability*, 17(4), 1618. <https://doi.org/10.3390/su17041618>
- Foster, N., & Schleicher, A. (2022). Assessing Creative Skills. *Creative Education*, 13(01), 1–29. <https://doi.org/10.4236/ce.2022.131001>
- Fujinami, K., Shimomae, K., Shimada, K., & Isozaki, T. (2025). Incorporating Socio-Scientific Issues in Science Classes: Co-Teaching with a Social Studies Teacher. *Research in Science Education*, 55(4), 1005–1028. <https://doi.org/10.1007/s11165-025-10270-0>
- Hogan, D., & O'Flaherty, J. (2021). Addressing Education for Sustainable Development in the Teaching of Science: The Case of a Biological Sciences Teacher Education Program. *Sustainability*, 13(21), 12028. <https://doi.org/10.3390/su132112028>
- Högström, P., Gericke, N., Wallin, J., & Bergman, E. (2025). Teaching Socioscientific Issues: A Systematic Review. *Science & Education*, 34(5), 3079–3122. <https://doi.org/10.1007/s11191-024-00542-y>
- Indriani, T., Nur, U., & Dwi, A. (2022). Interactive Socio-Scientific Inquiry: The Effects on Creative Thinking Skills. *Journal of Mathematics and Natural Sciences Education*, 23(8), 995–1005. <https://doi.org/http://dx.doi.org/10.23960/jpmipa/v23i3.pp995-1005>
- Karunarathne, W., & Calma, A. (2024). Assessing creative thinking skills in higher education: Deficits and improvements. *Studies in Higher Education*, 49(1), 157–177. <https://doi.org/10.1080/03075079.2023.2225532>
- Ke, L., Sadler, T., Zangori, L., & Friedrichsen, P. (2020). Students' Perceptions of Socio-Scientific Issue-Based Learning and Their Appropriation of Epistemic Tools for Systems Thinking. *International Journal of Science Education*, 42, 1339–1361. <https://doi.org/10.1080/09500693.2020.1759843>
- Ke, L., Sadler, T., Zangori, L., & Friedrichsen, P. (2021). Developing and Using Multiple Models to Promote Scientific Literacy in the Context of Socio-Scientific Issues. *Science & Education*, 30, 589–607. <https://doi.org/10.1007/s11191-021-00206-1>
- Lubis, SPW, Suryadarma, I., Paidi, P., & Yanto, BE (2022). The Effectiveness of Problem-based learning with Local Wisdom oriented to Socio-Scientific Issues. *International Journal of Instruction*. <https://doi.org/10.29333/iji.2022.15225a>
- Mulyono, Y., Yamtinah, S., & Sarwanto, S. (2023). Development of Critical and Creative Thinking Skills Instruments Based on Environmental Socio-Scientific Issues. *International Journal of Instruction*, 16(3), 691–710. <https://doi.org/10.29333/iji.2023.16337a>
- Nadlifah, P., Nita, T., & Nada, EI (2024). Efektivitas Model Problem Based Learning Berbasis Socio Scientific Issue Terhadap Keterampilan Berpikir Kreatif Siswa Materi Kimia Hijau. *Journal of Chemical Education Research*. 14(2), 136–143. <https://doi.org/10.21009/JRPK.142.08>
- Naitul, M., Arsih, F., & Padang, UN (2025). The Effectiveness of PjBL-Socioscientific Issues-Based Student Worksheets on Environmental Change and Conservation Material on the Creative Thinking Skills of High School/Islamic High School Students. 4(2), 56–63.
- Nugroho, A., Sajidan, S., Suranto, S., & Masykuri, M. (2025). The Effects of Socio-Scientific Inquiry Based Learning on Students' Problem-Solving Skills. *Journal of Baltic Science Education*. <https://doi.org/10.33225/jbse/25.24.149>
- Owens, D., & Sadler, T. (2023). Socio-Scientific Issues Instruction for Scientific Literacy: 5E Framing to Enhance Teaching Practice. *School Science and Mathematics*. <https://doi.org/10.1111/ssm.12626>
- Ritter, S. M., & Mostert, N. (2017). Enhancement of Creative Thinking Skills Using a Cognitive-Based Creativity Training. *Journal of Cognitive Enhancement*, 1(3), 243–253. <https://doi.org/10.1007/s41465-016-0002-3>
- Sa'diah, C., Purwanto, A., & Koto, I. (2025). Development of E-Modules Based on Socio-Scientific Issues to Improve the Creative Thinking Skills of High School Students. *Journal of Physics Learning Research*, 16(2), 179–190. <https://doi.org/10.26877/jp2f.v16i2.1435>

- Sakdiah, H., Wahdi Ginting, F., Sri Rezeki, N., & Miranda, A. (2023). The Effect of STEAM Learning and Scientific Attitude on Students' Creative Thinking Skills. *Proceedings of Malikussaleh International Conference on Multidisciplinary Studies (MICoMS)*, 3, 00040. <https://doi.org/10.29103/micoms.v3i.204>
- Santoso, IB, Waluyo, J., & Hariyadi, S. (2020). Effectiveness of Science Textbooks Based on Socio-Scientific Issues in Biotechnology Materials To Improve Creative Thinking Ability. *International Journal of Advanced Research*, 08(04), 140–144. <https://doi.org/10.21474/IJAR01/10757>
- Sun, M., Wang, M., & Wegerif, R. (2020). Effects of divergent thinking training on students' scientific creativity: The Impact of Individual Creative Potential and Domain Knowledge. *Thinking Skills and Creativity*, 37, 100682. <https://doi.org/10.1016/j.tsc.2020.100682>
- Suryani, Y., & Anggraini, W. (2025). The Effect of Socio-Scientific Issues Approach on Student Learning Outcomes in Physics Learning: A Review. *MIPA Incandescent Journal*. <https://doi.org/10.29303/jpm.v20i3.8861>
- Tang, T., Vezzani, V., & Eriksson, V. (2020). Developing critical thinking, collective creativity skills and problem solving through playful design jams. *Thinking Skills and Creativity*, 37, 100696. <https://doi.org/10.1016/j.tsc.2020.100696>
- Viehmann, C., Cárdenas, J. M. F., & Peña, C. G. R. (2024). The Use of Socioscientific Issues in Science Lessons: A Scoping Review. *Sustainability*. <https://doi.org/10.3390/su16145827>
- Vosniadou, S. (2019). The Development of Students' Understanding of Science. *Frontiers in Education*, 4, 32. <https://doi.org/10.3389/educ.2019.00032>
- World Intellectual Property Organization. (2025, December 2). Indonesia Ranking in the Global Innovation Index 2025. WIPO. <https://www.wipo.int/gii-ranking/en/indonesia>
- Yunita, L., & Mandasari, N. (2025). 21st-Century Skills-Oriented Science Education in the Context of Higher Education: A Review. *Panthera: Scientific Journal of Science and Applied Education*, 5(1), 40–49. <https://doi.org/10.36312/panthera.v5i1.334>
- Zatdni, G.F., & Mashfufah, A. (2025). Development of Socio-scientific Issues-Based Teaching Materials on Ecosystem Materials in Elementary School. *Elementary School*, 5(1), 68–78. <https://doi.org/10.24036/jlils.v5i1.150>
- Zhang, W., Sjoerds, Z., & Hommel, B. (2020). Metacontrol of Human Creativity: The Neurocognitive Mechanisms of Convergent and Divergent Thinking. *NeuroImage*, 210, 116572. <https://doi.org/10.1016/j.neuroimage.2020.116572>

## Developing a Digital Learning Management Strategy Using the Dick and Carey Model to Enhance Junior High School Students' Critical Thinking in Biology Learning

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### ABSTRACT

Biology learning at the junior secondary school level faces increasing challenges in fostering students' critical thinking skills as a core competency of the 21st century. International assessments consistently indicate that students' higher-order thinking skills in science remain relatively low, highlighting the need for learning strategies that emphasize systematic learning management rather than content transmission alone. This study aims to develop and examine the effectiveness of a digital learning management strategy through the integration of the Nearpod web-based platform using the Dick and Carey instructional design model to enhance junior high school students' critical thinking skills in Biology. This research employed a Research and Development (R&D) approach following the nine stages of the Dick and Carey model, including needs analysis, instructional analysis, learner analysis, instructional design, formative evaluation, revision, and field implementation. The participants consisted of 72 eighth-grade students, three Biology teachers, two media experts, and one educational technology expert. Data were collected through observations, questionnaires, critical thinking tests, interviews, and Nearpod learning analytics, and analyzed using qualitative techniques and gain score analysis. The results indicate an average increase of 26.8% in students' critical thinking skills (N-Gain 0.44), categorized as medium-high, demonstrating that systematically managed digital learning effectively supports higher-order cognitive processes. The study concludes that integrating Nearpod as a digital instructional management system within a coherent instructional design framework significantly enhances Biology learning quality. This research contributes theoretically by linking instructional design, digital learning management, and critical thinking development, and practically by offering an implementable model for technology-enhanced science instruction.

**Keywords:** *Biology Learning, Critical Thinking Skills, Dick and Carey Model, Digital Learning Management, Nearpod*



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### INTRODUCTION

Biology learning at the junior high school (SMP) level faces increasingly complex challenges, along with the need to strengthen critical thinking skills as part of 21st-century competencies. Various international reports indicate that students' higher-order thinking skills remain relatively low, particularly in science subjects that require evidence-based reasoning and in-

depth conceptual understanding (OECD, 2019; OECD, 2023). This situation requires learning strategies that are not only oriented towards content mastery but also focus on systematic management of the learning process and focus on students' cognitive activities (Facione, 2015; Ennis, 2018).

The development of digital technology has opened up vast opportunities for transforming science learning, including biology. However, studies of educational technology emphasize that technology integration does not automatically improve learning quality without adequate instructional design and learning management (Kirkwood & Price, 2014; Selwyn, 2016). Many digital learning practices still position technology solely as a medium for delivering content, thus underutilizing its potential as a manager of learning activities, a monitor of cognitive processes, and a provider of learning data (Dede, 2018; Mayer, 2020).

In the context of biology learning, these challenges are even more pronounced due to the abstract, dynamic nature of the material, which is often difficult to visualize using conventional methods. Previous research has shown that the use of interactive media and digital simulations can improve science students' conceptual understanding and higher-order thinking skills, provided they are integrated into a well-planned learning strategy (Smetana & Bell, 2012; Mayer, 2020). Therefore, a systemic approach that integrates digital technology with strong learning design principles is needed (Henderson et al., 2020).

Nearpod is a digital learning platform with potential as a learning management system. This platform provides learning planning features, interactive presentation of materials, real-time monitoring of student responses, and learning analytics that support data-driven instructional decision-making (Fisher & Newton, 2020; Harpaz, 2021). Unlike conventional Learning Management Systems (LMS) such as Moodle or Google Classroom, which often function primarily as asynchronous repositories for material distribution, Nearpod allows for 'live session' management. This enables teachers to control the pace of learning, provide immediate feedback during the thinking process, and monitor student engagement synchronously—capabilities that are crucial for managing the complex cognitive steps in the Dick and Carey model. Although Nearpod has been extensively researched, most international research focuses on student engagement or perceived usability, and little has been done to examine Nearpod as part of a digital learning management strategy integrated with an instructional system design model, particularly in junior high school biology (Mandinach & Gummer, 2016; Bond et al., 2020).

To bridge this gap, a systematic framework is essential. The Dick and Carey model offers a learning systems design framework that emphasizes alignment between needs analysis, instructional objectives, learning strategies, and evaluation. Instructional design literature suggests that implementing a systemic model like Dick and Carey's contributes significantly to the success of digital learning by ensuring instructional coherence and constructive alignment between learning components (Reigeluth, 2013; Dick et al., 2015). However, empirical studies integrating the Dick and Carey model with web-based digital learning platforms in the context of junior high school biology learning are still relatively limited.

Although extensive research has been conducted on learning technology and critical thinking (Putra & Lestari, 2021; Wahyuni, 2022), studies integrating Nearpod into a digital learning management perspective based on the Dick and Carey model in junior high school biology learning are still limited. Most studies focus solely on media effectiveness or improving learning outcomes, without examining how technology is managed as part of a comprehensive learning system. Therefore, this study is crucial to fill this gap by analyzing digital learning management strategies through the integration of web-based Nearpod in an effort to improve junior high school students' critical thinking skills in biology learning.

Based on the above explanation, this research aims to develop and test a digital learning management strategy through the integration of web-based Nearpod with the Dick and Carey model to improve junior high school students' critical thinking skills in Biology learning. This

research lies in the integration of Nearpod not only as a digital learning medium, but also as a digital learning management instrument systematically designed using the Dick and Carey model in the context of junior high school biology learning. This research provides a theoretical contribution by expanding the study of educational technology that links instructional system design, digital learning management, and the development of critical thinking in an integrated manner. Practically, this research offers an implementation model that can be used as a reference for teachers, schools, and policymakers in managing technology-based science learning in a structured, data-driven manner, and oriented towards the development of 21st-century skills.

## **METHODS**

### *Research Design*

This study uses a Research and Development (R&D) approach with the main objective of producing and testing the effectiveness of a learning product in the form of a web-based digital learning management strategy through the integration of Nearpod in junior high school Biology learning. The R&D approach was chosen because it is not only oriented towards testing theory, but also on developing systematic, contextual, and applicable instructional solutions in real educational environments (Borg & Gall, 2003; Richey & Klein, 2007).

The development framework used is the Dick and Carey instructional design model, which views learning as an integrated system of objectives, materials, strategies, media, and evaluation (Dick et al., 2015). This model is relevant in the context of educational technology because it allows for the structured and sustainable integration of digital technology into learning management. In this study, the Dick and Carey model is used not only as an instructional design guide but also as a managerial framework for managing Nearpod-based digital learning. The development followed nine integrated stages:

1. Learning Needs Analysis (Identify Instructional Goals)

The initial stage was conducted to identify gaps between the current Biology learning environment and the desired ideal environment. A needs analysis was conducted through preliminary studies, classroom observations, interviews with Biology teachers, and analysis of curriculum documents. This stage aimed to determine the need for digital learning development that could enhance students' critical thinking skills (Branch, 2009; Morrison et al., 2019).

2. Conduct Instructional Analysis

Learning analysis was conducted to outline the basic competencies of junior high school biology, which require critical thinking skills, particularly in the aspects of analysis, evaluation, and inference. At this stage, researchers identified the cognitive skill steps that students must master to optimally achieve biology learning objectives (Gagné et al., 2005; Ennis, 2018).

3. Analyze Learners and Contexts

This stage aims to analyze the characteristics of eighth-grade students, including their initial biology skills, digital literacy levels, learning styles, and school infrastructure readiness. Context analysis is conducted to ensure that the digital learning design aligns with the actual conditions of the school environment and supports the effective implementation of Nearpod (Reigeluth, 2013; Selwyn, 2016).

4. Formulating Learning Objectives (Write Performance Objectives)

Based on the analysis of student needs and characteristics, learning objectives are formulated specifically, measurably, and oriented toward developing critical thinking in biology. The formulation of objectives refers to the principles of outcome-based education and

constructive alignment, so that objectives, activities, and evaluations are in a systemic alignment (Biggs & Tang, 2011).

#### 5. Developing Assessment Instruments

An assessment instrument was developed to measure Biology students' critical thinking skills, encompassing indicators of analysis, evaluation, and inference. The instrument consisted of descriptive and reasoned-choice tests designed in accordance with Ennis and Facione's critical thinking framework. The instrument's content validity was assessed by experts, while its reliability was tested using the Cronbach's Alpha coefficient (Facione, 2015; Nitko & Brookhart, 2014).

**Developing an Instructional Strategy:** The learning strategy was designed by integrating Nearpod features, such as interactive slides, open-ended questions, collaborate boards, time to climb, and real-time quizzes. This strategy was designed to encourage active student engagement and facilitate higher-order thinking processes in Biology learning. This approach aligns with the principles of technology-enhanced learning and active learning in educational technology (Dede, 2018; Mayer, 2020).

**Developing and Selecting Instructional Materials** Biology learning materials are developed in the form of digital content on the Nearpod platform, including visualizations of biological processes, learning videos, interactive simulations, and formative questions. Material development takes into account the principles of multimedia learning so that students' cognitive load remains optimally managed (Mayer, 2020).

#### 6. Formative Evaluation (Design and Conduct Formative Evaluation)

Formative evaluation is conducted through expert review, one-to-one trials, and small group trials. This stage aims to obtain feedback to improve the quality of the learning design and ensure the product's applicability before wider field implementation (Tessmer, 1993; Dick et al., 2015).

#### 7. Revision and Field Implementation (Design and Conduct Summative Evaluation)

The final stage involved product revision based on the results of the formative evaluation and the implementation of Nearpod-based digital biology learning in the experimental class. The implementation aimed to test the effectiveness of digital learning management strategies in improving students' critical thinking skills.

### *Research Subjects and Ethical Considerations*

The research subjects consisted of 72 eighth-grade junior high school students, three biology teachers, two instructional media experts, and one educational technology expert. Subjects were selected using a purposive sampling technique, considering their direct involvement in the development and implementation of digital learning (Creswell & Plano Clark, 2018). Regarding ethical considerations, the researchers obtained formal research clearance from the participating school's administration. Furthermore, informed parental consent was secured for all 72 student participants, ensuring they were aware of the data collection process and that their anonymity would be maintained throughout the publication.

### *Data Collection Technique*

Research data was collected through several techniques, namely: (1) observation of Nearpod-based Biology learning to see the implementation of digital learning management strategies; (2) student and teacher response questionnaires to measure perceptions of the practicality and acceptability of the product; (3) Biology critical thinking ability tests in the form of pretests and posttests; (4) teacher interviews to obtain qualitative data related to the

managerial aspects of digital learning; and (5) documentation of Nearpod activities in the form of student-paced reports and class reports.

#### *Data Analysis Techniques*

Data analysis was conducted qualitatively and quantitatively. Qualitative data were analyzed through data reduction, data presentation, and drawing conclusions to describe the implementation and management of digital learning (Miles et al., 2014). Quantitative data were analyzed using N-Gain score calculations to assess improvements in critical thinking skills and learning effectiveness. Instrument validity and reliability were analyzed to ensure the accuracy of learning outcome measurements.

## **RESULTS AND DISCUSSION**

### *Results*

The implementation of the digital learning management strategy using the Dick and Carey model involved 72 eighth-grade students. The quantitative results indicate a significant improvement in students' critical thinking skills, with an average increase of 26.8% across three key domains. These findings are summarized in Table 1 below:

*Table 1. Comparison of Students' Pre-test and Post-test Critical Thinking Scores*

<b>Indicator of Critical Thinking</b>	<b>Pre-test Mean</b>	<b>Post-test Mean</b>	<b>Gain (%)</b>	<b>N-Gain Score</b>	<b>Interpretation</b>
Analysis	63.5	80.2	26.3%	0.46	Medium
Evaluation	61.2	78.5	28.3%	0.45	Medium
Inference	62.5	78.6	25.8%	0.43	Medium
<b>Overall Average</b>	<b>62.4</b>	<b>79.1</b>	<b>26.8%</b>	<b>0.44</b>	<b>Medium-High</b>

Observations of the learning process also showed that the Nearpod platform effectively recorded student engagement. Analytics from Nearpod's reports provided real-time data on student participation in interactive quizzes, collaborative boards, and open-ended responses, which served as the basis for formative assessment during the Biology lessons.

### *Discussion*

The significant increase in students' critical thinking skills (26.8%) demonstrates that a systematically managed digital learning environment can optimize high-level cognitive activities. This finding aligns with the principles of constructive alignment, where the success of technology integration depends on the coherence between learning objectives, instructional strategies, and evaluation (Biggs & Tang, 2011; Ennis, 2018; Facione, 2015).

From an educational technology perspective, the results of this study reinforce the view that digital technology does not automatically improve the quality of learning. The positive impact of technology depends heavily on the quality of instructional design and accompanying learning management (Kirkwood & Price, 2014; Selwyn, 2016). Nearpod in this study was integrated through the analysis of needs, student characteristics, and the demands of the junior high school biology curriculum, ensuring its use is contextual and goal-oriented (Dick et al., 2015). This approach aligns with the view that learning technology will be effective when used strategically to support complex thinking processes and meaningful learning (Dede, 2018).

Observations and analysis of student activity data indicate that Nearpod functions beyond conventional learning media and serves as a digital learning management tool. This platform provides comprehensive support ranging from lesson planning and interactive learning implementation, real-time monitoring of the learning process, to data-driven evaluation through learning analytics (Ifenthaler & Yau, 2020; Viberg et al., 2018). Nearpod's automated

reporting feature allows Biology teachers to obtain a comprehensive overview of student engagement levels, conceptual understanding, and responses to each learning activity, as recommended in the technology-enhanced learning literature (Gašević et al., 2016; Siemens & Long, 2011). This allows for rapid, adaptive, and empirically evidence-based instructional decision-making.

This approach aligns with the concept of data-informed instruction in educational technology, which emphasizes the use of learning data to improve teaching quality and student learning outcomes (Mandinach & Gummer, 2016; Datnow & Park, 2019). In biology, data from students' responses to open-ended questions, formative quizzes, and collaborative activities provides teachers with important diagnostic information to identify misconceptions, adjust instructional strategies, and design appropriate follow-up actions (Black & Wiliam, 2009; Shute, 2008). This suggests that Nearpod contributes to improving the quality of digital classroom management, particularly in science subjects that require continuous, evidence-based monitoring of conceptual understanding (OECD, 2019).

The successful integration of Nearpod in this study is inseparable from the role of the Dick and Carey model as a learning system design framework. This model provides a systemic and structured approach to developing technology-based biology learning by placing objectives, strategies, and evaluations in a single system (Dick et al., 2015; Branch, 2009). The stages of needs analysis and student characteristics analysis ensure that the content, activities, and evaluations developed are relevant to the cognitive development level of junior high school students and aligned with the core competencies of the curriculum (Anderson & Krathwohl, 2001; Merrill, 2013). The integration of critical thinking assessment instruments from the design stage strengthens instructional coherence and the quality of learning assessments (Nitko & Brookhart, 2014; Brookhart, 2010).

This finding is consistent with the instructional systems design literature, which emphasizes that the effectiveness of digital learning is largely determined by the alignment between components of the learning system, not by technological sophistication alone (Reigeluth, 2013; Morrison et al., 2019; Richey et al., 2011). In the context of educational technology, the use of the Dick and Carey model helps Biology teachers transform from mere technology users to instructional designers capable of designing, managing, and evaluating digital learning reflectively and sustainably (Ertmer & Ottenbreit-Leftwich, 2013; Trust et al., 2017).

Despite the positive outcomes, this study identifies a critical limitation regarding the digital divide. The "Live Participation" feature of Nearpod, which was central to this management strategy, requires high-speed internet stability. In rural school settings with limited bandwidth, teachers may face challenges in maintaining the real-time monitoring flow. Future research should explore the adaptation of this strategy in "Student-Paced" modes to ensure that the benefits of digital learning management are accessible to students in varied technological contexts.

## **CONCLUSION**

This study concludes that a digital learning management strategy through web-based Nearpod integration designed using the Dick and Carey model has proven effective in improving junior high school students' critical thinking skills in Biology learning. The 26.8% increase in critical thinking skills in the medium-high category indicates that systematically managed digital learning can optimize students' higher-level cognitive activities, particularly in the aspects of analysis, evaluation, and scientific inference. These findings confirm that the success of technology-based learning is not determined by the platform alone, but by the quality of the instructional design and accompanying learning management.

The integration of Nearpod in this study demonstrates a shift in the function of learning technology from simply a medium for delivering content to a digital learning management

system that supports integrated, data-driven learning planning, implementation, monitoring, and evaluation. The use of interactive features and learning analytics enables biology teachers to make adaptive, evidence-based instructional decisions, thereby sustainably improving the quality of science learning management.

The Dick and Carey model plays a significant role in ensuring alignment between learning objectives, learning strategies, learning activities, and evaluation. The systemic approach offered by this model helps maintain instructional coherence and constructive alignment in digital biology learning, while also strengthening the role of teachers as instructional designers capable of strategically, reflectively, and measurably managing learning technology.

Theoretically, this research enriches the study of educational technology by providing empirical evidence that the integration of instructional system design and digital learning platforms can significantly improve students' critical thinking skills in the context of science learning. Practically, the findings of this study provide implications for teachers, schools, and policymakers to develop and implement structured, data-driven digital learning management strategies oriented toward strengthening 21st-century competencies, particularly in Biology learning at the junior high school level.

#### CONFLICT OF INTEREST

No conflict of interest for this study.

#### REFERENCES

- Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. Longman.
- Biggs, J., & Tang, C. (2011). *Teaching for quality learning at universities* (4th ed.). Open University Press.
- Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability*, 21(1), 5–31. <https://doi.org/10.1007/s11092-008-9068-5>
- Bond, M., Bedenlier, S., Marín, V. I., & Händel, M. (2020). Emergency remote teaching in higher education: Mapping the first global online semester. *International Journal of Educational Technology in Higher Education*, 17(1), 1–24. <https://doi.org/10.1186/s41239-020-00227-y>
- Borg, W. R., & Gall, M. D. (2003). *Educational research: An introduction* (7th ed.). Allyn & Bacon.
- Branch, R. M. (2009). *Instructional design: The ADDIE approach*. Springer.
- Brookhart, S. M. (2010). *How to assess higher-order thinking skills in your classroom*. ASCD.
- Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE Publications.
- Datnow, A., & Park, V. (2019). *Data-driven leadership*. Jossey-Bass.
- Dede, C. (2018). Digital tools for deeper learning. *Educational Leadership*, 75(8), 20–24.
- Dick, W., Carey, L., & Carey, J. O. (2015). *The systematic design of instruction* (8th ed.). Pearson.
- Ennis, R. H. (2018). Critical thinking across the curriculum: A vision. *Topoi*, 37(1), 165–184. <https://doi.org/10.1007/s11245-016-9401-4>
- Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2013). Teacher technology change. *Journal of Research on Technology in Education*, 45(3), 255–284. <https://doi.org/10.1080/15391523.2013.10782611>
- Facione, P. A. (2015). *Critical thinking: What it is and why it counts*. Insight Assessment.
- Fisher, D., & Newton, C. (2020). Using Nearpod to promote active learning in science classrooms. *Journal of Science Education and Technology*, 29(6), 857–867. <https://doi.org/10.1007/s10956-020-09852-3>
- Gašević, D., Dawson, S., & Siemens, G. (2016). Let's not forget: Learning analytics are about learning. *TechTrends*, 60(2), 156–161. <https://doi.org/10.1007/s11528-016-0040-2>

- Gagné, R. M., Wager, W. W., Golas, K. C., & Keller, J. M. (2005). *Principles of instructional design* (5th ed.). Wadsworth.
- Harpaz, Y. (2021). Teaching for thinking in digital classrooms. *Educational Technology Research and Development*, 69(4), 2053–2070. <https://doi.org/10.1007/s11423-021-10022-7>
- Henderson, M., Selwyn, N., & Aston, R. (2020). What works and why? *Computers & Education*, 147, 103772. <https://doi.org/10.1016/j.compedu.2019.103772>
- Ifenthaler, D., & Yau, J. Y.-K. (2020). Utilizing learning analytics for study success. *Educational Technology & Society*, 23(3), 1–17.
- Kirkwood, A., & Price, L. (2014). Technology-enhanced learning and teaching. *Learning, Media and Technology*, 39(1), 6–36. <https://doi.org/10.1080/17439884.2013.770404>
- Mandinach, E. B., & Gummer, E. S. (2016). *Data literacy for educators*. Teachers College Press.
- Mayer, R. E. (2020). *Multimedia learning* (3rd ed.). Cambridge University Press.
- Merrill, M. D. (2013). *First principles of instruction*. Pfeiffer.
- Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis* (3rd ed.). SAGE Publications.
- Morrison, G. R., Ross, S. M., Kalman, H. K., & Kemp, J. E. (2019). *Designing effective instruction* (8th ed.). Wiley.
- Nitko, A. J., & Brookhart, S. M. (2014). *Educational assessment of students* (7th ed.). Pearson.
- OECD. (2019). *PISA 2018 results (Volume I): What students know and can do*. OECD Publishing. <https://doi.org/10.1787/5f07c754-en>
- OECD. (2023). *Education at a glance 2023: OECD indicators*. OECD Publishing. <https://doi.org/10.1787/e13bef63-en>
- Putra, R. A., & Lestari, S. (2021). Critical thinking skills of junior high school students in science learning. *Indonesian Journal of Science Education*, 10(3), 404–412.
- Reigeluth, C. M. (2013). *Instructional-design theories and models: Volume IV*. Routledge.
- Richey, R. C., & Klein, J. D. (2007). *Design and development research*. Lawrence Erlbaum Associates.
- Richey, R. C., Klein, J. D., & Tracey, M. W. (2011). *The instructional design knowledge base*. Routledge.
- Selwyn, N. (2016). *Education and technology: Key issues and debates* (2nd ed.). Bloomsbury Academic.
- Shute, V. J. (2008). Focus on formative feedback. *Review of Educational Research*, 78(1), 153–189. <https://doi.org/10.3102/0034654307313795>
- Siemens, G., & Long, P. (2011). Penetrating the fog. *EDUCAUSE Review*, 46(5), 30–40.
- Smetana, L. K., & Bell, R. L. (2012). Computer simulations to support science instruction. *International Journal of Science Education*, 34(9), 1337–1370. <https://doi.org/10.1080/09500693.2011.605182>
- Tessmer, M. (1993). *Planning and conducting formative evaluations*. Kogan Page.
- Trust, T., Krutka, S., & Carpenter, J. (2017). Transforming teacher education. *Journal of Digital Learning in Teacher Education*, 33(1), 1–5. <https://doi.org/10.1080/21532974.2016.1242390>
- Viberg, O., Hatakka, M., Bälter, O., & Mavroudi, A. (2018). The current landscape of learning analytics. *Computers in Human Behavior*, 89, 98–110. <https://doi.org/10.1016/j.chb.2018.07.027>
- Wahyuni, S. (2022). Profile of junior high school students' critical thinking skills in science learning. *Journal of Science Education Innovation*, 8(2), 145–154.

## **Integration of Gamification and the Problem-Based Learning (PBL) Model in Chemistry Learning to Improve Critical Thinking Skills: A Literature Review**

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### **ABSTRACT**

21st-century education requires students to master the 4C skills, which include critical thinking, collaboration, communication, and creativity. This study is based on the problem of low student analytical skills influenced by the dominance of teacher-centered learning, limited use of digital media, and the inconsistency of learning strategies with the demands of 21st-century competencies. This study aims to examine the use of gamification-based learning and problem-based learning in improving students' critical thinking skills. The research method used in this study is a literature review method by compiling various national and international publications published in the last five years collected through searches of academic databases (Scopus, Google Scholar, DOAJ, and Sinta). The results of the study indicate that the application of gamification and problem-based learning has provided consistent improvements in student motivation, engagement, and learning outcomes. Educational games have provided a learning environment that allows for independent exploration, strengthening reflective reasoning, and improving decision-making skills. However, the effectiveness of implementing this strategy is still influenced by the teacher's pedagogical competence, the availability of technological infrastructure, and the quality of alignment between game design and learning objectives. Based on the synthesis results, this study concludes that the integration of gamification and problem-based learning has strategic potential to support the transformation of learning toward a more adaptive and learner-oriented approach. These findings are expected to form the basis for developing innovative learning models that are relevant and effective in strengthening students' critical thinking skills.

**Keywords:** *21st Century Skills, Chemistry Learning, Critical Thinking, Gamification, Problem-based Learning*



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### **INTRODUCTION**

The rapid development of technology in the 21st century has impacted various aspects, one of which is education. 21st-century education faces increasingly complex challenges along with the development of digital technology and global demands. 21st-century education emphasizes students' development of the 4C skills: critical thinking, creativity, collaboration, and communication (Khafidh et al., 2025). These four skills are not only indicators of success in learning but also key assets in facing future challenges. Efforts to improve the quality of 21st-century skills will ensure improved education. Therefore, education must shift from conventional learning to one that is adaptive and relevant to current developments.

Critical thinking is one of the main skills in facing the challenges of the 21st century by involving the activities of receiving, processing, analyzing, and evaluating the information obtained to solve problems. However, its realization in the field has not been as expected, critical thinking skills in Indonesia are still relatively low (Amini et al., 2021). In the learning process, students' thinking skills can be developed through meaningful experiences, including problem-solving in the classroom. Teachers must be able to use appropriate media to motivate students to participate in the teaching and learning process and thus be able to absorb the material being studied (Efendi, 2022). The use of educational media and technology has proven effective in improving students' critical thinking skills. Schools that successfully integrate technology effectively are able to provide a more dynamic learning experience (Kusuma et al., 2024).

The current curriculum actually encompasses 21st-century skills in content, process, and assessment standards. However, in practice, learning remains teacher-centered (Arifin & Mu'id, 2024), characterized by the dominance of lecture methods and mechanical questions. Many teachers use more printed media, which causes students to feel bored during the learning process, so that students' academic grades and critical thinking skills are not honed properly (Kusuma et al., 2024). In addition to the factors mentioned above, the low student achievement in Indonesia can also be traced to the wide gap between curriculum policies, teacher capacity, and actual classroom conditions. Although the curriculum has adopted the principles of Higher Order Thinking Skills (HOTS), its implementation is hampered by the dominance of lecture methods and mechanical questions, which keep learning teacher-centered.

Study Rofi'ah & Rokhmaniyah, (2024), found that 85% of students still fall into the very low critical thinking skill category, with the primary cause being the conventional learning model. Furthermore, many teachers' pedagogical and technological competencies in designing inquiry-based learning and utilizing digital media are not evenly distributed, particularly in areas with limited access and facilities. This is exacerbated by a lack of ongoing training and an assessment system that does not fully measure analytical-evaluative thinking processes. As a result, students lack the space and meaningful experience to explore, argue, and solve problems, thus under-developing their critical thinking skills (Alfidyah, 2025).

21st-century teachers must be able to utilize technology and digital media as ideal instruments to provide enjoyable learning experiences for students. Batubara (2021), Digital learning media is a variety of teaching materials presented in visual form and can be accessed, processed, and shared through digital devices. Besides being known as multimedia, this type of media includes various forms of content such as audio, video, images, and animations that are used to increase student interest in the material being studied. The use of digital media as a medium for delivering learning materials is one of the most effective methods, because digital media is a medium that keeps up with the times and can be adapted to students' needs, abilities, and interests. The purpose of using digital media in the classroom is to make it easier for teachers and help students understand the material being explained (Fadiyah et al., 2024).

To address the persistence of teacher-centered learning, a fundamental shift in pedagogical strategy is required by integrating Problem-Based Learning (PBL) with gamification. PBL systematically shifts the teacher's role from a primary information source to a facilitator, placing students at the center of the learning process as they navigate real-world problems. When integrated with gamification, this model overcomes the passivity of traditional classrooms by utilizing game elements—such as points, badges, and challenges—to foster intrinsic motivation and active engagement. This combination creates a "joyful learning" environment where students are not just passive recipients of information but active explorers, allowing them to strengthen reflective reasoning and decision-making skills through structured, interactive participation.

Various studies show that the integration of gamification and interactive media in learning has the potential to improve critical thinking skills Lutfi (2023), reported that gamification in

chemistry learning can achieve learning completion, encourage more student-centered learning, and increase student motivation, curiosity, self-efficacy, and happiness, making it a suitable alternative for implementing the Independent Curriculum. Furthermore, Lukman et al. (2024) shows that practical and effective gamification-based mathematics teaching materials improve junior high school students' critical mathematical thinking skills with a moderate improvement category. In line with this, Pradnyana et al. (2025) proves that interactive gamification-based learning media in the Basic Computer and Network subject can be a source of independent and guided learning, while also contributing to improving students' critical thinking skills.

## **METHODS**

This study employed a qualitative approach with a literature review model. This approach was chosen to examine, collect, and reconstruct various previous research findings related to Problem-Based Learning (PBL) and its influence on improving critical thinking skills. The study materials were obtained from national and international journal articles, scientific proceedings, and academic literature published within the last five years (2021-2025), ensuring the information remains relevant and reflects the latest developments.

References were collected through several scientific databases, such as Scopus, Google Scholar, the Directory of Open Access Journals (DOAJ), and Sinta. The search was conducted using keywords including "problem-based learning," "gamification," "critical thinking skills," and "chemistry learning," along with variations of similar keywords.

The data collection process was conducted systematically, starting with establishing inclusion and exclusion criteria. The inclusion criteria for this study were: (1) articles published between 2020 and 2025; (2) studies specifically discussing the integration of gamification or PBL; (3) research measuring critical thinking skills as a primary outcome; and (4) articles written in English or Indonesian. Conversely, the exclusion criteria were: (1) articles focusing solely on general game-based learning without a PBL framework; (2) studies published before 2020; and (3) papers without full-text access.

Following these criteria, the selection process moved from initial screening through a review of titles and abstracts to reading the entire manuscript to ensure content consistency. Through this rigorous selection process, 5 key articles (N=5) were identified as meeting all criteria and were selected as the primary sources for synthesis. Important information recorded included the research design, study context, key findings, and limitations of each work.

The collected data was analyzed using content analysis. The analysis process included data reduction by selecting the most relevant literature, grouping it into thematic categories such as motivation, engagement, problem-solving skills, adaptability, and implementation constraints, and then synthesizing it to obtain a more comprehensive overview and narrative reasoning. The selection of literature sources was carried out using a purposive sampling technique, where the researcher deliberately selected research considered the most representative and appropriate to the focus of the study.

## **RESULTS AND DISCUSSION**

### *Results*

Based on literature studies through various scientific databases, namely Scopus, Google Scholar, Directory of Open Access Journals (DOAJ), and Sinta, using the keywords problem-based learning, gamification, critical thinking skills, and chemistry learning along with variations of equivalent terms. Five primary studies (N=5) and supporting literature were analyzed using content analysis techniques through data reduction stages, grouping into main themes such as motivation, involvement, problem-solving skills, adaptability, and implementation constraints, as well as compiling narrative synthesis to obtain a comprehensive picture. The selection of literature sources was carried out using purposive sampling techniques to ensure the depth of

analysis in accordance with the focus of the study. The following is a summary of data from various international and local studies relevant to the implementation of Problem Based Learning (PBL) with gamification media in improving critical thinking skills.

*Table 1. Summary of Referenced Research*

Study	Focus/Subject	Key Mechanics	Impact on Critical Thinking (Conclusion)
Lutfi (2023)	Chemistry Learning	Student-Centered Rewards & Pathways	Gamification in chemistry learning can train curiosity, increase self-confidence, and critical thinking skills in solving complex chemical problems.
Sandi et al. (2025)	Chemistry Learning	PBL-based e-Modules	The use of e-Modules based on Problem Based Learning is effective in improving students' critical thinking skills in electron configuration material.
Rahmasari (2025)	General Education	Gamified Evaluation Tools	The implementation of gamification-based evaluation tools is not only a means of assessment, but also an effective pedagogical strategy to strengthen conceptual understanding and thinking skills in the digital era.
Asmi et al. (2024)	High School (General)	PBL Syntax	Problem Based Learning is able to improve the critical thinking skills of high school students, as evidenced by the N-Gain value of 0.48 (medium category) and an increase in the average score of critical thinking skills of 55%, higher than the control class which only increased by 35%.
Ahmar & Azzajjad (2025)	Science or Chemistry Learning	PBL, Animation and Gamification	PBL-based learning combined with gamification and animation has proven to be more effective in improving students' 21st-century skills than lecture and question-and-answer methods.

### *Discussion*

#### 1. The Urgency of Improving High-Level Cognitive Skills in the Digital Era

All reviewed sources highlight a critical gap between 21st-century skill requirements and current conventional learning environments in Indonesia. Critical thinking and spatial abilities are recognized as higher-order cognitive skills crucial for solving complex problems, particularly in science and mathematics (Ahmar & Azzajjad, 2025; Angelelli et al., 2023). Within the context of Chemistry, these skills are indispensable for mastering abstract concepts that cannot be observed directly. However, reports such as TIMSS and PISA consistently show that Indonesian students' achievement in spatial reasoning remains low. This is exacerbated by a tendency toward monotonous, passive learning. Therefore, a pedagogical transformation is needed to develop thinking skills that are vital for the "digital native" generation (Berlin & Berlin, 2021).

#### 2. Problem Based Learning (PBL) as a Core Pedagogical Framework

The Problem-Based Learning (PBL) model has emerged as a major pedagogical framework to address these challenges by placing real-world problems as a context for learning (Ahmar & Azzajjad, 2025; Miterianifa et al., 2021). PBL places real-world problems as a context for students to acquire essential concepts and learn about critical thinking (Asmi et al., 2024; Oktaviani & Munahefi, 2025; Sandi et al., 2025; Wahyudiati, 2022). In the context of chemistry, PBL is used in the development of E-Modules for the material Electron Configuration and Electrolyte or Non-electrolyte Solutions, where this module guides students through the PBL syntax to analyze and find solutions to contextual problems (Sandi et al., 2025). The combination of PBL with appropriate media provides opportunities for students to develop analytical, evaluation, and problem-solving skills in both mathematics and chemistry.

### 3. Technology Integration Strategy: Gamification and Interactive Media

To address the issues of student engagement and media appeal in conventional PBL, the integration of visual technology and gamification is a superior solution. Gamification is defined as the use of game elements (such as points, badges, levels, and challenges) in non-game contexts to increase student motivation and active engagement (Oktaviani & Munahefi, 2025). Gamification has been proven to create a joyful learning atmosphere, increase learning motivation, curiosity, self-efficacy, and student happiness, so that learning becomes more student-centered and enjoyable (Chans & Castro, 2021; Rahmasari, 2025). Visual support is also important; animated videos and interactive e-modules present abstract concepts, such as chemical bonding and atomic or molecular configurations, in a dynamic and concrete way, helping students grasp spatial representations. Gamification and visual media enhance the process of visualization and spatial imagination, which are essential for three-dimensional chemistry concepts (Ahmar & Azzajjad, 2025; Jenkins & Mason, 2020; Lutfi, 2023).

### 4. Empirical Evidence of Improved Cognitive Skills

The effectiveness of implementing these innovative models is supported by empirical findings showing significant improvements in higher-order thinking skills. In a chemistry study, the integration of PBL with gamification and animated videos was shown to be significantly effective in improving students' spatial abilities ( $p < 0.001$ ) compared to a control class (Ahmar & Azzajjad, 2025). The average achievement in all spatial indicators (visualization, mental rotation, spatial orientation, and geometric transformation) in the experimental class was consistently higher. Meanwhile, the PBL-based E-Module development study showed a significant increase in students' critical thinking skills, achieving an N-gain value of 0.48 (moderate category) and an average score increase of 55%, placing students in the critical category (Asmi et al., 2024; Istianah et al., 2025). In addition, the PBL-based gamification approach also shows great potential to improve students' critical thinking skills and metacognition (Abbassyakhrin et al., 2024).

### 5. Impact on In-Depth Learning and Independent Curriculum Implementation

Overall, learning strategies that combine PBL with gamification and interactive media support deep learning achievements (Asmi et al., 2024). Deep learning requires students to analyze, evaluate, and apply new concepts with prior knowledge, a process driven by the tiered challenges and rapid feedback offered by gamification (Rahmasari, 2025). In fact, gamification-based assessment tools like Wordwall play a significant role in supporting deep learning because they foster student motivation and engagement in the assessment process, provide instant feedback, and reduce evaluation stress. By creating an interactive and enjoyable learning environment (joyful learning), this strategy aligns with the objectives of the Independent Curriculum, helps achieve complete classical learning outcomes, and supports the formation of the Pancasila Student Profile, particularly in the areas of critical and independent reasoning (Lutfi, 2023).

Based on a literature review, the results of the study indicate that the application of gamification consistently contributes positively to the quality of learning. Gamification can improve student achievement, engagement, and learning motivation, with the most frequently used elements including points and rewards, leaderboards, and digital badges. These findings are in line with the development of interactive, collaborative-based learning media in the Basic Computer and Networking subject at SMK Negeri 1 Nusa Penida, which has proven effective as a resource for independent and guided learning and plays a role in improving students' critical thinking skills (Pradnyana et al., 2025). Similar results were also seen in the development of gamification-based mathematics teaching materials (GEMAS Game) for junior high school students. Based on the practicality analysis, the GEMAS Game obtained a practicality score of

81% and is classified as practical, while the results of the effectiveness analysis showed that the media significantly improved mathematical critical thinking skills with a moderate improvement category. Thus, these various findings confirm that the integration of gamification through both collaborative interactive media and digital teaching materials such as the GEMAS Game has met the practical and effective criteria and has strong potential in supporting the improvement of students' critical thinking skills (Lukman et al., 2024).

According to recent international journals, the application of gamification and Problem-Based Learning (PBL), both separately and integrated, has proven effective in improving students' critical thinking skills at various levels of education. Experimental studies show that gamification- and PBL-based learning models, especially those supported by technologies such as artificial intelligence (AI), can significantly improve critical thinking scores compared to conventional methods (Naatonis et al., 2024). In addition, the combination of gamification and PBL also increases student motivation, engagement, and learning outcomes (Boom-Cárcomo et al., 2024).

While gamification offers significant potential, several limitations need to be addressed. Infrastructure issues are a significant obstacle in various educational institutions. The availability of devices, stable internet access, and the uneven availability of digital platforms have prevented gamification from being fully implemented. Research findings at the local level also indicate that limitations in digital media often hinder the optimal use of gamification in the learning process (Hidayatullah & Mitarlis, 2024). Furthermore, teacher readiness is a determining factor in the success of GBL implementation. Many educators still need to improve their techno-pedagogical competencies, particularly in designing interactive quizzes, managing digital classrooms, and utilizing adaptive data as a basis for learning decisions. Therefore, training focused on gamification-based instructional design is highly recommended (Fithri et al., 2021). Furthermore, the use of game elements that are not aligned with learning objectives has the potential to cause distraction. Several international meta-analyses have shown that gamification that overemphasizes external rewards, such as points and leaderboards, or that overemphasizes entertainment aspects, can reduce the depth of learning and even decrease students' intrinsic motivation (Gui et al., 2023). The game needs to be improved, especially in terms of unclear mathematical symbols, the addition of audio features that can be turned on and off, and the leaderboard that still cannot save automatically if there are the same accounts (Lukman et al., 2024). Thus, the success of gamification is largely determined by the quality of the design and the appropriate pedagogical integration, not solely by the presence of game components.

## **CONCLUSION**

Based on the results of the literature review that has been conducted, it can be concluded that the integration of the Problem Based Learning (PBL) model with gamification and interactive media has strong potential in improving students' critical thinking skills, especially in chemistry and other science learning fields. PBL acts as an effective pedagogical framework in encouraging students to be actively involved in contextual problem solving, while gamification functions as a supporting strategy that can increase motivation, engagement, and a meaningful and enjoyable learning experience. Empirical findings from various studies show a significant increase in indicators of critical thinking skills, problem-solving abilities, and higher-order cognitive skills when learning is designed in an innovative and learner-centered manner.

Furthermore, the use of gamification-based digital media, such as interactive e-modules, animated videos, and digital evaluation tools, has been proven to support deep learning and align with the objectives of the Independent Curriculum and the strengthening of the Pancasila Student Profile, particularly in the areas of critical reasoning and independent learning. However, the implementation of gamification and PBL still faces several challenges, including limited infrastructure, teachers' techno-pedagogical readiness, and the risk of distraction if

game elements are not designed in alignment with learning objectives. Therefore, thorough instructional design planning, ongoing teacher training, and adaptive education policy support are needed. With the right approach, the integration of PBL and gamification is expected to become an effective, inclusive, and sustainable learning strategy to improve the quality of education and students' critical thinking skills in the 21st century.

#### CONFLICT OF INTEREST

No conflict of interest for this study.

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#### REFERENCES

- Abbassyakhrin, A., Setyosari, P., Zubaidah, S., & Sulton, S. (2024). Gamification and academic ability impact on students' meta-cognition and critical thinking skills. *Research and Development in Education (RaDEn)*, 4(1), 127–137. <https://doi.org/10.22219/raden.v4i1.32126>
- Ahmar, D. S., & Azzajjad, M. F. (2025). Integrasi Gamifikasi dan Video Animasi dalam Model Problem Based Learning terhadap Peningkatan Kemampuan Spasial Siswa. *SEARCH: Science Education Research Journal*, 4(1), 1–10.
- Alfidyah, M. (2025). Penerapan Model Problem Based Learning untuk Meningkatkan Kemampuan Berpikir Kritis Siswa Sekolah Dasar. *Jurnal Pendidikan Guru Sekolah Dasar Indonesia*, 1(1), 1–9.
- Amini, J. N., Irwandi, D., & Bahriah, E. S. (2021). The Effectiveness of Problem Based Learning Model Based on Ethnoscience on Student's Critical Thinking Skills. *JCER (Journal of Chemistry Education Research)*, 5(2), 77–87.
- Angelelli, C. V., De Campos Ribeiro, G. M., Severino, M. R., Johnstone, E., Borzenkova, G., & Da Silva, D. C. O. (2023). Developing critical thinking skills through gamification. *Thinking Skills and Creativity*, 49, 101354. <https://doi.org/10.1016/j.tsc.2023.101354>
- Arifin, B., & Mu'id, A. (2024). Pengembangan Kurikulum Berbasis Keterampilan dalam Menghadapi Tuntutan Kompetensi Abad 21. *DAARUS TSAQOFAH Jurnal Pendidikan Pascasarjana Universitas Qomaruddin*, 1(2), 118–128.
- Asmi, A., Silaban, S., & Silaban, R. (2024). Developing an interactive chemistry e-module based on problem-based learning to improve critical thinking skills of high school students. *Jurnal Paedagogy*, 11(1), 94–101.
- Asmi, A., Silaban, S., & Silaban, R. (2024). Developing an interactive chemistry e-module based on problem-based learning to improve critical thinking skills of high school students. *Jurnal Paedagogy*, 11(1), 94. <https://doi.org/10.33394/jp.v11i1.9875>
- Batubara, H. H. (2021). *Media Pembelajaran Digital*. PT Remaja Rosdakarya.
- Berlin, H. Z., & Berlin, H. Z. (2021). *Fostering critical thinking by a gamification approach*. The Future of Education. [https://conference.pixel-online.net/library\\_scheda.php?id\\_abs=5137](https://conference.pixel-online.net/library_scheda.php?id_abs=5137)
- Boom-Cárcamo, E., Buelvas-Gutiérrez, L., Acosta-Oñate, L., & Boom-Cárcamo, D. (2024). Gamification and Problem-Based Learning (PBL): Development of Creativity in the Teaching-Learning Process of Mathematics in University Students. *Thinking Skills and Creativity*. <https://doi.org/10.1016/j.tsc.2024.101614>
- Chans, G. M., & Castro, M. P. (2021). Gamification as a strategy to increase motivation and engagement in higher education chemistry students. *Computers*, 10(10), 132. <https://doi.org/10.3390/computers10100132>

- Efendi, A. (2022). Improve Critical Thinking Skills with Informatics Educational Games. *Journal of Education Technology*, 6(3), 521–530.
- Fadiyah, H., Kurnianti, E. M., & Hasanah, U. (2024). Studi Literatur: Peningkatan Kemampuan Berpikir Kritis Siswa Sekolah Dasar Melalui Media Digital. *Didaktik: Jurnal Ilmiah PGSD STKIP Subang*, 10(2), 211–224.
- Fithri, S., Pada, A. U. T., Artika, W., Nurmaliah, C., & Hasanuddin, H. (2021). Implementasi LKPD berbasis STEM untuk meningkatkan keterampilan berpikir kritis peserta didik. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, 9(4), 555–564.
- Gui, Y., Cai, Z., Yang, Y., Kong, L., Fan, X., & Tai, R. H. (2023). Effectiveness of Digital Educational Game and Game Design in STEM Learning: a Meta-analytic Review. *International Journal of STEM Education*, 10(1), 36.
- Hidayatullah, W. N., & Mitarlis, M. (2024). Pembelajaran Dengan Pendekatan Science, Technology, Engineering, and Mathematic (STEM) dalam Meningkatkan Kemampuan Literasi Sains Pada Materi Redoks. *Jurnal Penelitian Pendidikan Matematika Dan Sains*, 8(2), 36–43.
- Istianah, F., Wijayanti, A. Y., & Widodo, W. (2025). The effectiveness of STEM-Based E-Modules in enhancing critical thinking skills of elementary school students. *Attadrib Jurnal Pendidikan Guru Madrasah Ibtidaiyah*, 8(3), 679–694. <https://doi.org/10.54069/attadrib.v8i3.1053>
- Jenkins, D. A., & Mason, D. (2020). Gamification in General Chemistry. In *Active Learning in College Science* (pp. 439–449). Springer, Cham. [https://doi.org/10.1007/978-3-030-33600-4\\_27](https://doi.org/10.1007/978-3-030-33600-4_27)
- Khafidh, A. N., Widyawati, F., Yani, S., Nuraeni, Y., Inesrawanti, V., Salam, H. A., & Damayanti, F. (2025). Pemanfaatan Game Based Learning dan Gamifikasi Adaptif dalam Pembelajaran STEM: Penelitian. *Jurnal Pengabdian Masyarakat Dan Riset Pendidikan*, 4(2), 9468–9477.
- Kusuma, E., Handayani, A., & Rakhmawati, D. (2024). Pentingnya Pengembangan Kemampuan Berpikir Kritis Pada Siswa Sekolah Dasar: Sebuah Tinjauan Literatur. *Jurnal Wawasan Pendidikan*, 4(2), 369–379.
- Lukman, H. S., Agustiani, N., & Setiani, A. (2024). Gamifikasi Bahan Ajar Matematika Smp: Analisis Kepraktisan Dan Efektivitas Terhadap Kemampuan Berpikir Kritis Matematis. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 13(1), 198–208.
- Lutfi, A. (2023). Gamifikasi Dalam Pembelajaran Kimia Pada Implementasi Kurikulum Merdeka. *Prosiding Seminar Nasional Kimia*, 2, 1–8.
- Miterianifa, N., Ashadi, N., Saputro, S., & Suciati, N. (2021). A Conceptual Framework for Empowering Students' Critical Thinking through Problem Based Learning in Chemistry. *Journal of Physics Conference Series*, 1842(1), 012046. <https://doi.org/10.1088/1742-6596/1842/1/012046>
- Naatonis, R., Rusijono, R., Jannah, M., & Malahina, E. A. U. (2024). Evaluation of Problem Based Gamification Learning (PBGL) Model on Critical Thinking Ability with Artificial Intelligence Approach Integrated with ChatGPT API: An Experimental Study. *Qubahan Academic Journal*. <https://doi.org/10.48161/qaj.v4n3a919>
- Oktaviani, E. P., & Munahefi, D. N. (2025). Literature Review: Penerapan Media Gamification Dengan Pendekatan Problem Based Learning Untuk Meningkatkan Kemampuan Berpikir Kritis Matematis. *Journal of Mandalika Literature*, 6(2), 511–518.
- Pradnyana, I. K. A., Mertayasa, I. N. E., & Subawa, I. G. B. (2025). Pengembangan Multimedia Gamifikasi Kolaboratif Untuk Meningkatkan Keterampilan Berpikir Kritis Siswa Pada Mata Pelajaran Sistem Komputer. *KARMAPATI (Kumpulan Artikel Mahasiswa Pendidikan Teknik Informatika)*, 14(2), 274–282.
- Rahmasari, T. P. (2025). Wordwall: Evaluasi Pembelajaran Berbasis Gamifikasi dalam mendukung Deep Learning. *Jurnal Pengabdian Masyarakat Dan Riset Pendidikan*, 4(1), 3840–3844.

- Rofi'ah, S., & Rokhmaniyah, R. (2024). Analisis Kemampuan Berpikir Kritis Siswa dalam Memecahkan Masalah pada Mata Pelajaran IPAS kelas V Sekolah Dasar. *Social, Humanities, and Educational Studies (SHES): Conference Series*, 7(3).
- Sandi, S., Syahri, W., & Gusti, D. R. (2025). Pengembangan E-Modul Berbasis Problem Based Learning pada Materi Konfigurasi Elektron untuk Meningkatkan Keterampilan Berfikir Kritis Siswa. *JIP-Jurnal Ilmiah Ilmu Pendidikan*, 8(4), 4054–4060.
- Wahyudiati, D. (2022). Critical thinking skills and scientific attitudes of Pre-Service Chemistry teachers through the implementation of Problem-Based Learning Model. *Jurnal Penelitian Pendidikan IPA*, 8(1), 216–221. <https://doi.org/10.29303/jppipa.v8i1.1278>

## Optimizing Early Conflict Detection: The Role of Digital Technology in BHABINKAMTIBMAS Operational Learning

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### ABSTRACT

The integration of digital technology into the operational learning of BHABINKAMTIBMAS (Public Security and Order Officer) is a transformative strategy to enhance early social conflict detection. This study evaluates how digital tools function as pedagogical mediums that reshape officers' analytical competencies. The research follows a literature review methodology, involving three strategic steps: 1) identifying high-impact literature from 2014–2024, 2) synthesizing data using a thematic matrix (technical, instructional, and social outcomes), and 3) validating findings through cross-case triangulation. Results indicate that digital platforms—such as the Binmas Online System (BOS) and GIS mapping—increase detection response speed by 30% and prediction accuracy by 5.2%. The effectiveness of this technology-enhanced learning is significantly governed by officers' digital literacy and institutional support. In conclusion, optimizing early detection requires a shift from technical tool usage toward a comprehensive digital competency framework. This study contributes to the field of Educational Technology by providing a strategic model for "Operational Learning" in professional security training, offering a novel perspective on how digital integration can bridge the gap between field intelligence and instructional innovation in policing.

**Keywords:** *BHABINKAMTIBMAS, Digital Technology, Early Conflict Detection, Educational Technology, Operational Learning*



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### INTRODUCTION

In recent years, Indonesia has faced various social conflict potentials arising from socio-economic dynamics, local politics, cultural identity differences, and the utilization of public spaces. Conflicts between martial arts groups, disputes over village boundaries, or clashes between community groups often emerge as local conflicts that, if not detected early, escalate significantly. Research in Jombang Regency shows that the socio-cultural unit of the National Police performs early detection of conflicts between martial arts groups as a vital operation to prevent local riots (Santoso, 2024). Conversely, in Karanganyar, fatalities resulting from conflicts between pencak silat organizations prompted the Karanganyar Police to optimize intelligence and security units through early detection strategies (Purnomo, 2024).

The rapid advancement of digital technology offers significant opportunities for security forces, including BHABINKAMTIBMAS (*Bhayangkara Pembina Keamanan dan Ketertiban Masyarakat*) or in English is called Public Security and Order Officer, to conduct early detection of social conflicts more rapidly, accurately, and responsively. Technologies such as electronic

applications (e-applications), social media, database systems, digital mapping, and community reporting apps enable real-time information gathering and public discourse monitoring. However, from an educational technology perspective, the integration of these tools into police work represents a form of operational learning that requires specific digital competencies. Previous research on digital policing highlights that while technology has evolved, implementation often remains suboptimal, leading to delays in anticipatory or predictive actions (Ismail, 2023). This gap suggests a critical need for better instructional strategies and technology integration within police training frameworks.

At the community level, BHABINKAMTIBMAS serves as the frontline of the National Police in villages, possessing strategic potential to combine traditional approaches with digital technology to strengthen pre-emptive functions. Studies on the *e-Bhabin* application in Bogor indicate that electronic apps strengthen the pre-emptive function by enabling early detection of local security disturbances, despite technical and resource implementation barriers (Rycko, 2024). Local empirical data also shows that society in major cities responds positively to digital transformation in police services. For instance, a study in Semarang found that digital platforms in community-oriented policing increased accessibility ( $M = 4.29$ ), trust ( $M = 4.09$ ), and collaboration ( $M = 4.00$ ), with digital literacy and ease of use being significant predictors (Muchtart, 2025).

Despite these opportunities, a significant literature gap remains regarding how digital technology serves as an instructional medium for operational learning among BHABINKAMTIBMAS personnel. Most existing studies focus on the technical utility of apps rather than the pedagogical process of how these tools enhance the cognitive and analytical skills of officers in the field. Current challenges include uneven digital literacy, lack of digital infrastructure in remote areas, and a profound lack of specialized technical training or instructional support for BHABINKAMTIBMAS members. Furthermore, institutional and legal challenges persist in ensuring the effective use of digital platforms for community engagement (Herlydinata, 2025).

To address these gaps, this study shifts the focus toward the intersection of policing and educational technology. The objective of this research is to analyse how digital technology can be optimized as an operational learning tool for BHABINKAMTIBMAS in enhancing their early social conflict detection competencies. Specifically, this study aims to evaluate the digital mechanisms, identify implementation challenges from an instructional perspective, and propose strategies to strengthen conflict prevention functions through technology-enhanced learning at the local level.

## **METHODS**

This study employs a literature review with a descriptive-analytical approach to explore the integration of digital technology in BHABINKAMTIBMAS operational learning. This method was selected to synthesize diverse empirical findings and theoretical frameworks regarding educational technology's role in social conflict detection.

### *Data Sources and Search Strategy*

The literature search was conducted across several reputable databases, including Google Scholar, Scopus, and Sinta-indexed journals. To ensure the "originality and novelty", the search focused on academic books published within the last 10 years and peer-reviewed journal articles from the last 8 years. Key terms used for the search included: BHABINKAMTIBMAS, digital policing, community policing, early detection, social conflict, instructional technology, and operational learning.

### *Sampling Technique (Source Selection)*

Following the reviewer's recommendation for detailed sampling, this study applied a purposive sampling technique for literature selection based on the following inclusion criteria: (1) Studies specifically discussing digital transformation within the Indonesian National Police (POLRI); (2) Research focusing on the effectiveness of digital applications or platforms in community policing; and (3) Literature addressing pedagogical or instructional models in professional police training. Sources that did not meet the criteria for relevance, currency, and academic contribution to "Learning Innovation" were excluded.

### *Instruments for Analysis and Validation*

To measure the effectiveness of digital integration (as requested by the reviewer), the instrument used in this study is a thematic synthesis matrix. This matrix categorized findings into three domains: (1) Technical Effectiveness: The performance of e-applications in data gathering; (2) Instructional Impact: How technology facilitates operational learning for officers; and (3) Social Outcomes: The impact on community trust and conflict reduction. The validation phase was conducted through data triangulation by comparing empirical results from multiple case studies (e.g., studies in Bogor, Jombang, and Semarang) to ensure the reliability of the formulated conceptual recommendations.

### *Data Analysis Procedure*

The data were analysed through a thematic synthesis process, which involved identifying recurring patterns and concepts. This analysis aimed to find research gaps and formulate a strategic framework for "Pedagogical models and practices" in the digital era of policing.

## **RESULTS AND DISCUSSION**

### *The Integration of Digital Technology in BHABINKAMTIBMAS Operational Learning for Early Conflict Detection*

The utilization of digital technology by BHABINKAMTIBMAS represents a strategic initiative by the Indonesian National Police (POLRI) to enhance the effectiveness of early detection of social conflicts at the village level. From the perspective of operational learning, this integration is not merely a technical upgrade but a transformation of how field officers acquire and process situational intelligence. Based on the concept of community policing, BHABINKAMTIBMAS serves not only as security monitors but also as facilitators of interaction between the police and the community to prevent conflict escalation (Bayley, 2016). Early detection of social conflicts requires accurate, up-to-date, and contextual information; therefore, the integration of digital technology as an instructional and operational medium becomes a vital element in accelerating the identification of potential social disturbances (Sanusi & Vanel, 2025).

According to communication for development theory, effective communication processes play a crucial role in building community awareness, participation, and response toward social issues (Hyland-wood et al., 2021). In the context of operational learning, digital communication through social media, instant messaging apps, and online reporting platforms enables BHABINKAMTIBMAS to deliver preventive messages while simultaneously engaging in real-time information gathering. For instance, the Binmas Online System (BOS) application, implemented nationwide, provides features for community complaints, conflict mapping, and social incident reporting accessible directly by BHABINKAMTIBMAS. Research indicates that the use of digital applications by BHABINKAMTIBMAS increases the response speed to community reports by up to 30% compared to manual methods (Karim & Fachrie, 2024).

Empirically, the level of digital technology utilization as an operational learning tool can be measured through indicators such as the frequency of digital platform use, the types of features utilized, and the level of interaction with the community (Van Veldhoven & Vanthienen, 2022). A study by Putri & Sutrisno (2023) revealed that 78% of BHABINKAMTIBMAS in Bogor City use

digital applications to monitor environmental situations, while 65% utilize social media to accommodate community grievances or aspirations. This indicates a high adoption rate of digital technology, although variations across regions are still influenced by infrastructure factors and the digital literacy of the community.

From the perspective of innovation theory, diffusion of innovation explains that the adoption of new technology is influenced by perceived benefits, ease of use, compatibility with existing practices, and institutional support (Xia et al., 2022). In an operational learning framework, BHABINKAMTIBMAS officers with high digital literacy and institutional support tend to adopt technology more rapidly for early conflict detection. Conversely, limited training, inadequate digital facilities, and resistance to technology remain significant barriers. Sanusi & Vanel (2025) emphasize that a lack of technical training for BHABINKAMTIBMAS members contributes to the suboptimal utilization of digital applications, highlighting the need for better instructional design in police training.

Furthermore, social media serves as a strategic information source for detecting potential conflicts through public discourse analysis, opinion trends, and community interactions. The phenomenon of social media listening allows BHABINKAMTIBMAS to perform informal operational learning by monitoring comments, posts, or viral issues that serve as early indicators of local conflicts (Handaningtias et al., 2025). For example, monitoring RT/RW WhatsApp groups or online community forums can identify conflicts regarding land disputes, economic activities, or cultural differences before they escalate. Thus, digital technology expands communication reach while increasing the sensitivity of officers to social dynamics.

Digital technology also supports data integration through digital mapping or GIS (Geographic Information System), enabling BHABINKAMTIBMAS to visualize potential conflict concentrations based on location, incident type, and time. According to Sanusi & Vanel (2025), digital mapping facilitates the prioritization of pre-emptive actions and cross-sector coordination with village officials, community leaders, and educational institutions. This strengthens early detection capacity because information can be analyzed spatially and temporally, moving beyond slow and scattered manual reports. However, the effectiveness of this technology-enhanced learning is inseparable from challenges. Limited community digital literacy can lead to inaccurate or delayed reports, while trust in digital media also affects the quality of information received by BHABINKAMTIBMAS (Gudykunst, 2018). Additionally, data security and privacy are critical; any misuse of information or data breaches poses legal and social risks, necessitating those officers be equipped with ethical procedures and cybersecurity standards.

The literature review demonstrates that the utilization of digital technology by BHABINKAMTIBMAS in early social conflict detection is significant, particularly through *e-Bhabin* platforms, community social media, and digital mapping. The integration of technology allows for a faster, more responsive, and more accurate identification process compared to traditional methods. Nevertheless, effectiveness is still contingent upon internal factors (officer competence and training), external factors (community digital literacy and trust), and institutional support. Therefore, optimizing digital technology utilization requires a comprehensive approach that combines BHABINKAMTIBMAS capacity building through continuous operational learning, community education, and the strengthening of secure, accessible digital systems.

#### *Digital Indicators for Social Conflict Detection in Operational Learning contexts*

A deep understanding of social conflict indicators is fundamental to the early detection strategies executed by BHABINKAMTIBMAS. In an instructional framework, these indicators serve as the "learning cues" that officers must master to identify the early signs or signals of potential disputes, friction, or tension within the community. According to Muliono (2020) and

Sunarso (2023), social conflict can manifest in three distinct forms: manifest, latent, and structural. Manifest conflict is visible through concrete actions such as riots, protests, or open disputes, whereas latent conflict emerges through dissatisfaction, rumors, and perceptions of injustice that have not yet physically appeared. Structural conflict, on the other hand, stems from systemic inequalities that create potential opposition. In the digital context, these indicators can be systematically identified through interaction patterns on social media, online community reports, or digital mapping of conflict-prone areas (Sulianta, 2024).

The utilization of digital indicators for social conflict is conducted by observing several critical aspects, including: 1) the frequency of negative communication in online community forums, 2) discussion topics with the potential to cause division, 3) groups or individuals actively spreading controversial opinions, and 4) geographic locations that serve as social hotspots. This analysis aligns with the principles of social media listening and data mining, which function as cognitive tools allowing BHABINKAMTIBMAS to identify symptoms of conflict before they escalate (Servaes, 2020). For example, monitoring RT/RW WhatsApp groups can reveal small grievances or friction regarding land ownership, local economic activities, or village administrative issues. Empirically, a study by Febriandri Hamzah et al. (2022) demonstrates that BHABINKAMTIBMAS utilize indicators such as community complaints, increased communication patterns in online groups, and reports of minor incidents as early warning signals. These findings suggest that using digital indicators is highly effective for predicting conflict escalation, though it still requires field verification to ensure data accuracy. The use of these digital-based indicators allows officers to allocate resources more efficiently and perform proactive interventions before conflicts broaden.

The utilization of digital conflict indicators can be enriched through Geographic Information Systems (GIS), which visualize the distribution of potential conflicts within the assigned area (Pauzi & Khaeruddin Said, 2019). Young et al. (2023) emphasize that digital mapping assists in identifying areas with a history of conflict, locations of social activities prone to friction, and areas requiring intensive monitoring. From a pedagogical perspective, this approach not only accelerates early detection but also supports the development of evidence-based and targeted communication strategies. However, the effectiveness of using digital indicators faces several challenges, primarily data accuracy and community digital literacy. Invalid reports or distorted information on social media can lead to misinterpretation. Aririguzoh (2022) underscores the importance of cross-cultural communication competence and social sensitivity for officers to ensure that digital indicators are interpreted accurately. Additionally, community resistance to digital monitoring may arise, potentially causing distrust; therefore, BHABINKAMTIBMAS must balance digital data collection with participatory and humanistic communication approaches.

From a conflict risk management and operational learning perspective, the use of digital indicators enables BHABINKAMTIBMAS to prioritize pre-emptive actions, such as community dialogues, mediation, or cross-sector coordination. The results of a study by Jensen et al. (2024) indicate that utilizing digital indicators can lead to a greater reduction in conflict escalation rates compared to conventional methods. This reinforces the idea that digital indicators are not merely monitoring tools but strategic components in data-driven decision-making—a core competency in modern digital policing.

The literature review reveals that social conflict indicators detectable digitally encompass communication aspects, public opinion, online interaction patterns, and geographic mapping of conflict-prone areas. BHABINKAMTIBMAS have begun implementing these indicators through *e-Bhabin* platforms, community social media, and digital mapping systems. However, successful implementation remains dependent on the internal capacity of the officers, institutional support, community digital literacy, and public trust. Therefore, the optimization of digital indicators must be followed by digital competency training, community education, and clear ethical and data security protocols.

### *Supporting and Inhibiting Factors in Digital Technology Integration for Operational Learning*

The integration of digital technology by BHABINKAMTIBMAS for early social conflict detection is not an automatic process but is significantly influenced by various internal and external factors. Within the framework of instructional technology, these factors determine the effectiveness of implementation and the success of digital strategies in enhancing professional response to community conflicts.

Competence and Cognitive Acceptance from an internal perspective, the competence and capacity of BHABINKAMTIBMAS personnel serve as the primary drivers of operational learning. Human resource theory posits that technical skills, information technology literacy, and data analysis capabilities are essential assets for digital-based decision-making (Ghasemaghaei et al., 2018). Buchan et al. (2024) emphasize that individuals with high digital literacy tend to be faster and more effective in utilizing digital devices, community social media, and digital mapping systems. Conversely, gaps in knowledge and pedagogical training remain significant barriers, leading to suboptimal technology use. Furthermore, the motivation and attitudes of officers toward digital tools dictate their adoption levels. According to the Technology Acceptance Model (TAM), "perceived ease of use" and "perceived usefulness" are the core determinants of technology adoption (Hussain et al., 2025). Officers who recognize the benefits of digital technology in accelerating conflict response tend to be more proactive learners, whereas those who perceive the systems as overly complex or irrelevant may resist integration.

Institutional Support and Community Literacy is external factors supporting digital integration include institutional support, infrastructure, and community participation. Sauers & Richardson (2019) highlight the necessity of institutional leadership in providing digital hardware, stable internet connectivity, and clear digital platform policies. Adequate infrastructure, such as broadband networks in rural areas, secure data servers, and mobile devices for BHABINKAMTIBMAS, is a prerequisite for seamless technology-enhanced learning and operations. Additionally, active community participation in reporting conflicts via digital platforms strengthens early detection, as the data gathered becomes more valid and representative.

However, substantial external barriers persist. First, uneven community digital literacy poses a challenge in obtaining accurate information; citizens unfamiliar with digital reporting may provide incomplete or distorted data, hindering effective conflict analysis (Kang et al., 2014). Second, social resistance due to privacy concerns, data misuse, or lack of trust in authorities can emerge. This requires BHABINKAMTIBMAS to balance digital data collection with humanistic and participatory communication approaches—a critical skill in social-pedagogical policing.

Legal, Ethical, and Organizational Challenges are additional challenges arise from the legal and regulatory landscape. Digital approaches to conflict detection must comply with regulations regarding personal data protection, information security, and online communication ethics. Taddeo (2020) emphasizes that digital integration must be accompanied by clear ethical guidelines to avoid creating new conflicts or legal liabilities. Without a robust regulatory framework, the use of technology carries risks such as information misuse or the spread of misinformation.

Beyond these factors, organizational culture significantly influences the implementation of digital technology (Butt et al., 2024). An organizational culture that is open to innovation, collaboration, and continuous learning encourages BHABINKAMTIBMAS to adopt digital technology more effectively. In contrast, hierarchical or closed cultures may slow down technology adoption and reduce the effectiveness of social conflict detection (Stempfle, 2011).

To maximize the potential of digitalized conflict detection, an integrated strategy for mitigating these inhibitors is essential. This includes: 1) digital literacy and data analysis training

for BHABINKAMTIBMAS personnel, 2) strengthening digital infrastructure and communication networks, 3) community education to improve digital literacy and participation, 4) developing ethical guidelines and standard operating procedures (SOPs), and 5) fostering an innovative organizational culture. Through these steps, barriers can be minimized, and the digital transformation of operational learning in policing can be fully realized.

### *Strategies for Optimizing Digital Technology Integration in BHABINKAMTIBMAS Operational Learning*

The utilization of digital technology by BHABINKAMTIBMAS for early social conflict detection requires a systematic and sustainable strategy. This strategy aims not only to increase the capacity of officers in detecting potential conflicts rapidly and accurately but also to strengthen community participation and police legitimacy. In an instructional technology framework, the strategic approach can be categorized into three main dimensions: internal capacity building, infrastructure and technology development, and the establishment of collaborative mechanisms with the community.

#### 1. Internal Capacity Building through Continuous Operational Learning

Strengthening the internal capacity of BHABINKAMTIBMAS is a fundamental prerequisite. According to Cui et al. (2021) in the diffusion of innovation theory, the adoption of new technology requires a clear understanding of its benefits, ease of use, and continuous training. Training in digital literacy, data analysis, and information security are essential components that significantly enhance the ability of BHABINKAMTIBMAS to effectively read and interpret social conflict indicators through digital media. These skills enable officers to critically evaluate information, identify misinformation, and understand social media dynamics—critical for preventing and managing social conflicts.

Integrating these competencies leads to more informed decision-making and proactive conflict resolution strategies. Digital literacy is vital for identifying misinformation and assessing the credibility of online content; users with high digital literacy can focus on metadata to evaluate message authenticity (Steinfeld, 2023). In an educational environment, digital literacy has been proven to improve learning outcomes and engagement, which translates into better professional performance for BHABINKAMTIBMAS officers (Cowling et al., 2025).

#### 2. Strategic Development of Infrastructure and Multi-Source Data Integration

The development of digital infrastructure is a strategic component that cannot be ignored. This includes providing adequate hardware, software, stable internet networks, and Geographic Information Systems (GIS). Integrating data from multiple sources—such as community reports, social media, and police records—significantly enhances real-time analysis of social conflict dynamics. This multi-source approach allows BHABINKAMTIBMAS to identify patterns and trends that might be invisible when relying on a single data source, thereby improving conflict prediction, emergency planning, and public safety management. Combining various data types provides unique and holistic insights, enabling more timely and informed decision-making (Donnay et al., 2018; Mayer et al., 2021).

The specific benefits of multi-source data integration include:

- a. **Enhanced Conflict Analysis:** Combining event datasets allows for a nuanced understanding of underlying trends (Donnay et al., 2019; Mayer et al., 2021).
- b. **Improved Emergency Planning:** Social media and community reports serve as vital information sources, especially in resource-limited local contexts, helping to predict recurring events (Shih et al., 2015).
- c. **Crime Prediction:** Platforms like CrimeTelescope utilize data fusion to forecast crime hotspots more accurately, increasing prediction accuracy by 5.2% compared to traditional methods (Yang et al., 2018).

### 3. Ethical Governance and Trust-Based Digital Communication

The use of digital technology in social conflict detection must adhere to principles of personal data protection, information security, and ethical communication standards to ensure compliance and maintain public trust. Integrating digital technology presents complex ethical considerations regarding privacy and responsible information use. Privacy and personal data protection are fundamental human rights, essential for maintaining individual dignity and freedom of expression (Friedewald & Pohoryles, 2013). However, a "privacy paradox" exists where individuals are willing to share data despite privacy concerns (Büschel et al., 2014). To address this, sociotechnical mechanisms like Advanced Data Protection Control (ADPC) empower individuals to protect their digital rights through cognitive and contextual support (Human, 2024).

From an information security perspective, increasing reliance on ICT necessitates strict security measures (Glorioso, 2015). The application of Artificial Intelligence (AI) in social media monitoring must adhere to ethical principles, including respect for individuals, beneficence, and justice (Flores & Young, 2022). Furthermore, developing digital ethics frameworks assists professionals in ethical reflection and decision-making regarding technology deployment (Becker et al., 2023; Clark et al., 2019). In sensitive professional fields, specialized guidelines are required to maintain professional boundaries and confidentiality (Sabin & Harland, 2017). Ultimately, public transparency is a crucial factor for the success of digital policing applications, requiring careful and ethical communication to ensure the community trusts the authorities managing the technology (Ranisch et al., 2021).

### CONCLUSION

Based on the literature review and analysis, it can be concluded that the integration of digital technology plays a strategic role in the operational learning of BHABINKAMTIBMAS for early social conflict detection. Digital tools—including the BOS application, community social media, and Geographic Information Systems (GIS)—enable the real-time identification of conflict patterns and trends, significantly increasing response speed and detection accuracy compared to conventional methods. These technologies provide critical learning cues through online communication patterns, public opinion, and geographic data, which enrich analysis and support evidence-based decision-making.

The effectiveness of this digital integration as a technology-enhanced learning process is influenced by internal factors, such as the digital literacy and attitudes of BHABINKAMTIBMAS personnel, as well as external factors including institutional support, infrastructure, and community participation. However, significant barriers such as low community digital literacy, social resistance to online monitoring, and data security risks necessitate robust mitigation strategies. Ultimately, the optimization of digital technology requires internal capacity building, multi-source data integration (social media, community reports, and police records), and strict adherence to data protection principles and ethical communication standards to maintain public trust and prevent data misuse.

Based on the research findings, several strategic recommendations are proposed to enhance the effectiveness of digital technology in BHABINKAMTIBMAS operational learning.

First, there is an urgent need to strengthen the internal capacity of BHABINKAMTIBMAS through regular training in digital literacy, data analysis, and information security. This instructional focus should empower officers to interpret conflict indicators accurately while maintaining ethical digital standards and cross-cultural sensitivity. Second, institutional support must prioritize the development of digital infrastructure, including stable internet connectivity and optimized GIS mapping to facilitate real-time predictive analysis. Third, a collaborative

mechanism must be established with community leaders and local institutions to improve public digital literacy and ensure the validity of community-generated data.

Fourth, all digital policing activities must operate under strict ethical protocols and data security frameworks to safeguard personal privacy and foster public trust. Fifth, the use of interactive dashboards and hotspot mapping should be intensified to support proactive, data-driven pre-emptive actions. Finally, these digital strategies must undergo routine evaluation and updates to remain adaptive to technological advancements and the evolving dynamics of social conflict in the digital era.

#### CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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#### REFERENCES

- Aririguzoh, S. (2022). Communication competencies, culture and SDGs: Effective processes to cross-cultural communication. *Humanities and Social Sciences Communications*, 9(1), 1–11. <https://doi.org/10.1057/s41599-022-01109-4>
- Bayley, D. H. (2016). *Changing the guard: Developing democratic police abroad*. Oxford University Press.
- Becker, S. J., Nemat, A. T., Lucas, S., Heinitz, R. M., Klevesath, M., & Charton, J. E. (2023). A code of digital ethics: Laying the foundation for digital ethics in a science and technology company. *AI & SOCIETY*, 38(6), 2629–2639. <https://doi.org/10.1007/s00146-021-01376-w>
- Buchan, M. C., Bhawra, J., & Katapally, T. R. (2024). Navigating the digital world: Development of an evidence-based digital literacy program and assessment tool for youth. *Smart Learning Environments*, 11(1), 8. <https://doi.org/10.1186/s40561-024-00293-x>
- Büschel, I., Mehdi, R., Cammilleri, A., Marzouki, Y., & Elger, B. (2014). Protecting human health and security in digital Europe: How to deal with the “privacy paradox”? *Science and Engineering Ethics*, 20(3), 639–658. <https://doi.org/10.1007/s11948-013-9511-y>
- Butt, A., Imran, F., Helo, P., & Kantola, J. (2024). Strategic design of culture for digital transformation. *Long Range Planning*, 57(2), 102415. <https://doi.org/10.1016/j.lrp.2024.102415>
- Clark, K., Duckham, M., Guillemin, M., Hunter, A., McVernon, J., O’Keefe, C., Pitkin, C., Praver, S., Sinnott, R., Warr, D., & Waycott, J. (2019). Advancing the ethical use of digital data in human research: Challenges and strategies to promote ethical practice. *Ethics and Information Technology*, 21(1), 59–73. <https://doi.org/10.1007/s10676-018-09490-4>
- Cowling, M., Sim, K. N., Orlando, J., & Hamra, J. (2025). Untangling digital safety, literacy, and wellbeing in school activities for 10 to 13 year old students. *Education and Information Technologies*, 30(1), 941–958. <https://doi.org/10.1007/s10639-024-13183-z>

- Cui, Q., Hu, X., Liu, X., Zhao, L., & Wang, G. (2021). Understanding architectural designers' continuous use intention regarding BIM technology: A China case. *Buildings*, 11(10), 448. <https://doi.org/10.3390/buildings11100448>
- Donnay, K., Dunford, E. T., McGrath, E. C., Backer, D., & Cunningham, D. E. (2018). Integrating conflict event data. *Journal of Conflict Resolution*, 63(5), 1337–1364. <https://doi.org/10.1177/0022002718777050>
- Febriandri Hamzah, R., Hairunnisa, & Alfando WS, J. (2022). Analisis efektivitas quick response Bhayangkara pembina keamanan dan ketertiban masyarakat (Bhabinkamtibmas) terhadap pelayanan 2009–2020 di Kota Samarinda. *EJournal Ilmu Komunikasi*, 10(4), 165–174.
- Flores, L., & Young, S. D. (2022). Ethical considerations in the application of artificial intelligence to monitor social media for COVID-19 data. *Minds and Machines*, 32(4), 759–768. <https://doi.org/10.1007/s11023-022-09610-0>
- Friedewald, M., & Pohoryles, R. J. (2013). Technology and privacy. *Innovation: The European Journal of Social Science Research*, 26(1–2), 1–6. <https://doi.org/10.1080/13511610.2013.768011>
- Ghasemaghaei, M., Ebrahimi, S., & Hassanein, K. (2018). Data analytics competency for improving firm decision making performance. *The Journal of Strategic Information Systems*, 27(1), 101–113. <https://doi.org/10.1016/j.jsis.2017.10.001>
- Glorioso, L. (2015). Cyber conflicts: Addressing the regulatory gap. *Philosophy & Technology*, 28(3), 333–338. <https://doi.org/10.1007/s13347-015-0197-8>
- Herlydinata, M. D. (2025). Toward digital community policing: Opportunities and barriers for social media engagement in Indonesia. *Proceedings of Police Academy*, 1(1), 72–86.
- Human, S. (2024). Humans [plural] in the loop: The forgotten collective aspects of privacy, consenting, controlling, and digital protection. *Frontiers in Political Science*, 6, 1391755. <https://doi.org/10.3389/fpos.2024.1391755>
- Hussain, A., Zhiqiang, M., Li, M., Jameel, A., Kanwel, S., Ahmad, S., & Ge, B. (2025). The mediating effects of perceived usefulness and perceived ease of use on nurses' intentions to adopt advanced technology. *BMC Nursing*, 24(1), 33. <https://doi.org/10.1186/s12912-024-02648-8>
- Hyland-Wood, B., Gardner, J., & Leask, J. (2021). Strategies in the era of COVID-19. *Humanities and Social Sciences Communications*, 8(1), 1–11. <http://dx.doi.org/10.1057/s41599-020-00701-w>
- Ismail, M. (2023). Digital policing; Studi pemanfaatan teknologi dalam pelaksanaan tugas intelijen kepolisian untuk mencegah kejahatan siber (cybercrime). *Jurnal Ilmu Kepolisian*, 17(3), 15. <https://doi.org/10.35879/jik.v17i3.428>
- Jensen, B., Valeriano, B., & Whitt, S. (2024). How cyber operations can reduce escalation pressures: Evidence from an experimental wargame study. *Journal of Peace Research*, 61(1), 119–133. <https://doi.org/10.1177/00223433231219440>
- Kang, R., Kane, A., & Kiesler, S. (2014). Teammate inaccuracy blindness. *Proceedings of the 17th ACM Conference on Computer Supported Cooperative Work & Social Computing*, 797–806. <https://doi.org/10.1145/2531602.2531681>
- Karim, A., & Fachrie, M. (2024). Perancangan sistem pengaduan masyarakat berbasis mobile (Studi kasus: Kabupaten Banjarnegara). *Jurnal Teknologi Dan Sistem Informasi Bisnis*, 6(1), 162–171. <https://doi.org/10.47233/jteksis.v6i1.1101>

- Mayer, B., Lawonn, K., Donnay, K., Preim, B., & Meuschke, M. (2021). VEHICLE: Validation and exploration of the hierarchical integration of conflict event data. *Computer Graphics Forum*, 40(3), 1–12. <https://doi.org/10.1111/cgf.14284>
- Muchtar, J. (2025). From street to cyberspace: Digital transformation for community-oriented policing. *Proceedings of Police Academy*, 1(1), 58–71.
- Muliono, M. (2020). Pola perubahan, wacana, dan tren konflik sosial di Indonesia. *Al-Adyan: Journal of Religious Studies*, 1(2), 115–132.
- Pauzi, & Said, K. (2019). *Pemetaan potensi konflik sosial & faham radikal*. Penerbit Lembaga Penelitian dan Pengabdian Masyarakat.
- Purnomo, H. C. (2024). Optimization of the police intelligence unit performance in early detection to prevent conflicts between pencak silat organizations in the Karanganyar Police region. *Advances in Police Science Research Journal*, 5(2), 82–95. <https://doi.org/10.70526/apsrj.v5i2.822>
- Ranisch, R., Nijssingh, N., Ballantyne, A., van Bergen, A., Buyx, A., Friedrich, O., Hendl, T., Marckmann, G., Munthe, C., & Wild, V. (2021). Digital contact tracing and exposure notification: Ethical guidance for trustworthy pandemic management. *Ethics and Information Technology*, 23(3), 285–294. <https://doi.org/10.1007/s10676-020-09566-8>
- Rycko, M. Y. (2024). Optimization of the role of the future police by Bhabinkamtibmas as the spear of the pre-emptive function through the electronic application of Bhabinkamtibmas (e-Bhabin) at Bogor Police. *Indonesian Journal of Police Studies*, 6(12), 110–125. <https://doi.org/10.70526/ijps.v6i12.258>
- Sabin, J. E., & Harland, J. C. (2017). Professional ethics for digital age psychiatry: Boundaries, privacy, and communication. *Current Psychiatry Reports*, 19(9), 55. <https://doi.org/10.1007/s11920-017-0815-5>
- Santoso, A. (2024). The effectiveness of early detection by the social cultural unit in preventing conflict between silat colleges at the Jombang Police. *Advances in Police Science Research Journal*, 9(3), 162–175. <https://doi.org/10.70526/apsrj.v9i3.1626>
- Sanusi, M., & Vanel, Z. (2025). Strategi komunikasi Polres Salatiga untuk membangun kepercayaan masyarakat. *Jurnal Komunikasi Nusantara*, 7(1), 38–53.
- Sauers, N. J., & Richardson, J. W. (2019). Leading the pack: Developing empowering responsible use policies. *Journal of Research on Technology in Education*, 51(1), 27–42. <https://doi.org/10.1080/15391523.2018.1539644>
- Shih, P. C., Han, K., & Carroll, J. M. (2015). Using social multimedia content to inform emergency planning of recurring and cyclical events in local communities. *Journal of Homeland Security and Emergency Management*, 12(3), 627–652. <https://doi.org/10.1515/jhsem-2014-0071>
- Steinfeld, N. (2023). How do users examine online messages to determine if they are credible? An eye-tracking study of digital literacy, visual attention to metadata, and success in misinformation identification. *Social Media + Society*, 9(3). <https://doi.org/10.1177/20563051231196870>
- Stempfle, J. (2011). Overcoming organizational fixation: Creating and sustaining an innovation culture. *The Journal of Creative Behavior*, 45(2), 116–129. <https://doi.org/10.1002/j.2162-6057.2011.tb01091.x>
- Sulianta, F. (2024). *Resolusi konflik ranah digital*. Feri Sulianta.
- Sunarso, B. (2023). *Resolusi konflik sosial*. Penerbit Adab.

- Taddeo, M. (2020). The ethical governance of the digital during and after the COVID-19 pandemic. *Minds and Machines*, 30(2), 171–176. <https://doi.org/10.1007/s11023-020-09528-5>
- Van Veldhoven, Z., & Vanthienen, J. (2022). Digital transformation as an interaction-driven perspective between business, society, and technology. *Electronic Markets*, 32(2), 629–644. <https://doi.org/10.1007/s12525-021-00464-5>
- Xia, Z., Wu, D., & Zhang, L. (2022). Economic, functional, and social factors influencing electric vehicles' adoption: An empirical study based on the diffusion of innovation theory. *Sustainability*, 14(10), 6283. <https://doi.org/10.3390/su14106283>
- Yang, D., Heaney, T., Tonon, A., Wang, L., & Cudré-Mauroux, P. (2018). CrimeTelescope: Crime hotspot prediction based on urban and social media data fusion. *World Wide Web*, 21(5), 1323–1347. <https://doi.org/10.1007/s11280-017-0515-4>
- Young, H. R., Cha, Y., den Boer, H., Schellens, M., Nash, K., Watmough, G. R., Donovan, K., Patenaude, G., Fleming, S., Butchart, B., & Woodhouse, I. H. (2023). Strata: Mapping climate, environmental and security vulnerability hotspots. *Political Geography*, 100, 102791. <https://doi.org/10.1016/j.polgeo.2022.102791>