JEIT 1(1) (2025)

Journal of Educational Innovation and Technology

https://journal.sigufi.com/index.php/jeit/index

Enhancing Elementary Students' Cognitive Skills on Time Units Through the NHT Cooperative Learning Model with Analog Clock Media

Gusti Aprianti Sari [1*], Yuni Ratnasari [2], Asep Irvan Irvani[3]

[1] Department of Primary School Teacher Education, Universitas Terbuka, Tangerang Selatan, Indonesia.
[2] Department of Primary School Teacher Education, Universitas Muria Kudus, Kudus, Indonesia.
[3] Department of Physics Education, Universitas Garut, Garut, Indonesia.

Received: February 5, 2025
Revised: February 28, 2025
Accepted: March 16, 2025
Published: March 31, 2025

Corresponding Author:
Author Name*: Gusti Aprianti Sari
Email*: gtapriants13@gmail.com

Abstract: This study aims to enhance the cognitive abilities of second-grade students in learning mathematics, specifically on the topic of time units, by applying the cooperative learning model Numbered Heads Together (NHT) assisted by analog clock media. The research involved 25 students and employed a Classroom Action Research (CAR) design conducted over three cycles, each consisting of four stages. Evaluation tests were administered at the end of each cycle, and the results were analyzed using descriptive quantitative methods in the form of percentages, mean scores, and learning achievement rates. The findings revealed significant improvement across the cycles: in Cycle I, the individual and classical mastery rate was 48% with an average score of 78.7; in Cycle II, it increased to 84% with an average of 84; and in Cycle III, it reached 100% with an average score of 92.8. These results demonstrate that the use of the NHT model supported by analog clock media effectively improves students' cognitive understanding of time unit concepts. Therefore, this approach can serve as an alternative teaching strategy to enhance student engagement and learning outcomes in elementary mathematics education.

Keywords: Analog Clock Media, Cognitive Ability, Numbered Heads Together Model.

Introduction

One of the core subjects that must be taken by elementary school students is mathematics. Mathematics is an essential subject that plays a significant role in education, as it is not only a subject taught in schools but also closely related to daily life (Arisoy & Aybek, 2021; Rawzis et al., 2024; Sharma, 2021). One of the mathematics topics that has strong relevance to real-life contexts is the concept of time units. A solid understanding of time units is expected to support students' overall academic success. Learning outcomes refer to students' ability after acquiring knowledge and experience, with the results typically measured by the teacher through numerical scores or test assessments (Asim et al., 2021; Goss, 2022; Irvani & Hanifah, 2024).

The learning outcomes of second-grade students in Class 2-A at SD Negeri 2 Loktabat Selatan regarding the topic of time units remain suboptimal. Based on the results of a recent daily assessment, 16 out of 25 students (64%) were unable to score above 50%. Observations indicate that the learning process tends to be monotonous, as the teacher frequently uses lecture-based methods that are teacher-

How to Cite:
Sari, G.A., Ratnasari, Y., & Irvani, A.I. (2025). Enhancing Elementary Students' Cognitive Skills on Time Units Through the NHT Cooperative Learning Model with Analog Clock Media. Journal of Educational Innovation and Technology, JEIT 1(1)

centered and lack the support of instructional media. As a result, students are often disengaged, struggle to grasp the material, and some even display indifference during lessons. This ultimately leads to unsatisfactory academic performance. If this issue continues unaddressed, students may find it difficult to achieve the intended learning objectives. Moreover, it can hinder the development of active participation, reduce self-confidence, and foster a tendency to give up due to a limited understanding of the subject matter. Therefore, selecting an appropriate and effective learning model, such as the Numbered Heads Together (NHT) cooperative strategy, may help overcome the current challenges and foster more engaging and effective classroom learning (Mahmudah & Rasyid, 2022; Reyes et al., 2024; Saputro, 2023).

This model encourages students to engage more actively in thinking and interacting throughout the teaching and learning process in the classroom. Cooperative learning emphasizes collaboration in order to achieve common goals (Hernandi et al., 2024; Mendo-Lázaro et al., 2022; Yang, 2023). Numbered Heads Together (NHT) is a type of cooperative learning model that involves grouping students into teams of four to six members and assigning each member a number. One of the key strengths of this model is its potential to improve students' academic achievement. This learning type can be applied across various subjects and educational levels (Chen et al., 2023; Hooda et al., 2022; Muhajir et al., 2025; Tong et al., 2022). Through NHT, students are encouraged to think critically and work together in small groups, which enhances their classroom participation and academic performance. This approach directs students to collaboratively solve problems, aiming to foster student engagement, shared responsibility, group success, effective communication, and mutual respect within the learning environment.

The NHT learning model has a clear structure designed to foster effective collaboration among group members. The model consists of six sequential steps: preparation, numbering, questioning, answering, summarizing, and giving rewards (Henukh et al., 2024; Kumar & Solanki, 2023; Yildiz, 2022). This structured approach encourages student participation and accountability within their teams. Several advantages of the NHT model include its ability to improve student learning outcomes, enhance interpretation skills, create an enjoyable learning experience, foster positive attitudes, build leadership qualities, stimulate curiosity, boost self-confidence, develop a sense of belonging, and support the development of future-oriented skills (Lumbantoruan, 2022; Rijal, 2021; Yuliani et al., 2021).

By applying the Numbered Heads Together (NHT) model, the learning process becomes more structured and effective in promoting collaboration among students within groups. Moreover, the six implementation steps of the NHT model not only encourage students to actively cooperate in solving problems but also create an enjoyable learning environment. This, in turn, enhances students' engagement, improves comprehension, and contributes to better learning outcomes.

In addition to learning models, instructional media also play a crucial role in the learning process. Teaching materials can be explained more effectively when appropriate media are used. Teachers should bridge the logical thinking of children with the abstract nature of mathematics through the use of concrete objects or visual aids (Gündüz et al., 2022; Okoth, 2021; Paling et al., 2024; Rozata & Theoneste, 2024). In the topic of time units, the chosen instructional medium is the analog clock. The use of wall clock boards (analog clocks) has been found to significantly enhance students' understanding of the material being taught (Eren & Buldaç, 2023; Umami & Wardono, 2025). Supporting this view, analog clock boards are an effective media choice in teaching mathematics, as their application provides students with a fun and interactive learning experience throughout the instructional process (Trocado et al., 2024).

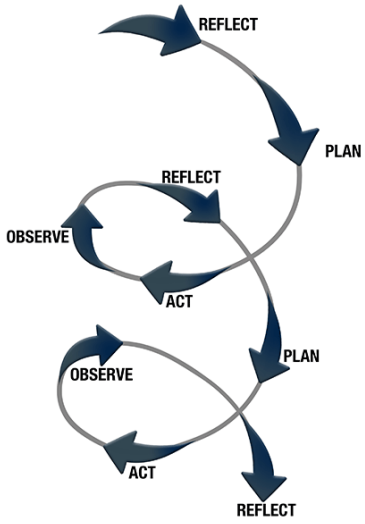
In the learning process, instructional media play a vital role in helping teachers deliver material more effectively and enabling students to better understand the content being taught—one such medium is the analog clock. By using an analog clock as a learning tool for teaching time units, students' understanding of the material can be significantly enhanced. It allows for direct, hands-on learning experiences and makes the teaching process more effective, efficient, enjoyable, and interactive.

Based on the above explanation, the researcher was motivated to conduct a study entitled "Enhancing Elementary Students' Cognitive Skills on Time Units Through the NHT Cooperative Learning Model with Analog Clock Media" as an effort to improve the cognitive learning outcomes of second-grade students in mathematics, particularly in the topic of time units. This study is grounded

in the need for more engaging and effective instructional strategies that not only facilitate students' understanding of abstract mathematical concepts but also promote active participation, collaboration, and enjoyment in the learning process. By integrating an appropriate learning model and concrete media, the study aims to address existing classroom challenges and contribute to improved academic performance and student motivation.

Method

This instructional improvement was implemented using the action research method. Action research is a method aimed at improving the quality of actions through collaboration between experts and practitioners by conducting interventions and monitoring the results (Amarulloh & Irvani, 2025; Calzada, 2023; Coughlan & Coghlan, 2023; Davison et al., 2021). It is an effort to enhance the quality of learning, focusing on the implementation of action-based research activities within the classroom (Lufungulo et al., 2021). The Kemmis and McTaggart model, which includes four stages in Classroom Action Research—planning, action, observation, and reflection—has been described as a foundational framework for this approach (Munir et al., 2022; Vianty et al., 2024).



Ficture 1. Action Research Cycle (Johnson, 2020)

The instructional improvement applied through the Classroom Action Research (CAR) approach was carried out over three cycles: Cycle I on May 7, 2025, Cycle II on May 15, 2025, and Cycle III on May 21, 2025. This classroom action research was conducted during the 2024/2025 academic year involving 25 second-grade students at SD Negeri 2 Loktabat Selatan. The data collection technique in the pre-cycle phase involved reviewing the students' daily test scores on the topic of time units, followed by evaluation tests at the end of each cycle. The test format consisted of 10 multiple-choice questions with three options and 5 short-answer questions. Each correct multiple-choice item was scored with 1 point, while each correct short-answer item was scored with 2 points.

Each student's score was calculated based on a percentage scale ranging from 0 to 100. Classical mastery was determined by the number of students who achieved cognitive learning success out of the total number of participants. Conventionally, student learning is considered successful if at least 80% of the students who took the test reach the minimum competency threshold.

This study collected data through evaluation tests conducted at the end of each cycle. The results were analyzed using a quantitative descriptive approach and presented in the form of percentages, mean scores, and learning mastery levels. Quantitative descriptive research aims to provide a comprehensive and accurate explanation of a phenomenon (Amarulloh & Irvani, 2025; Creswell & Creswell, 2017). This method seeks to describe a particular condition or phenomenon and answer questions such as what, where, when, and how (Urcia, 2021; Williams, 2021). Therefore, it can be

concluded that quantitative descriptive research aims to provide a detailed overview of an event or situation. Its primary objective is to explain facts based on measurable data. Moreover, this approach helps to answer all relevant questions related to the phenomenon being studied.

Result and Discussion

Pre-cycle

The data was obtained from the class teacher using the students' daily test results. It was found that 10 students achieved the specified indicator, representing 36%, while 15 students did not meet the indicator, representing 64%, with an average class score of 68.8. Based on these results, a learning process using the Numbered Heads Together (NHT) model assisted by analog clock media will be implemented. The cognitive learning outcomes in the pre-cycle are shown in Table 1.

Table 1. Cognitive Learning Outcomes of Pre-Cycle Students

No	Description	Number of students	Percentage (%)	Average Test Score
1	Complete	10	36	**68**
2	Incomplete	15	64	

Plan Stage (Cycle I)

Cycle I was conducted on Wednesday, May 7, 2025, from 09:30 to 10:40 WITA. This action research was carried out in the second-grade classroom at SD Negeri 2 Loktabat Selatan, applying the Numbered Heads Together (NHT) learning model with analog clock media. Before the lesson, the researcher prepared a teaching module for the time units' topic, followed by preparing the instructional media for the learning process. The researcher also prepared group work sheets and student worksheets, as well as a scoring form for assessment.

Act Stage (Cycle I)

At this stage, there are three main activities: the opening activity, the core activity, and the closing activity. In the opening activity, the teacher enters the classroom, greets the students, inquiries about their condition, leads a prayer, checks attendance, and conducts an apperception by engaging the students in a question-and-answer session related to the topic of time units. The teacher then presents the lesson material and informs the students about the learning objectives for the day.

In the core activity, before presenting the material, the teacher first divides the students into five groups and assigns each student a number, which is placed on their head. The teacher then distributes wooden analog clocks as learning media and explains the topic of time units while conducting a question-and-answer session. After providing the explanation, the teacher invites students to ask questions. Next, the teacher explains how group work will proceed using the Numbered Heads Together (NHT) model and provides the group discussion worksheets. Once all groups have completed their discussions, the teacher calls out one number from 1 to 5 and asks the student with the corresponding number to come forward, take turns presenting their answers, and invite feedback from other students on the response given. The teacher then offers feedback and adds any necessary information if the answer is incomplete (this activity is carried out alternately with different numbers until all questions have been answered). After all the questions have been addressed, the teacher collects the group discussion worksheets one by one.

In the closing activity, the teacher engages the students in reflecting on the day's activities and guides them in drawing conclusions. The teacher also gives appreciation for the students' positive attitudes and participation throughout the lesson. The teacher then distributes a test sheet for the students to complete independently. Once the allotted time is up, the teacher collects the test sheets one by one, along with the analog clock learning media. Finally, the teacher expresses gratitude and closes the session with a farewell greeting.

Observation Stage (Cycle I)

The observation stage runs concurrently with the process of instructional improvement. The aspects observed include the implementation of the learning improvement process according to the teaching

module that has been prepared and the test sheets completed by the students. The learning outcomes of the students in this cycle are shown in Table 2.

Table 2. Student Learning Outcomes Cycle I

No	Achievement Aspect	Result
1	Number of students who achieved mastery	12
2	Individual percentage	48%
3	Classical percentage	48%
4	Average score	78.8
5	Highest score	100
6	Lowest score	35

In Table 2, it can be seen that 12 students achieved mastery with scores ≥ 80, in accordance with the established indicators. The individual mastery rate is 48%, and the classical mastery rate is also 48%. This result has not yet reached the target of 80% for classical mastery, as set in the objectives. The average score obtained was 78.8, with the highest score being 100 and the lowest being 35. These results indicate that the researcher needs to conduct Cycle II in order to further maximize the students' cognitive learning outcomes using the same model and media.

Cycle II

The learning activities in this cycle are almost identical to those in the previous cycle, following the teaching module that had been designed. In Cycle II, the same learning model was applied with the assistance of analog clocks. After delivering the lesson on time units, the teacher provided a test sheet. The learning outcomes of the students in this cycle are shown in Table 3.

Table 3. Student Learning Outcomes Cycle II

No	Achievement Aspect	Result
1	Number of students who achieved mastery	21
2	Individual percentage	84%
3	Classical percentage	84%
4	Average score	84
5	Highest score	100
6	Lowest score	55

It can be seen in Table 3 that in this second cycle, 21 students achieved mastery with scores ≥ 80, in accordance with the established indicators. In this cycle, the individual mastery rate was 84%, and the classical mastery rate was also 84%. This result has already reached the target of 80% for classical mastery. The average score obtained was 84, with the highest score being 100 and the lowest score being 55. Although this result has met the classical mastery indicator, the researcher decided to proceed with Cycle III in order to further strengthen the effectiveness of the chosen learning model and determine whether Cycle III could achieve a 100% classical mastery percentage.

Cycle III

The learning activities in this cycle are almost identical to those in the previous cycle, following the teaching module that had been designed. After completing the lesson on time units, the teacher provided the evaluation test sheet. The learning outcomes of the students in this cycle are shown in Table 4.

Table 4. Student Learning Outcomes Cycle III

No	Achievement Aspect	Result
1	Number of students who achieved mastery	25
2	Individual percentage	100%
3	Classical percentage	100%
4	Average score	92,8

No	Achievement Aspect	Result
5	Highest score	100
6	Lowest score	80

In Table 4, it can be seen that all 25 students achieved mastery in Cycle III with scores ≥ 80, in accordance with the established indicators. In Cycle III, the individual mastery rate was 100%, and the classical mastery rate was also 100%. This result has met the target of 80% classical mastery. The average score obtained was 92.8, with the highest score being 100 and the lowest score being 80.

The evaluation test contained questions with varying cognitive levels, including remembering (C1), understanding (C2), applying (C3), and analyzing (C4). A detailed description of each question item can be found in Table 5.

Table 5. Percentage of Cognitive Question Items for All Cycles

Cycle	Percentage (%) of Correct Answers														
	Multiple Choice Questions										Essay Questions				
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5
	C1	C2	C2	C3	C3	C4	C4	C1	C1	C3	C1	C2	C1	C2	C3
I	76	88	96	92	80	84	76	88	84	68	80	76	84	64	64
II	84	100	100	96	96	84	76	96	84	64	84	84	68	88	88
III	96	100	100	96	84	96	80	100	92	84	88	100	100	96	84

Discussion

Based on Cycles I to III, there was an improvement in achieving the established indicators through the application of the Numbered Heads Together (NHT) cooperative learning model assisted by analog clocks at SD Negeri 2 Loktabat Selatan. This approach was effective in enhancing students' cognitive abilities on the topic of time units, both individually, class-wide, and in terms of average scores.

In Cycle I, 12 students achieved mastery, with an individual mastery percentage of 48% and a classical mastery percentage of 48%. This result has not yet met the 80% target for classical mastery, and the average score was 78.8. In this cycle, the students most frequently answered incorrectly (below 80%) on the following multiple-choice questions: Question 1, with a 76% incorrect response rate at the C1 cognitive level, where students were asked to recall the function of one of the hands on an analog clock; Question 7, with a 76% incorrect response rate at the C4 cognitive level, where students were asked to analyze an activity related to short time durations (the question presented a story with three different activities); Question 10, and Item 5, both with incorrect response rates of 68% and 64%, respectively, at the C3 cognitive level, where students were asked to apply knowledge about time and required duration; and Item 2, with a 76% incorrect response rate, and Item 4, with a 64% incorrect response rate, both at the C2 cognitive level, where students were asked to understand the position of the minute and hour hands on the clock. For example, Question 4 presented an illustration: “When the minute hand is at 12 and the hour hand is at 8, if written in 24-hour duration, what time is it at night?” This occurred because the teacher provided explanations too quickly and briefly, making it difficult for students to fully grasp the material.

In Cycle II, 21 students achieved mastery, with an individual mastery percentage of 84% and a classical mastery percentage of 84%. This result met the 80% target for classical mastery, and the average score was 84. The students most frequently answered incorrectly (below 80%) on the following questions: Question 7, with a 76% incorrect response rate at the C4 cognitive level, where students were asked to analyze an activity related to short time durations (the question presented a story with three different activities); Question 10, with a 64% incorrect response rate at the C3 cognitive level, where students were asked to apply knowledge about time and the required duration (e.g., "I studied from 6 PM to 8 PM, how long did I study?"); and Item 3, with a 68% incorrect response rate at the C1 cognitive level, where students were asked to recall which hand moves faster. This still occurred because the teacher did not explain the material clearly and in detail, and many students appeared to be distracted or not fully focused.

In Cycle III, all 25 students achieved mastery, with an individual mastery percentage of 100% and a classical mastery percentage of 100%. This result met the 80% target for classical mastery, and the

average score was 92.8. In this cycle, all questions were answered correctly, as each question had a mastery rate of 80% or higher. This success occurred because the teacher provided more detailed and slower explanations, reminded students to focus while listening, and paid closer attention to those students who were still struggling to understand the questions.

There was an increase in learning outcomes in each cycle. From Cycle I to Cycle II, the individual and classical mastery percentages increased by 36%, and the class average score rose by 5.2 points. From Cycle II to Cycle III, the individual and classical mastery percentages increased by 16%, and the class average score rose by 8.8 points. This improvement in cognitive learning outcomes can be attributed to the teacher's ability to select an appropriate model and media for the material being taught throughout the lessons.

Choosing a teaching model for the learning process in the classroom is one of the key strategies used by teachers. A learning model is a clear procedure for organizing the learning mechanism to achieve the established learning objectives (Fan et al., 2025; Jarilkapovich, 2025; Soelton, 2023; Sulastri et al., 2024). More specifically, a learning model is a preparation or design that includes a series of clear steps, which are implemented by the teacher to manage the learning process with the goal of achieving the previously set learning objectives. One such model is the cooperative learning model.

The cooperative learning model has important goals in the learning process. This model aims to improve students' academic performance, help students appreciate differences in friendships, and develop social skills (Reyes et al., 2024; Saputro, 2023). Numbered Heads Together (NHT) is one of the models under cooperative learning. This learning model requires students to collaborate within their groups, share tasks, and work together to find solutions to presented problems (Rijal, 2021; Yuliani et al., 2021). By using this model, students can collaborate more effectively within their groups, take greater responsibility for understanding the material, and actively participate in solving the problems in each question given.

Teachers can choose other strategies in the teaching and learning process, such as determining the media to be used. By using the designated learning media, it becomes easier for teachers to explain the material. Learning media is an instrument that can be used to convey messages to students, aiming to provide access to various sources of information, broaden perspectives, and enhance thinking skills (Boari et al., 2023; Irvani, 2022; Lubis et al., 2023; Paling et al., 2024). Learning media is crucial for teachers in delivering lessons to students, as it serves as a link for the information being presented. Media that connect the information provided by the teacher to the students are intended to ensure that the content is absorbed effectively and appropriately, in line with the established learning objectives (Rahmawati et al., 2025).

The research that applied the Numbered Heads Together (NHT) cooperative learning model and analog clock media in this learning improvement process has proven to enhance students' cognitive learning outcomes. This is in line with a study focused on implementing the NHT model to improve the mathematics learning outcomes of second-grade elementary students, with the results showing a significant improvement in learning outcomes through the application of the NHT cooperative learning model (Reyes et al., 2024). Similarly, research examining the effectiveness of the NHT model in improving the mathematics achievement of fifth-grade students indicated that students' mathematics performance could be enhanced through the application of the NHT cooperative learning model (Dessi & Shah, 2023; Sari et al., 2023).

Furthermore, a study investigated the use of the NHT learning model to enhance student activity and learning outcomes, with the findings indicating that the model was effective in improving the activity and learning outcomes of fifth-grade students at SD Negeri 03 Lahat (Refai, 2022). Similarly, research on second-grade students at SD Negeri Karangpule Kebumen demonstrated an improvement in mathematics learning outcomes with the use of analog clock media, showing that the use of analog clock media significantly enhanced students' understanding of the time unit's topic (Rakhmawati et al., 2022). Additionally, a study explored the impact of analog clock media on the learning achievement of second-grade students in the topics of time and duration, with results indicating that the use of analog clock media had a significant effect on students' learning outcomes in this area (Seyaningsih & Fadilah, 2025)

Conclusion

Based on the research findings, it can be concluded that the application of the Numbered Heads Together (NHT) cooperative learning model, assisted by analog clocks, significantly enhances the cognitive abilities of elementary students in learning time units at SDN 2 Loktabat Selatan. This is evident from the consistent increase in individual and classical mastery percentages, as well as the average scores in each cycle. In Cycle I, individual and classical mastery were at 48%, with an average score of 78.7. In Cycle II, mastery rates rose to 84%, with an average score of 84. Finally, in Cycle III, both individual and classical mastery reached 100%, with an average score of 92.8.

The following suggestions can be made: For teachers, it is recommended that the findings of this study be used to consider the Numbered Heads Together (NHT) cooperative learning model as one of the options that can be applied in the teaching and learning process. For other researchers, it is suggested that these findings be utilized effectively and serve as a reference for further and more in-depth research on this learning model.

References

Amarulloh, R. R., & Irvani, A. I. (2025). *Metode Penelitian Kuantitatif dalam Pendidikan: Sebuah Panduan Praktis*. PT. Sigufi Artha Nusantara.

Arisoy, B., & Aybek, B. (2021). The Effects of Subject-Based Critical Thinking Education in Mathematics on Students' Critical Thinking Skills and Virtues. *Eurasian Journal of Educational Research*, *92*, 99–119.

Asim, H. M., Vaz, A., Ahmed, A., & Sadiq, S. (2021). A Review on Outcome Based Education and Factors That Impact Student Learning Outcomes in Tertiary Education System. *International Education Studies*, *14*(2), 1–11.

Boari, Y., Megavitry, R., Pattiasina, P. J., Ramdani, H. T., & Munandar, H. (2023). The Analysis Of Effectiveness Of Mobile Learning Media Usage In Train Students' Critical Thinking Skills. *Mudir: Jurnal Manajemen Pendidikan*, *5*(1), 172–177.

Calzada, I. (2023). Smart rural communities: Action research in Colombia and Mozambique. *Sustainability*, *15*(12), 9521.

Chen, Y., Jensen, S., Albert, L. J., Gupta, S., & Lee, T. (2023). Artificial intelligence (AI) student assistants in the classroom: Designing chatbots to support student success. *Information Systems Frontiers*, *25*(1), 161–182.

Coughlan, P., & Coghlan, D. (2023). Action research. In *Research Methods for Operations and Supply Chain Management* (hal. 219–251). Routledge.

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

Davison, R. M., Martinsons, M. G., & Malaurent, J. (2021). Research perspectives: Improving action research by integrating methods. *Journal of the Association for Information Systems*, *22*(3), 851–873.

Dessi, L. C., & Shah, M. (2023). Application of the numbered head together type cooperative learning model to improve student learning outcomes in mathematics subjects. *Interval: Indonesian Journal of Mathematical Education*, *1*(2), 67–72.

Eren, G. H., & Buldaç, M. (2023). An Analysis of Clock Design in terms of Analogical Thinking. *Online Journal of Art & Design*, *11*(3).

Fan, Y., Tang, L., Le, H., Shen, K., Tan, S., Zhao, Y., Shen, Y., Li, X., & Gašević, D. (2025). Beware of metacognitive laziness: Effects of generative artificial intelligence on learning motivation, processes, and performance. *British Journal of Educational Technology*, *56*(2), 489–530.

Goss, H. (2022). Student learning outcomes assessment in higher education and in academic libraries: A review of the literature. *The Journal of Academic Librarianship*, *48*(2), 102485.

Gündüz, T., Sillem, C., Bhat, S., Mortimer, J., & McKenzie, S. (2022). *To increase and deepen learners'*

conceptual mathematical understanding by using sequences of concrete, pictorial and abstract representations delivered online through virtual manipulatives. Department of Education. London. https://www. et-foundation. co. uk/wp ….

Henukh, A., Rochintaniawati, D. D., Riandi, R., Setiawan, A., Irvani, A. I., & Aini, R. Q. (2024). Environmental Physics Learning: Implementation and Assessment in Higher Education. *Kasuari: Physics Education Journal (KPEJ)*, *7*(2), 269–279. https://doi.org/10.37891/kpej.v7i2.613

Hernandi, A., Warliani, R., & Irvani, A. I. (2024). Keterampilan Berpikir Kritis Siswa dalam Pembelajaran Fisika dengan Model Talking Stick. *JPF (Jurnal Pendidikan Fisika) Universitas Islam Negeri Alauddin Makassar*, *12*(2), 71–90. https://doi.org/10.24252/jpf.v12i2.50769

Hooda, M., Rana, C., Dahiya, O., Rizwan, A., & Hossain, M. S. (2022). Artificial intelligence for assessment and feedback to enhance student success in higher education. *Mathematical Problems in Engineering*, *2022*(1), 5215722.

Irvani, A. I. (2022). Merancang Media Pembelajaran Berdasarkan Bagaimana Siswa Belajar. *Jurnal Pendidikan Fisika dan Sains*, *5*(1), 1–9. https://doi.org/10.52188/jpfs.v5i1.205

Irvani, A. I., & Hanifah, H. S. (2024). Sosialisasi penerapan disiplin positif dalam mewujudkan merdeka belajar di lingkungan sekolah dasar. *JPM: Jurnal Pengabdian Masyarakat*, *3*(2), 394–403. https://doi.org/10.52434/jpm.v3i2.4009

Jarilkapovich, M. A. (2025). Program Technology for Choosing an Effective Educational Methodology Based on Modern Pedagogical Research in The Educational System. *CURRENT RESEARCH JOURNAL OF PEDAGOGICS*, *6*(02), 30–33.

Johnson, E. S. (2020). Action research. In *Oxford Research Encyclopedia of Education*.

Kumar, S., & Solanki, A. (2023). An abstractive text summarization technique using transformer model with self-attention mechanism. *Neural Computing and Applications*, *35*(25), 18603–18622.

Lubis, L. H., Febriani, B., Yana, R. F., Azhar, A., & Darajat, M. (2023). The use of learning media and its effect on improving the quality of student learning outcomes. *International Journal Of Education, Social Studies, And Management (IJESSM)*, *3*(2), 7–14.

Lufungulo, E. S., Mambwe, R., & Kalinde, B. (2021). The meaning and role of action research in education. *Multidisciplinary Journal of Language and Social Sciences Education (2664-083X, Online ISSN: Print ISSN: 2616-4736)*, *4*(2), 115–128.

Lumbantoruan, J. H. (2022). Further insight into student learning outcomes of derivative materials: numbered head together and expository learning model. *Utamax: Journal of Ultimate Research and Trends in Education*, *4*(2), 135–145.

Mahmudah, H., & Rasyid, F. (2022). Engaging Students in Cooperative Learning Model of Reading Course Through Numbered Head Together. *ETERNAL (English Teaching Journal)*, *13*(1), 53–67.

Mendo-Lázaro, S., León-del-Barco, B., Polo-del-Río, M.-I., & López-Ramos, V. M. (2022). The impact of cooperative learning on university students' academic goals. *Frontiers in Psychology*, *12*, 787210.

Muhajir, S. N., Irvani, A. I., Mulvia, R., Fitriyani, F., & Lestari, R. T. (2025). The implementation of PeSACCS (Peer and Self-Assessment for Collaboration and Communication Skills) in experimental class. *WaPFi (Wahana Pendidikan Fisika)*, *10*(1), 33–44.

Munir, A., Miswanto, M., & Nurarjani, N. (2022). Application of Make a Match Cooperative Learning Model in Counseling Models Courses to Increase Participation and Student Learning Outcomes. *Budapest International Research and Critics in Linguistics and Education (BirLE) Journal*, *5*(3), 213–222.

Okoth, O. P. (2021). *Exploring the use of concrete materials in teaching and learning of fractions in grade three: a case study of a public primary school in Homa-bay County, Kenya*.

Paling, S., Makmur, A., Albar, M., Susetyo, A. M., Putra, Y. W. S., Rajiman, W., Djamilah, S., Suhendi, H. Y., & Irvani, A. I. (2024). *Media Pembelajaran Digital*. TOHAR MEDIA.

Rahmawati, S., Warliani, R., & Mulvia, R. (2025). Implementation of Android-Based Interactive Learning Media on Students' Critical Thinking Skills in Physics Learning. *Lensa: Jurnal Kependidikan Fisika*, *13*(1), 1–11.

Rakhmawati, N., Anafiah, S., & Yulianingsih, E. (2022). PENINGKATAN HASIL BELAJAR MATEMATIKA MENGGUNAKAN MEDIA BENDA KONKRET JAM ANALOG PADA PESERTA DIDIK KELAS II SD NEGERI KARANGPULE KEBUMEN. *PROSIDING SEMINAR NASIONAL PENDIDIKAN PROFESI GURU*, *1*(1).

Rawzis, K., Irvani, A. I., Elviana, T., Abe, Y., & Chatimah, H. (2024). A Decade of Bibliometrics Exploration on Wind Tunnel as Learning Media in Fluid Mechanics. *Tarbiyah Suska Conference Series*, *3*(1), 86–103. https://jom.uin-suska.ac.id/index.php/TSCS/article/view/3602

Reyes, M. S., Capuno, F. T., & Baluyos, G. R. (2024). Enhancing Students' Academic Performance in Science Through the Use of Numbered Heads Together (NHT) Learning Strategy. *United International Journal for Research & Technology*, *5*(11).

Rijal, M. (2021). Differences in learners' critical thinking by ability level in conventional, NHT, PBL, and integrated NHT-PBL classrooms. *IJERE*, *10*(4), 1133–1139.

Rozata, U., & Theoneste, H. (2024). Concrete Pictorial Abstract Approach Use in Teaching Mathematics on Secondary Students' Participation in Six Selected Schools in Kicukiro District, Rwanda. *African Journal of Empirical Research*, *5*(4), 1243–1251.

Saputro, K. W. W. (2023). THE IMPLEMENTATION OF NUMBERED HEADS TOGETHER (NHT) AS A COOPERATIVE LEARNING STRATEGY IN TEACHING READING TO THE TENTH-GRADE OF SMK NEGERI 1 KALIGONDANG, PURBALINGGA REGENCY. *PURBALINGGA REGENCY (Doctoral dissertation, STATE ISLAMIC UNIVERSITY)*.

Sari, R., Supatminingsih, T., Hasan, M., Rahmatullah, R., & Nurjannah, N. (2023). THE EFFECT OF NUMBERED HEADS TOGETHER (NHT) COOPERATIVE LEARNING MODEL AND LEARNING INTEREST ON STUDENT LEARNING OUTCOMES IN ECONOMICS SUBJECT AT SMAN 11 WAJO, TAKKALALLA DISTRICT, WAJO DISTRICT. *Jurnal Eduscience*, *10*(1), 87–103.

Seyaningsih, R., & Fadilah, L. (2025). The Influence of Media-Based Learning Analog Clocks to Improve Understanding of Time Concept Students in Grade 2 of NU Metro Elementary School. *Journal of Research in Islamic Education*, *7*(1), 322–330.

Sharma, P. (2021). Importance and application of mathematics in everyday life. *International Journal for Research in Applied Science and Engineering Technology*, *9*(11), 868–879.

Soelton, M. (2023). Conceptualizing organizational citizenship behavior and learning organization in the labor sector. *Jurnal Organisasi Dan Manajemen*, *19*(1), 239–255.

Sulastri, H. P., Irvani, A. I., & Warliani, R. (2024). PENGEMBANGAN MODUL DIGITAL FISIKA BERBASIS PROJECT BASED LEARNING (PjBL) DALAM MENINGKATKAN MINAT BELAJAR PESERTA DIDIK. *OPTIKA: Jurnal Pendidikan Fisika*, *8*(1), 97–111. https://doi.org/10.37478/optika.v8i1.3696

Tong, D. H., Uyen, B. P., & Ngan, L. K. (2022). The effectiveness of blended learning on students' academic achievement, self-study skills and learning attitudes: A quasi-experiment study in teaching the conventions for coordinates in the plane. *Heliyon*, *8*(12).

Trocado, A., Dos Santos, J. M. D. S., Lento, M. A. T., Dana-Picard, T., & Lavicza, Z. (2024). Time Learning on Analog Clocks in an Automatic Feedback Context. *The International Journal of Science, Mathematics and Technology Learning*, *32*(1), 29.

Umami, N., & Wardono, W. (2025). Problem Based Learning Innovation Using Analog Clock Learning Media To Improve Student Learning Outcomes on Time Concept Materials in Elementary School. *International Journal of Education, Information Technology, and Others*, *8*(2), 74–81.

Urcia, I. A. (2021). Comparisons of adaptations in grounded theory and phenomenology: Selecting the

specific qualitative research methodology. *International journal of qualitative methods*, *20*, 16094069211045474.

Vianty, M. M., Anwar, Y., Wargadalem, F., Pulungan, M., & Amrullah, A. (2024). Pre-Service English Teachers' Experiences in Conducting Classroom Action Research. *Scope: Journal of English Language Teaching*, *9*(1), 316–321.

Williams, H. (2021). The meaning of "Phenomenology": Qualitative and philosophical phenomenological research methods. *The Qualitative Report*, *26*(2), 366–385.

Yang, X. (2023). A historical review of collaborative learning and cooperative learning. *TechTrends*, *67*(4), 718–728.

Yildiz, B. (2022). Reinforcement learning using fully connected, attention, and transformer models in knapsack problem solving. *Concurrency and Computation: Practice and Experience*, *34*(9), e6509.

Yuliani, H., Normilawati, T. A., & Aulia, M. (2021). Advantages and disadvantages of applying the NHT type cooperative learning model physics learning in school. *Jurnal Ilmiah Pendidikan Fisika*, *5*(1), 55–61.