JPPIPA 10(8) (2024)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

The Effectiveness of Collaborative E-Learning-Based Learning in Reducing Student Misconceptions on Heat in East Java High Schools During Merdeka Belajar

Heny Ekawati Haryono[1*], Moh Zayyadi[2], Iib Marzuqi[1], Ida Kaniawati[3]

[1] Universitas Islam Darul 'Ulum, Lamongan, Indonesia.
[2] Universitas Madura, Pamekasan, Indonesia.
[3] Universitas Pendidikan Indonesia, Bandung, Indonesia.

Received: March 20, 2024
Revised: June 20, 2024
Accepted: August 25, 2024
Published: August 31, 2024

Corresponding Author:
Heny Ekawati Haryono
henny@unisda.ac.id

DOI: 10.29303/jppipa.v10i8.8179

Abstract: This study aims to determine the effectiveness of Collaborative E-learning-Based Learning (KABEL) to remedy student misconceptions for heat in high schools in East Java during merdeka belajar. The study used a pre-experimental design, specifically a one-group pre-test post-test design. The study includes a sample of 290 10th-grade students who were randomly chosen from different high schools in East Java. The data collection instrument consists of 20 multiple-choice questions, each with 3 alternative answers and open-ended reasons. The average percentage of student misconceptions was 94.67% before and 39.33% after remediation. The Mc Nemar test showed a significant improvement in student conceptual understanding after remediation, as evidenced by a chi-square value (X_2) of 11.16, which exceeded the critical chi-square value (X_2table) of 3.84 for a degree of freedom (df) of 1 and a significance level (α) of 5%. The obtained proportion value of 0.56 shows a moderate effectiveness of the direct instruction model with animation media in addressing student misconceptions.

Keywords: Collaborative; Effectiveness; E-learning; Heat; KABEL

Introduction

Natural Science, also known as IPA, refers to the knowledge about natural objects and phenomena obtained through scientists' contemplation and investigation. This process involves the use of experimental skills and the application of the scientific method. According to Bramantha (2021), IPA is a scientific discipline that involves observing and classifying data, organizing and verifying it using quantitative laws, and applying mathematical reasoning and analytical data interpretation to understand natural phenomena. Physics is a crucial aspect of IPA education. Physics is an academic discipline that involves the study of natural phenomena and the development of problem-solving skills through qualitative and quantitative analysis (Purwanti & Heldalia, 2022). Physics learning aims to foster critical, creative, and independent scientific thinking, as stated in (Departemen Pendidikan Nasional, 2013). According to Haryono et al. (2021) and Haryono et al. (2023), many students perceive physics as difficult.

As a result, this perception hinders the adequate formation of a favorable disposition towards physics. Student perceptions may lead to decreased interest or enthusiasm for physics lessons. Many students have a non-scientific understanding. Based on interviews with physics teachers in 10th-grade classes at several high schools in East Java, it is obvious that a significant number of students demonstrate limited proficiency in answering questions and struggle to grasp the concepts of temperature and heat transfer, specifically the concept

How to Cite:
Haryono, H. E., Zayyadi, M., Marzuqi, I., & Kaniawati, I. (2024). The Effectiveness of Collaborative E-Learning-Based Learning in Reducing Student Misconceptions on Heat in East Java High Schools During Merdeka Belajar. *Jurnal Penelitian Pendidikan IPA*, *10*(8), 4543–4550. https://doi.org/10.29303/jppipa.v10i8.8179

of heat transfer. This observation is based on daily assessments conducted in 2023 on 10th-Grade students in several high schools located in East Java. The assessments focused on the topic of temperature and heat. 30% of students scored above the Minimum Mastery Criteria (MMC), while 70% obtained scores below MMC at 75.

Misconception relates to inaccuracies in comprehending principles of physics. According to Mukhlisa (2021), misconceptions refer to concepts that vary from those acknowledged by experts. Misconceptions in physics often arise from students and can be classified into various aspects, such as preconceived notions, associative thinking, humanistic thinking, flawed reasoning, incorrect intuition, cognitive development stages, students' abilities, and learning interests. Temperature and heat are subjects covered in 10th-grade high school curriculum. Students in junior high school have already been introduced to heat transfer, thus possessing prior knowledge and understanding of its basic concepts. Students' initial concepts can be either accurate or inaccurate, as they have wide-ranging implications in daily situations. The objective of studying this topic is for students to acquire a precise understanding of temperature and heat concepts and effectively apply them in everyday situations.

Sembiring et al. (2015) researched misconceptions about heat transfer among 10th-grade students at State Senior High School 7 Pontianak. The study identified several misconceptions, such as the belief that conduction involves the simultaneous transfer of heat and particles, the misconception that convection only occurs in liquids, and persistent confusion between the concepts of convection and radiation. Misconceptions, or mistaken student concepts, are widely recognized in academic discourse. To reduce potential misconceptions from students' limited comprehension and engagement with heat transfer in the upcoming grade, it is imperative to implement suitable interventions or strategies to tackle this concern. Misconception rectification is a common approach that often involves remediation. As defined by Mohyuddin et al. (2016), Niyibizi et al. (2024), and Wulanningtyas et al. (2022) remediation refer's to addressing and rectifying students' misconceptions. The remediation process should improve students' learning outcomes. Hence, it is essential to utilize methods or models that effectively capture students' interest in the subject matter, thereby promoting active engagement in the learning process. One possible remediation strategy for addressing students' misconceptions on temperature and heat in 10th-grade high schools in East Java is the implementation of Collaborative E-learning-Based Learning (KABEL) as a form of E-teaching.

This study focuses on collaborative learning through E-learning using a Learning Management System (LMS) called KABEL (Haryono et al., 2023). Collaborative learning can occur through synchronous (direct) and asynchronous (indirect) methods (Sari et al., 2022). Collaborative learning is effective when all group members have confidence in the superiority of the outcomes achieved through group work compared to individual efforts (Fitriasari et al., 2020; Haryono et al., 2023). Collaborative learning fosters the development of teamwork skills and encourages students to share their knowledge effectively. LMS is a web-based application utilized to facilitate the learning process. KABEL, an application available at https://kabel.unisda.ac.id/, is an implementation of the concept of learning management system (LMS).

There has been a lot of research on student misconceptions that has been carried out previously (Kusairi & Zulaikah, 2016; Setyadi & Komalasari, 2012; Febrianti et al., 2019). Diagnose student misconceptions using the Three Tier Test (Kusairi & Zulaikah, 2016), Misconceptions about temperature and heat among students are still very high (Setyadi & Komalasari, 2012), and provide information about temperature and heat misconceptions that occur in high school students (Febrianti et al., 2019; Fenditasari et al., 2020; Rizaldi, 2020). Of these several studies, no one has conducted research on the application of Collaborative E-learning-Based Learning (KABEL) as a form of E-teaching. Therefore, it is important to carry out this research with the aim of overcoming students' misconceptions about temperature and heat in class X SMA in East Java by implementing Collaborative E-learning-Based Learning (KABEL).

Method

Types of research

This study uses a pre-experimental design with a one-group pre-test post-test design. The one-group pre-test post-test design allows a more accurate assessment of the impact of a treatment by comparing the conditions before and after the intervention. The research design can be summarized as follows:

Table 1. Research design of One Group Pre-Test-Post-Test Design (Rutten et al., 2013)

O1	X	O2
Pre-test	treatment	Post-test

Research Sample

The study population consists of 290 10th-grade students in high schools in East Java. The intact group sampling technique involves including all students in a class as samples (Adnan et al., 2021). The sampling

method used in this study is saturated sampling, which involves selecting all members of the population as samples (Pangarso et al., 2021). This study included intact groups of 290 students from 10 high schools in East Java during learning freedom. These groups were selected as research samples.

Data Collection and Instrument

The data collection instrument used in this study was a diagnostic test. It includes 20 multiple-choice questions with 3 alternative answers and reasons adapted from (Larasaty, 2022). The test item's in both the pre-test and post-test are the same in terms of representing the same concepts. The test items are reviewed and re-validated by two validators: a Physics Education program lecturer from the mathematics and natural sciences faculty, UNESA and a Physics teacher from Senior high school Xin Zhong. The validation results show a validity level of 4.0, showing that it is appropriate for use in the research. The test items were tested on June 12, 2023, in 10th-grade classes in high schools located in East Java. The reliability coefficient, calculated using KR.20, is 0.504, categorized as moderate.

This one group pretest-posttest design research was designed to be carried out in one group only without a comparison group. In this design, observations are carried out twice, namely before the experiment (pre-test) and after the experiment (post-test). After that, an analysis was carried out and used pre-test and post-test as a comparison. The comparison between pre-test and post-test is assumed to be the effect of the development and implementation of E-learning based collaborative learning (KABEL).

Result and Discussion

This study aims to determine the effectiveness of Collaborative E-learning-Based Learning (KABEL) to remedy student misconceptions for heat in high schools in East Java during *merdeka belajar*. The Collaborative E-learning Based Learning (KABEL) display is as shown in Figure 1.

Student Conception Profile on Heat Before and After Using Collaborative E-learning-Based Learning

The following is a profile of students' conceptions of heat before and after using E-learning based collaborative learning in research as in table 2.

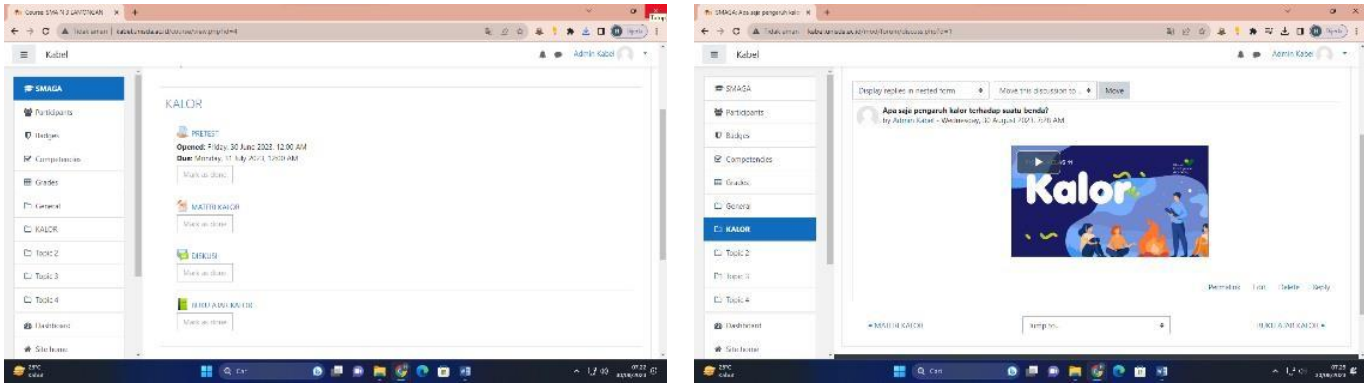

Figure 1. The front pages of KABEL

Table 2. Student Conception Profile in Pre-Test and Post-Test

Indicators	Form Misconceptions	
	Pre-test	Post-test
Identify the heat transfer process by conduction	▪ Students consider that heat is carried by particles moving from end A to end B accompanied by particle movement ▪ Students assume heat only propagates through solid objects ▪ Students assume that particles move because they are heated	Students consider that heat is carried by particles moving from end A to end B accompanied by particle movement
Identify the process of heat transfer by convection	▪ Students consider that heat travels through the pan from the bottom to the top of the pan because it experiences evaporation ▪ Students consider convection transfer to be heat transfer that is not accompanied by particle movement	▪ Students consider convection transfer to be heat transfer that is not accompanied by particle movement ▪ Students consider convection transfer to be heat transfer without intermediaries

Indicators	Form Misconceptions	
	Pre-test	Post-test
Identify the process of heat transfer by radiation	▪ Students consider convection transfer to be heat transfer without intermediaries ▪ Students consider heat transfer by radiation to be the transfer of heat using an intermediary substance ▪ Students consider radiation to be the transfer of heat accompanied by the movement of particles	Students consider that radiation is the transfer of heat accompanied by the movement of particles

Reduction of Student Misconceptions on Heat Transfer Before and After Using Collaborative E-learning-Based Learning Reduction of Student Misconceptions

The following is data on reducing student misconceptions as in table 3.

Table 3. Reduction of Student Misconceptions in Every School

School code	Misconception		(n)	Δn (%)
	n_0	n_t		
A-1	20	3	0.85	85
A-2	18	5	0.72	72
A-3	19	2	0.89	89
A-4	20	18	0.10	10
A-5	20	20	0	0
A-6	18	5	0.72	72
A-7	19	6	0.68	68
A-8	20	1	0.95	95
A-9	20	4	0.80	80
A-10	19	1	0.95	95
average				67

Based on the results of the analysis, it was found that the average percentage reduction in the number of misconceptions per student regarding heat transfer material after E-learning (KABEL) based collaborative learning was carried out was 67%.

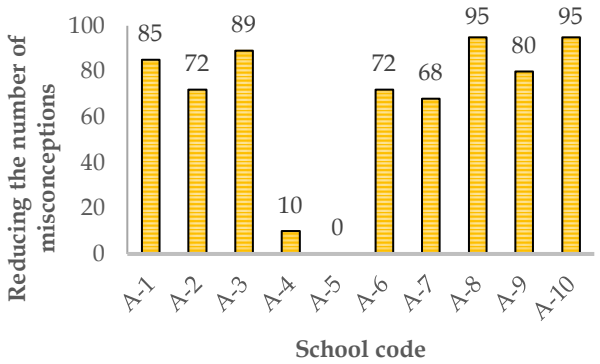

Figure 2. Graph of decreasing number of misconceptions for each school

Reduction of Misconceptions for Each Indicator

Based on the figure 3, it shows that the average percentage of students' misconceptions decreased by 67%. Mc Test. Nemar showed a significant reduction in the number of misconceptions. The largest reduction in the number of misconceptions in the concept of heat transfer by convection is 69% and the smallest reduction in the number of misconceptions in the indicator of heat transfer by conduction is 65%.

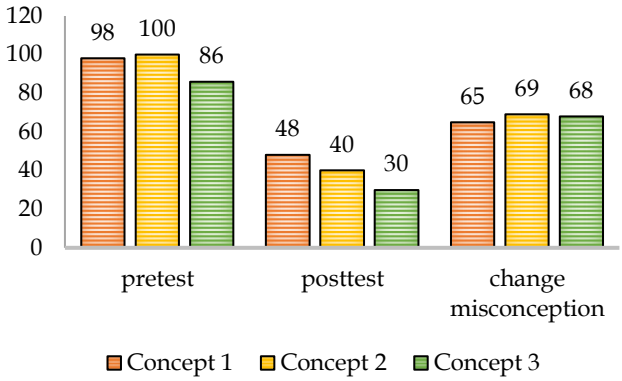

Figure 3. Graph of the percentage of student misconceptions during the pre-test, post-test and reduction in misconceptions for each concept

Note:
Concept 1 = heat transfer by conduction
Concept 2 = heat transfer by convection
Concept 3 = radiation heat transfer

Conceptual Changes in Students after Collaborative E-Learning-Based Learning (KABEL) on Heat Material

The Mc-Nemar calculation was used to determine students' conceptual changes following their exposure to Collaborative E-learning-Based Learning (KABEL) on heat material. The Mc-Nemar Test calculation results are presented for each question item in the Mc-Nemar Test assistance table. Table 5 shows the results of the Mc-Nemar Test calculations. According to the Mc-Nemar Test in Table 4.4, the $\chi 2$ value (3.84) is smaller than the $\chi 2$ values (12.06, 11.07, 8.10, 10.56, 12.07, 11.07) for df = 1 and α = 5%, sequentially corresponding to questions numbered 1, 2, 3, 4, 5, and 6. This indicates a significant conceptual change in students' understanding of the material on Heat between before and after the implementation of Collaborative E-learning-Based Learning (KABEL).

Level of Effectiveness of E-learning (KABEL) Based Collaborative Learning on Heat Material

This study aims to determine the effectiveness of E-learning based collaborative learning (KABEL) in a classroom setting. Table 5 shows how implementing collaborative learning through E-learning (KABEL) can successfully reduce the number of misconceptions regarding heat transfer among students. The largest decrease in the number of students with misconceptions occurred in indicator 1, namely identifying heat transfer by conduction by 62.5%, while the smallest decrease in the number of students occurred in indicator 3, namely identifying heat transfer by radiation by 50%. The effectiveness of E-learning-based collaborative learning (CABEL) can be seen in the average percentage reduction of students, which is 0.56, showing moderate effectiveness as per the finger joint rule.

Discussion

The research implementation in 10th-grade classes of high schools in East Java during freedom of learning lasted for a total of 5 hours (2 sessions). This included a 1-hour pre-test, a 3-hour treatment session, and a 1-hour post-test. The pre-test was conducted during the first session on June 12, 2023, while the post-test was administered on July 2, 2023, during the third session. Both the pre-test and post-test consisted of 20 multiple-choice questions with open-ended questions. This study aimed to identify students' misconceptions before and after implementing collaborative E-learning-based learning (KABEL). The study showed that before implementing collaborative E-learning-based learning (KABEL), the average value of misconceptions for each concept was 94.67%. Following the implementation of collaborative E-learning-based learning (KABEL), the average percentage of misconceptions decreased to 39.33%. This indicates a reduction in misconceptions by 54.67%.

The pre-test and post-test data analysis shows a reduction in misconceptions among all students and across all indicators. Certain students who held misconceptions before the pre-test demonstrated improved performance and could answer correctly during the post-test. The analysis revealed a mean decrease of 55% in the quantity of misconceptions per student. The decline in student misconceptions is further evidenced by the higher prevalence of misconceptions during the pre-test compared to the post-test. The research findings indicate that the pre-test revealed a relatively low mastery of the heat transfer material among students, with a high percentage of misconceptions at 94.67%.

The pre-test showed a significant number of misconceptions, which can be attributed to two factors. One factor contributing to student misconceptions is incomplete or inadequate reasoning, as noted by Comins (Guarango, 2022). Incomplete reasoning can result from inadequate information or insufficient data, leading to incorrect conclusions and subsequent misconceptions. Another factor that can lead to misconceptions is incorrect intuition, as students' intuition and emotions can also play a role. Intuition refers to the spontaneous perception and expression of objective and rational ideas. Hermansyah et al. (2019) conducted a study on using Guided Discovery with worksheets to fix misconceptions about heat transfer in high school. The study revealed that 62.3% of students held misconceptions. Misconceptions regarding temperature flow, particle movement in conduction, convection limited to liquids, and confusion between convection and radiation were identified.

The Learning process at KABEL encouraged active student participation, fostering cooperation and group discussions, resulting in increased student engagement. Following remediation, there was a significant decrease in student misconceptions, with the percentage decreasing to 39.33%. This represents a reduction of 55.34% in misconceptions. The decrease in learning time can be attributed to the use of collaborative E-learning-based learning (KABEL), which allows students to understand concepts that are in line with scientific principles. Students were instructed to listen to the teacher's explanation on heat transfer and engaged in collaborative E-learning activities focused on heat transfer (Gerhátová et al., 2020). These activities aimed to foster students' critical thinking skills in comprehending the concept of heat transfer (Kobus, 2013).

The calculation of the remediation effect of collaborative E-learning-based learning (KABEL) reveals varying ΔS values for each indicator. The diverse average proportion values for each indicator indicate that the reduction in student misconceptions varies across indicators. The average reduction in misconceptions for the three indicators ranged from 50% to 60%. Table 4.3 shows students' values for collaborative E-learning-based learning (KABEL). The data shows an average decrease of 55.34% in the number of misconceptions. Blasco-Arcas et al. (2013), Almajed et al. (2016), and Troussas et al. (2023) used collaborative learning, which yielded positive results. These included a score of 3.03, 90.09% student engagement in relevant activities, and a 91.18% completion rate for the classical study.

Elberkawi et al. (2020), and Darma et al. (2022) implemented e-learning, which led to a significant improvement in the average pre-test score, increasing it from 57 to 79.8 in the post-test. Vosniadou (2012) preconceptions, also known as initial conceptions, are the beliefs held by students before engaging in learning

activities (Kobus, 2013; Longfield, 2009; Tanner & Allen, 2005). On the other hand, final conceptions refer to the beliefs that students develop after the learning process. In the field of physics education, students' initial conceptions play a vital role in their understanding of scientific concepts within the school environment. Comprehending students' initial conceptions is crucial as they are subjective and frequently include misconceptions. Collaborative e-learning (KABEL) enables learners to engage in collaborative activities with teachers and peers, fostering a sense of choice and flexibility in the learning process. In collaborative E-learning-based learning (KABEL), learners interact socially to construct knowledge and discover new concepts through discussions. This condition was indicated by the value of sig. < 0.05. As a result, the SEIE model e-learning based on PjBL was effective on students' ability to understand concepts and their agility, both partially and simultaneously (Setemen et al., 2023).

The researcher's demonstration activities significantly influence students' conceptions (Fatima et al., 2022). Students' initial conceptions about pre-test questions can be assessed through demonstration activities, which can determine the accuracy or inaccuracy of their initial understanding. Inaccurate student conceptions can be reduced during the discussion phase by providing worksheets by teachers. These worksheets serve to guide students and enhance their attention to detail. Despite being unclear and potentially containing misconceptions, students' initial conceptions must be recognized as the initial stage in the process of conceptual change. Teachers can facilitate conceptual changes in learning activities by understanding students' conceptions.

The Mc-Nemar test results in Table 4.4 show that the $\chi 2$ value (3.84) is smaller than the $\chi 2$ values (12.06, 11.07, 8.10, 10.56, 12.07, 11.07) for df = 1 and α = 5% in questions 1, 2, 3, 4, 5, and 6, respectively. This suggests a notable shift in students' understanding before and after participating in remediation through collaborative E-learning-based learning (KABEL). The significant change is due to the students' high level of misconceptions observed in the pre-test. This supports Joan Davis's perspective cited in Keay et al. (2019) that teaching conceptual change entails two key elements: challenging students' initial concepts and employing diverse techniques to change their initial concept (Rutten et al., 2012). This study found that students' initial concepts were incorrect due to their lack of attention to the researcher's demonstrations and the presented material. Certain students could modify their initial concepts after engaging in collaborative E-learning-based learning (KABEL).

KABEL is effective when learners undergo a conceptual shift. The alignment of students' concepts with expert concepts is evident in the disparity between the numbers of misconceptions observed prior to treatment (pre-test) and after treatment (post-test). The Mc-Nemar test revealed a significant impact of direct instruction with animated media on conceptual change during remediation. The findings suggest that collaborative E-learning-based learning (KABEL) effectively addresses student misconceptions related to heat transfer. The effectiveness of collaborative E-learning-based learning (KABEL) on heat transfer was assessed using the proportion formula and evaluated based on the rule of thumb. The effectiveness of the treatment was determined to be moderate (0.56) based on the pre-test and post-test results.

Conclusion

The research findings show that students' misconceptions about heat, as measured by the average percentage of misconceptions in the pre-test, are 94.67%. The average percentage of misconceptions after treatment decreases to 39.33%. Consequently, there is a 23.45% reduction in the number of misconceptions. The implementation of collaborative E-learning based learning (KABEL) in senior high schools in East Java during the era merdeka belajar has reduced student misconceptions about heat, both at the individual student level and in connection to specific question indicators. There was a substantial 55% reduction in the average misconception per student. The significant decrease in the average misconception per student is 55%, and the average percentage of student misconceptions for each indicator during the pre-test is 94.67%. The average post-test misconception score is 39.33%, showing a 55.34% decrease in misconception percentage. There is a significant change in the number of student misconceptions between before and after the implementation of Collaborative E-learning-based learning (KABEL) on heat in high schools in East Java during the era of independent learning. The Mc-Nemar test showed a significant result ($\chi 2$ = 3.84, $p < 0.05$), indicating a significant reduction in misconceptions related to heat transfer concepts. Collaborative E-learning-based learning (KABEL) has been found to effectively address misconceptions among high school students in East Java during the era of independent learning. The effectiveness value of KABEL was 0.56, indicating a moderate level of effectiveness.

Acknowledgments

Thanks to the authors and all those who contributed to the research and writing of this article.

Author Contributions
Conceptualization of themes, article content, research methods by all authors.

Funding
This research was funded by the Ministry of Research and Technology.

Conflicts of Interest
The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

References

Adnan, G., Zulfikar, T., Armia, M. S., Gade, S., & Walidin, W. (2021). Impacts of inquiry learning model on students' cognitive and critical thinking ability. *Cypriot Journal of Educational Sciences*, *16*(3), 1290–1299. https://doi.org/10.18844/CJES.V16I3.5851

Almajed, A., Skinner, V., Peterson, R., & Winning, T. (2016). Collaborative learning: Students' perspectives on how learning happens. *Interdisciplinary Journal of Problem-Based Learning*, *10*(2). https://doi.org/10.7771/1541-5015.1601

Blasco-Arcas, L., Buil, I., Hernández-Ortega, B., & Sese, F. J. (2013). Using clickers in class. The role of interactivity, active collaborative learning and engagement in learning performance. *Computers & Education*, *62*, 102–110. https://doi.org/10.1016/j.compedu.2012.10.019

Bramantha, H. (2021). Perbedaan Kemampuan Berpikir Kritis Siswa Menggunakan Model Pembelajaran Ekspositori Dengan Model Pembelajaran Inquiry Berbantuan Media Video. *Education Journal : Journal Educational Research and Development*, *5*(2), 195–202. https://doi.org/10.31537/ej.v5i2.515

Darma, I. K., Karma, I. G. M., Santiana, I. M. A., & Suastawa, I. W. (2022). Effect Size of Mathematics Blended Learning Design on Increasing Mathematical Problem-Solving Ability of Polytechnic Students in the Covid-19 Pandemic Period. *Logic : Jurnal Rancang Bangun Dan Teknologi*, *22*(1), 43–50. https://doi.org/10.31940/logic.v22i1.43-50

Departemen Pendidikan Nasional. (2013). *Pelaksanaan Peraturan Pemerintah Nomor 32 Tahun 2013 Tentang Perubahan Atas Peraturan Pemerintah Nomor 19 Tahun 2005 Tentang Standar Nasional Pendidikan Terhadap Pelakanaan Ujian Nasional Sebagai Standar Mutu Pendidikan*. Retrieved from https://jdih.setkab.go.id/PUUdoc/173768/PP032013.pdf

Elberkawi, E. K., Ateeyah, M. A., Elakeili, S. M., & Maatuk, A. M. (2020). Issues and Challenges of Implementing E-Learning in A Public University: Students and Instructors Perspective. *Proceedings of the 6th International Conference on Engineering \& MIS 2020*. https://doi.org/10.1145/3410352.3410826

Fatima, S., Ali, M., & Saad, M. I. (2022). The effect of students' conceptions of feedback on academic self-efficacy and self-regulation: evidence from higher education in Pakistan. *Journal of Applied Research in Higher Education*, *14*(1), 180–199. https://doi.org/10.1108/JARHE-07-2020-0209

Fenditasari, K., Jumadi, Istiyono, E., & Hendra. (2020). Identification of misconceptions on heat and temperature among physics education students using four-tier diagnostic test. *Journal of Physics: Conference Series*, *1470*(1). https://doi.org/10.1088/1742-6596/1470/1/012055

Fitriasari, N. S., Apriansyah, M. R., & Antika, R. N. (2020). Pembelajaran Kolaboratif Berbasis Online. *Inspiration: Jurnal Teknologi Informasi dan Komunikasi*, *10*(1). https://doi.org/10.35585/inspir.v10i1.2564

Gerhátová, Ž., Perichta, P., & Palcut, M. (2020). Project-Based Teaching of the Topic "Energy Sources" in Physics via Integrated e-Learning—Pedagogical Research in the 9th Grade at Two Primary Schools in Slovakia. *Education Sciences*, *10*(12). https://doi.org/10.3390/educsci10120371

Guarango, P. M. (2022). Analisis Kompetensi Pustakawan Dalam Meningkatkan Pelayanan Di Upt Perpustakaan Sekolah Tinggi Pariwisata (STP) Mataram. *Jurnal Ilmu Perpustakaan (JIPER) FISIP UMMAT, 8*, 2003-2005.

Haryono, H. E., Marzuqi, I., & Kaniawati, I. (2023). Development of E-Learning-Based Collaboration (KABEL) Article Info Abstract. *Studies in Learning and Teaching*, *4*(3), 444–456. https://doi.org/10.46627/silet

Haryono, H. E., Marzuqi, I., Kaniawati, I., & Maryani. (2023). Student Learning Outcomes on Heat Material Using E-Learning-Based Collaborative Learning (KABEL). *Jurnal Penelitian Pendidikan IPA*, *9*(11), 10273–10279. https://doi.org/10.29303/jppipa.v9i11.5066

Haryono, H. E., Samsudin, A., Aini, K. N., & Siahaan, P. (2021). Teams' games tournaments with cognitive conflict instruction (CCI) model to unveil students' misconceptions. *Cypriot Journal of Educational Sciences*, *16*(4), 1343–1356. https://doi.org/10.18844/cjes.v16i4.5983

Hermansyah, H., Gunawan, G., Harjono, A., & Adawiyah, R. (2019). Guided inquiry model with virtual labs to improve students' understanding on heat concept. *Journal of Physics: Conference Series*,

1153(1). https://doi.org/10.1088/1742-6596/1153/1/012116

Keay, J. K., Carse, N., & Jess, M. (2019). Understanding teachers as complex professional learners. *Professional Development in Education*, *45*(1), 125–137. https://doi.org/10.1080/19415257.2018.1449004

Kobus, C. J. (2013). *On Why the Flipped Classroom Model May Be the Optimum for Heat Transfer Education*. https://doi.org/10.1115/HT2013-17093

Larasaty, Y. (2022). *an Analysis of Writing Task in Bupena English Textbook for the Eighth Grade English Education Study Program Education Department Faculty of Tarbiya and Teacher Training State Islamic University*. Retrieved from https://rb.gy/7a9b09

Longfield, J. (2009). Discrepant teaching events: Using an inquiry stance to address students' misconceptions. International Journal of Teaching and Learning in Higher Education, 21(2), 266. Retrieved from https://digitalcommons.georgiasouthern.edu/ct2-facpubs/3/

Mohyuddin, R. G., & Khalil, U. (2016). Misconceptions of Students in Learning Mathematics at Primary Level. *Bulletin of Education and Research, 38*(1), 133-162. Retrieved from http://files.eric.ed.gov/fulltext/EJ1210348.pdf

Mukhlisa, N. (2021). Miskonsepsi Pada Peserta Didik. *SPEED Journal : Journal of Special Education*, *4*(2), 66–76. https://doi.org/10.31537/speed.v4i2.403

Niyibizi, O., & Kazinyirako, J. P. (2024). Assessing the effectiveness of remedial strategies on senior one student's academic performance in mathematics and sciences. *Journal of Classroom Practices*, *3*(1), 1–12. https://doi.org/10.58197/prbl/AWNH3573

Pangarso, A., Gilang, A., & Fatihah, N. (2021). The effect of service quality on job satisfaction: Evidence from Indonesian electrical owned state firm. *Management Science Letters*, *11*, 1797–1806. https://doi.org/10.5267/j.msl.2021.2.002

Purwanti, E., & Heldalia, H. (2022). Korelasi Keterampilan Proses Sains Dengan Kemampuan Berpikir Kritis Siswa Pada Materi Pemantulan Pada Cermin Datar. *Journal Evaluation in Education (JEE)*, *1*(4), 143–148. https://doi.org/10.37251/jee.v1i4.146

Rizaldi, W. R. (2021, January). Profile of conceptual understanding and misconceptions of students in heat and temperature. In *4th Sriwijaya University Learning and Education International Conference (SULE-IC 2020)* (pp. 751-756). Atlantis Press. https://doi.org/10.2991/assehr.k.201230.192

Rutten, G. M., Harting, J., Bartholomew, L. K., Schlief, A., Oostendorp, R. A., & De Vries, N. K. (2013). Evaluation of the theory-based Quality Improvement in Physical Therapy (QUIP) programme: A one-group, pre-test post-test pilot study. *BMC Health Services Research*, *13*(1), 1–13. https://doi.org/10.1186/1472-6963-13-194

Rutten, N., van Joolingen, W. R., & van der Veen, J. T. (2012). The learning effects of computer simulations in science education. *Computers & Education*, *58*(1), 136–153. https://doi.org/10.1016/j.compedu.2011.07.017

Sari, D. I., Zayyadi, M, Osman, S., Milawati, M., & Kurniati, D. (2022). The Application of Synchronous and Asynchronous Learning using E-learning on Elementary Linear Algebra. *Jurnal Didaktik Matematika*, *9*(1), 22–38. https://doi.org/10.24815/jdm.v9i1.24759

Sembiring, K. C., Rinaldi, N., & Simanungkalit, S. P. (2015). Bio-oil from Fast Pyrolysis of Empty Fruit Bunch at Various Temperature. *Energy Procedia*, *65*, 162–169. https://doi.org/10.1016/j.egypro.2015.01.052

Setemen, K., Sudirtha, I. G., & Widiana, I. W. (2023). The Effectiveness of Study, Explore, Implement, Evaluate E-Learning Model Based on Project-Based Learning on the Students Conceptual Understanding and Learning Agility. *Journal of Technology and Science Education*, *13*(3), 583–596. https://doi.org/10.3926/jotse.1624

Tanner, K., & Allen, D. (2005). Approaches to biology teaching and learning: Understanding the wrong answers-teaching toward conceptual change. In *Cell Biology Education* (Vol. 4, Issue SUMMER, pp. 112–117). https://doi.org/10.1187/cbe.05-02-0068

Troussas, C., Giannakas, F., Sgouropoulou, C., & Voyiatzis, I. (2023). Collaborative activities recommendation based on students' collaborative learning styles using ANN and WSM. *Interactive Learning Environments*, *31*(1), 54–67. https://doi.org/10.1080/10494820.2020.1761835

Vosniadou, S. (2012). Reframing the Classical Approach to Conceptual Change: Preconceptions, Misconceptions and Synthetic Models. In *Second International Handbook of Science Education* (pp. 119–130). Springer Netherlands. https://doi.org/10.1007/978-1-4020-9041-7_10

Wulanningtyas, M. E., & Marhaeni, N. H. (2022). Analisis Kesalahan Siswa dan Remedialnya Dalam Mengerjakan Soal Cerita Perbandingan Matematika. *JIPM (Jurnal Ilmiah Pendidikan Matematika)*, *10*(2), 359. https://doi.org/10.25273/jipm.v10i2.10114