



## Development of E-Learning-Based Collaboration (KABEL)

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### ABSTRACT

E-learning-based collaboration (KABEL) can be used as an alternative to improve learning outcomes and student cooperation. This study aims to develop high school physics learning tools using e-learning based collaboration model in the form of lesson planning, student worksheet, teaching materials and learning outcomes on heat material. The method used is development research 4-D development models (Define, Design, Develop, Disseminate). The results of the study show: 1) The validation of learning devices achieves very valid criteria; 2) The practicality of learning devices is determined through the implementation of learning at 87% with very good criteria and student response questionnaires at 83.77% with good criteria; 3) The effectiveness of learning devices is determined through student activities at 83.64% with good criteria and student learning outcomes in temperature and heat at 45 with criteria N-gain medium. Thus, it was concluded that the design of learning devices using collaborative learning models based on e-learning heat material is valid, practical, and effective criteria.



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### INTRODUCTION

One of the biggest challenges faced in education is teaching students how to use modern information and communication technologies effectively and think critically, solve problems creatively, and communicate clearly (Gazali & Pransisca, 2020). Skills in both communicating effectively and working together effectively are required. According to the United Nations (UN), these skills indicate the knowledge-based society that characterizes the globalized modern period (Vali, 2013). Society 5.0 is a society that can solve various challenges and social problems by utilizing various innovations that were born in the era of the industrial revolution 4.0 such as the Internet on Things (internet for everything), Artificial Intelligence (artificial intelligence), Big Data (large amounts of data), and robots to improve the quality of human life. This era is an opportunity as well as a new challenge for students to improve their soft skills as preparation for the future (Indarta et al., 2022).

Physics is a science that examines the interaction between energy and matter, which forms the basis of natural science. In learning physics, students are expected not only to master physics concepts theoretically but also to be able to use the scientific method to prove the physics concepts derived from the theory (Herayanti et al., 2017). Physics is considered a difficult subject because there are many formulas that must be memorized, and students find it difficult to answer questions related to internal events in everyday life. This is because learning in schools is focused on solving physics formulas only (Haryono, 2020). Argued that science Physics is a science that is considered difficult by most students. because in it many equations

that must be memorized (Sari et al., 2020). The subject of heat is one of the materials that some students consider difficult, because to understand it requires some knowledge of the concepts of heat, specific heat, heat capacity, latent heat, Black's principle, changes in state and heat transfer (Fithriani et al., 2016).

Recent technological developments have made it easier for people to quickly access a wide range of information (Siregar & Nasution, 2020). The internet makes it easier to satisfy people's insatiable curiosity. Using the internet as a teaching tool is one of its many educational benefits. The internet is a supplement to traditional classroom instruction, an alternative to traditional classroom instruction, and a replacement for traditional classroom instruction. The internet can be used as an instrument for research and study. The use of the internet as a learning medium can be considered as something that is commonly used among students. The internet as a source of learning makes it easier for us to access various sources of information available, because the internet can help us improve our lives through education. The internet can also access various references, both in the form of research results, and articles on the results of studies in various fields (Sasmita, 2020).

Media in education is a valuable tool for facilitating the teaching and learning process (Gunawan et al., 2017). Learning media refers to the various tools' educators employ to deliver educational content to students systematically. These tools are designed to promote effective and efficient learning in an environment conducive to learning. The advancement of computer technology offers potential for scientific learning innovations, particularly in physics. Computer technology is an invention that enhances the presentation of various forms of interaction, thereby optimizing the learning process. Physics concepts are implemented in computer programs using user-friendly software. The integration of computer technology in education has been found to benefit students' cognitive abilities and ability to achieve learning objectives (Herayanti & Habibi, 2017).

The media is not the only factor determining success in achieving learning outcomes. Teachers and lecturers should pay attention to appropriate learning models, accurate methods, and teaching approaches that have a significant impact (Affandy, 2020). Effective communication and knowledge transfer are crucial for educators. Educators should facilitate learning experiences that develop students' logical, systematic, critical, and creative thinking skills and ability to collaborate in comprehending physics concepts. Applying suitable learning tools can facilitate this outcome. Physics education still predominantly relies on direct instruction, where educators actively deliver content to students and teach it to the entire class. Consequently, the learning process often becomes repetitive, leading to students experiencing feelings of boredom and distress. When teaching physics to students, educators should utilize diverse approaches, strategies, methods, and learning media suitable for the specific context to achieve the intended learning objectives effectively.

E-learning is an internet-based platform that connects educators and students in a virtual learning environment (Hadisi & Muna, 2015). E-learning has proven to be an effective solution for overcoming the limitations of time and space between educators and students (Sudaryanto, 2017). The object is not limited to a single dimension of time and space, allowing it to exist at any time. The application of media-based learning E-learning facilitates efficient and convenient communication between educators and students, overcoming limitations of distance, location, and time through internet-based platforms. The media also contributes to developing students' creativity in learning science. E-learning does not mean replacing the learning model conventional in the classroom but strengthens the learning model through content enrichment and technology development education (Elyas, 2018).

The use of media and learning models is significant in explaining science. E-learning-based collaboration (KABEL) is a solution that can be used as an alternative to improving student learning outcomes and collaboration. E-learning-based collaboration (KABEL) is a potential solution to the problem mentioned above, as it involves students collectively in a group. Study groups engage in collaborative learning based on their competencies (Chairunnisa et al., 2022).

E-learning-based collaboration (KABEL) is suitable for high school education as it promotes students' cooperative work. (Kusumastuti et al., 2012) states that this model facilitates collaboration, mutual support, shared learning, idea contribution, and collective responsibility for achieving learning outcomes and progress. E-learning-based collaborative learning (KABEL) is one of the solutions that can be used as an alternative to improve student learning outcomes and collaborative learning.

Based on some of these studies, e-learning-based learning can be said to be effective, active, and innovative in its use in learning. With an attractive and fun display, it can attract students' interest in learning. Because there are many positive things in educational games, researchers are interested in developing e-learning-based collaborative learning (KABEL) to reduce misconceptions in Heat Material for Class XI high school students in the 2022/2023 academic year in East Java. This research was developed from previous research in terms of models, methods and materials used.

## RESEARCH METHOD

This study was developmental research that focused on developing E-learning based collaborative models to develop a valid, practical, and effective learning device. This study used a 4-D development model method. S. Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel developed the model's design (Haryono et al., 2021). The 4-D model consists of four different phases: defining, planning, development, and spread. The study did not include the deployment stage, focusing only on the limited trial stage.

The subjects of this study were 150 grade XI students with details of 98 female students and 52 male students, where the majority were Muslim and Javanese and were in the province of East Java. The setting of this study was at SMA X, SMA Y, SMA Z in June for the 2022/2023 academic year East Java. This research was conducted in three meetings. Data analysis on the development of the learning device was validity, practicality, and effectiveness analysis. This analysis is used to determine the quality of the learning tools developed.

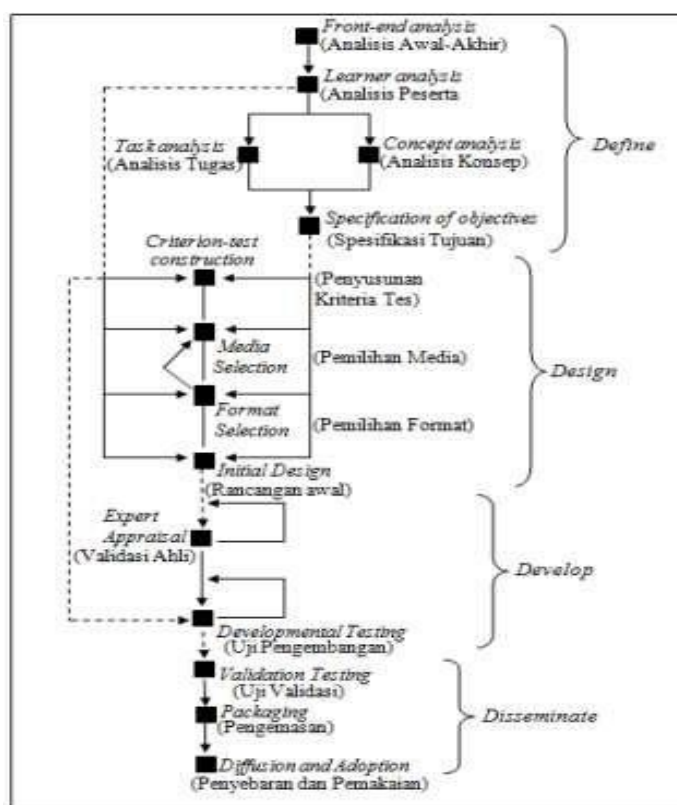


Figure 1. 4D design model

## RESULTS AND DISCUSSION

### Results

The product developed is collaborative learning media based on E-learning (CABLE) for SMA class XI students. The title of the developed product is KABEL <http://kabel.unisda.ac.id/>. This e-learning-based learning is developed using a collaborative learning model. The development model used is the 4D development model. There are 4 stages as follows.

### Define Stage

In the defining stage, several activity steps are carried out. This defining stage begins with a needs analysis by means of direct observation, student analysis, task analysis, and media analysis. The following describes the results of the defining stage:

**a. Needs analysis**

Based on the field observations made, a media is needed in the learning process that can help increase not only the active participation of students, but also increase the understanding of concepts in a fun way.

**b. Learner analysis**

During the learning process, students only memorize concepts, theories and laws contained in textbooks. Learners are more passive because the learning process is still dominated by the teacher, this makes students lazy to think independently, get bored quickly and not focus when learning.

**c. Task analysis**

Task analysis is the determination of content in learning units, task analysis is carried out to detail the content of teaching materials in the form of an outline.

**d. Curriculum analysis**

At the curriculum analysis stage, researchers know that the existing curriculum at school is the 2013 curriculum. The 2013 curriculum emphasizes self-development in students or student-centered learning.

**e. Media analysis**

Conducted to select and determine the right media to be used during learning.

### Design Stage

The next stage prepares learning materials that are loaded in the learning management system (LMS) application via the link <http://kabel.unisda.ac.id/>. There are three steps at this stage, namely:

**a. Selection of learning tools**

Selection of learning tools in accordance with task analysis, media analysis, student characteristics and objectives to deliver learning materials.

**b. Format selection**

Format selection is adjusted to the format required in the learning media so that the media can be used to cover the problems that occur in learning.

**c. Initial Design**

To design the product to be developed in the form of CABLE media using the main program the learning management system (LMS) application via the link <http://kabel.unisda.ac.id/> other programs that support.

### Develop Stage

The development stage consists of expert and practitioner assessments, as well as product development tests. The average validation results of media experts, material experts and linguists calculated can be seen in Table 1.

**Table 1.** Instrument validation results

Instrument Type	$\sum$ JTV	$\sum$ JST	PPV	% Category
Lesson plan	159	180	88,33	Very Valid
Teaching materials	162	180	90	
Student worksheet	105	120	87,5	
THB	97	108	89,81	

Based on the validator's contribution to the learning tools, revisions were made to refine the learning devices made before. After refining teaching materials, the score of lesson plan was 88.33%, teaching materials at 90%, student worksheet at 87.50%, and THB at 89.81% with very valid categories.

This research was conducted in 3 meetings through the learning management system (LMS) application via the link <http://kabel.unisda.ac.id/> for 150 students consisting of students from SMA X, SMA Y, SMA Z. This research was conducted on heat material in class XI students. Figure 2 is the average score of the results of the learning implementation data.

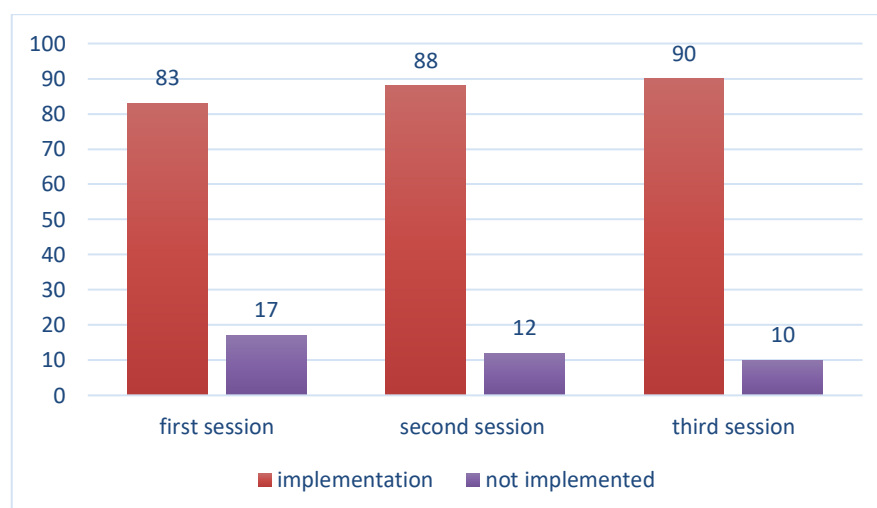
**Figure 2.** The learning implementation

Figure 2 shows that the implementation percentage for the first session is 83%, the remaining 17% not implemented. The second session shows an implementation 88%, remaining 12% not implemented. During the third session, there was a 90% implementation rate, the remaining 10% not implemented. The average score was 87%, met the criteria for excellent performance. The survey results show the approach is practical and meets the required criteria. Following are the results of the student response questionnaire percentage.

**Table 2.** Percentage of student questionnaire

Criteria	Average percentage (%)
Very good	65.38
Good	34.62
Enough	0.00
Less	0.00
Very less	0.00

Based on table 2 above, out of 150 students from SMA X, SMA Y, SMA Z. The 98 students or 65.38% responded in the very good category, and 52 students or 34.62% responded in the good category. From the average results it reached 83.77% with good criteria, the percentage results showed that the results of the student questionnaire met the practical criteria. This is in line with the research conducted by (Putra, 2021) which stated that the results of the student questionnaire met the practicality criteria.

Observational research on student activity during the learning process was conducted 3 times with 150 students in class XI consisting of students from SMA X, SMA Y, SMA Z and was observed by 2 observers. Table 3 below shows the results of the percentage of student activity data.

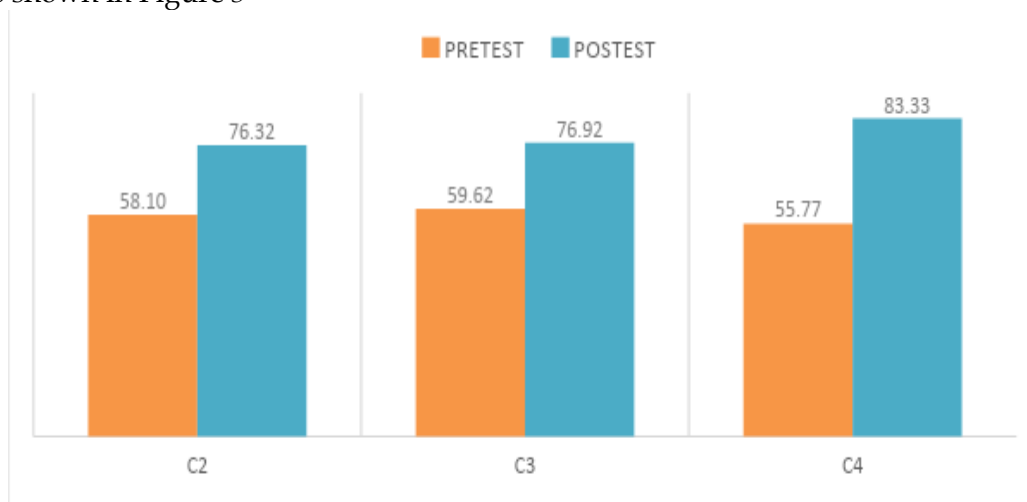
**Table 3.** Percentage of student activity

Criteria	Average percentage (%)
Very good	79.49
Good	3.85
Enough	3.85
Less	3.85
Very less	8.97

Based on Table 3 above, 79.49% of students with very good criteria totaled 119 students on average. Students with good criteria at 3.85% or 6 students. With sufficient criteria of 3.85% or an average of 6 students, with less criteria 3.85% or an average of 6 students, with very lacking criteria of 8.97%, namely an average of 13 students. Of the average results achieved, 83.64% achieved good criteria, this percentage indicates that student activities meet the effectiveness criteria.

Table 3 shows that most students, specifically 79.49%, obtained an very good score. On average, this corresponds to 119 students. The percentage of students with good scores was 3.85%, corresponding to an average of 6 students. The percentage of students with enough score was 3.85%, with an average of 6 students. Similarly, the proportion of students with less score was also 3.85%, with an average of 6 students. Furthermore, 8.97% of students obtained a significantly very low rating, with an average of 13 students falling into this category. On average, 83.64% of students attained a satisfactory rating, indicating that their level of engagement met the effectiveness criteria.

The learning outcomes test is in the form of PG questions (multiple choice) with 29 questions. The learning outcomes test was conducted on 150 class XI students from SMA X, SMA Y, SMA Z. Improvements in student learning outcomes were observed at each cognitive level, as shown in Figure 3



**Figure 3.** N-gain pretest and posttest

Figure 3 shows each indicator's cognitive range percentage using the N-Gain formula for pre-test and post-test. The the pre-test score for the C2 indicator (understanding) was 58.10% with 19 questions. The C3 indicator (application) with 4 questions was 59.62%. Indicator C4 (analysis) with 6 questions was 55.77%. The cognitive level of learning outcomes after the test with indicator C2 (understanding) with a total of 19 questions was 76.32%. Indicator C3 (applying) with a total of 4 questions was 76.92%. And the C4 indicator (analyzing) with a total of 6 questions was 83.33%. The learning process before the student's treatment produces

value(*pre-test*) student learning outcomes was 60.08%, while after the value treatment (*post-test*) student learning outcomes was 76.92%. Based on the two results before and after the test, it can be seen that the difference between the two results is 16.84%, with an increase in the N-Gain value of 0.45 ( $0.70 > \text{N-Gain} > 0.30$ ), including in the medium category. According to Hadromi and Susanto (2020), the results of their research showed an increase in the moderate category.

## Discussion

This study aimed to develop e-learning-based collaboration (KABEL), for teaching heat material. These devices were implemented through a learning management system (LMS) application accessible via the link <http://kabel.unisda.ac.id/>. The study was conducted at SMA X, SMA Y, SMA Z. The development of learning tools for collaborative models of heat materials involves a four-stage process known as 4D development. According to Thiagarajan and Semmel, research (Martini et al., 2017) includes: definition (define), design (design), development (develop), and deployment (disseminate). The first stage is the definition stage, followed by the design of draft 1 learning tools. The third stage refers to development, while the fourth pertains to deployment. However, the deployment phase was not executed. During the development stage of the previously designed learning device (Draft 1), enhancements were implemented based on feedback from three validators. These improvements were made to ensure the validity of the device and its suitability for learning purposes. The revised version of the device, referred to as the final tool (Draft II), was the outcome of this iterative process. The researchers will conduct online trials of the learning tools they have developed with a limited sample of 150 class XI students from SMA X, SMA Y, SMA Z.

The validity of the learning devices was determined through expert validation conducted by three validators using validation instrument sheets. The validation process includes evaluating the content's development, readability, language, and overall content quality (Suhandi et al., 2023). The validation results from three validators indicate that the learning device uses e-learning-based collaboration (KABEL), which is deemed feasible for use with minor revisions. The results are presented as an average percentage value. The validated learning tools included the RPP (Implementation of lesson Plan), LKPD (Student work Sheet), Teaching Materials, and THB (Learning Outcomes) (Lainata et al., 2021). The modified learning materials were categorized as very valid, with 88.33% at lesson plan, teaching materials at 90%, student worksheet at 87.50%, and learning outcome at 89.81%. The validation results show that the learning tools developed are valid through construct validation tests with minor revisions and are categorized as very valid based on validity criteria according to (Asy'Ari et al., 2021; Palupi & Ningsih, 2017; Riani et al., 2021), these devices are considered very valid based on validity criteria. The developed devices are both feasible and suitable for educational purposes. According to (Chalisah et al., 2022; Dismarianti et al., 2020; Utami & Amiruddin, 2018), their research findings indicate that the developed learning tools are both feasible and meet valid criteria.

The practicality of learning devices is assessed by implementing learning and analyzing student questionnaire responses. When both teachers and students positively engage with well-designed learning devices, they are considered valid. According to (De Fauw et al., 2018; Utariadi et al., 2021; Astuti et al., 2015), learning devices are considered as practical when experts or practitioners confirm their applicability and usability in real-world settings. The practical suitability of learning devices is obtained by analyzing the implementation of learning questionnaires and feedback from students learning. Based on research data, learning implementation was 83% at the first meeting, with 17% not implemented. At the second meeting, the implementation of learning was 88%, with 12% not implemented. Whereas at the third meeting, the implementation of learning was 90%, with 10% not implemented. The data found and analyzed above shows that it has greater implementation than those that were not implemented. Similar to the opinion of Putri et al., (2020); Anggreni & Yohandri, (2022); and Wahyudi, (2017); they stated that the learning devices developed are considered practical if

experts or practitioners state that the learning devices developed can be applied and used in the field, the practicality of the learning tools developed is based on the implementation in classroom.

The study used a student response questionnaire comprising 16 statements. A closed-ended questionnaire with a Likert scale was utilized, encompassing both positive and negative statements. The effectiveness of student worksheet was categorized positively, while implementing the E-learning based collaborative Model (KABEL) in activities 1-5 was also positively categorized. However, activities 4 and 6 were categorized negatively. Similarly, the effectiveness of instructional implementation for activities 1-3 was regarded as positive, whereas activity 2 was categorized as negative. The questionnaire responses indicate that the instructional materials were considered practical for use in the classroom. This finding is consistent with (Edelson et al., 2021; Harti, 2022; Gola et al., 2022), who proposed that using practical instructional materials can support teachers in facilitating the learning process. Supported by (Fadilah et al., 2020) research conducted at SMPN 1 Bluto and the results obtained by the learning device were stated to be valid in terms of the results of the validity of the device with a score of 3.57; Effective teaching materials in terms of student responses are included in the very good category with a result of 83.2%.

(Winget & Persky, 2022) The effectiveness of the learning process is assessed based on the extent to which students achieve the predetermined learning objectives. Learning devices show effectiveness when they accomplish predetermined learning objectives based on specific criteria. Learning devices are effective when they successfully impact all needed student learning outcomes, meeting or surpassing the predetermined minimum competency level. Learning devices can be utilized if their design has successfully attained effectiveness. One can acquire effective learning tools by observing student activities and evaluating the resulting learning outcomes. The effectiveness measurement is conducted by utilizing student activity indicators that have been adjusted to align with the level of the lesson plan, also known as Lesson Plan. According to (Chowdhury et al., 2022; Rohmaya et al., 2023; Taufiqurrahman et al., 2022), the developed learning devices demonstrate effective criteria for attaining learning objectives. The observed increase in student learning outcomes from the pre-test to the post-test suggests that the utilization of the WhatsApp application has a positive effect. This finding aligns with the research conducted by (Alamer et al., 2023), which suggests that the use of WhatsApp significantly influences student learning outcomes, leading to positive effects. Students believe that the act of communicating, coordinating, and discussing becomes more convenient in the absence of face-to-face interactions. The average percentage of student participation across three meetings was 83.64%, considered as "good" category. The data indicates that the students' activities align with the criteria for effectiveness in the learning process when using the collaborative learning model. According to (Ntobuo et al., 2018), the learning model collaboration can be understood as a cooperative process undertaken by individuals and groups, both within the original group and the expert group. This approach emphasizes the significance of fostering meaningful and intellectual learning by cultivating social aspects, aiming to attain shared objectives. The effectiveness of the model used in the study was confirmed.

Based on the test results of learning from students obtained from data analysis before learning obtained a percentage of 0.08%, whereas after being given treatment the value (post-test) student learning outcomes 76.92%. Based on both pre-test scores and posttest, post-test seen that the difference in value between the two is 16.84%, with an increase in value  $T_{\text{une}}$  of 0.45 ( $0.70 > N\text{-gain} = 0.30$ ) included in the moderate category. Based on the distribution of score categories gain given by Hake (1999), the gain score obtained is in the high category. So that it can be ascertained that learning devices using e-learning-based collaboration (KABEL) model was highly developed. This is in line with (Gitadewi et al., 2022) research conducted at SMPN 21 Surabaya which stated that the results of the students' concept comprehension tests showed an increase in the scores obtained between the pretest and posttest scores, namely the medium

category and 90% of students passed. Similar research has also been carried out by (Mufida & Qosyim, 2020; Aeni & Widodo, 2022; Layyina et al., 2021) N-Gain increased understanding of concepts in the experimental class by 0.75 with a high category and the control class by 0.62 with a moderate category. While the acquisition of mastery indicator scores for understanding concepts is included in the high category. Then the results of student learning motivation showed an increase in the acquisition of scores between the pretest and posttest in the medium category. The data obtained shows that the Integrated Flipped Classroom model with Nested is effective as a learning tool to increase students' conceptual understanding and learning motivation during the Covid-19 pandemic.

## CONCLUSION

The research discussed in the previous chapter led to the conclusion that the use of models for e-learning-based collaboration (KABEL) on the heat material (Design of lesson plan; Student worksheet, Teaching Materials; Learning Outcomes) is valid, practical, and effective, with N-gain of 0.45 ( $0.70 > N\text{-gain} = 0.30$ ) categorized as a moderate category. Future researchers should pay more attention to time efficiency used in research so that learning products to be revised and validated are not too late. Further research is needed to test the effectiveness of the e-learning-based collaboration (KABEL) model in learning other physics materials, as well as learning other subjects.

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## REFERENCES

- Aeni, W. N., & Widodo, W. (2022). Penggunaan e-modul interaktif untuk meningkatkan hasil belajar siswa smp pada materi kalor. *Pensa E-Jurnal: Pendidikan Sains*, 10(2), 193–202.
- Affandy, H. (2020). Integrasi nanoteknologi dalam pembelajaran di era society 5.0: Kajian dari perspektif pembelajaran fisika. *Jurnal Materi Dan Pembelajaran Fisika*, 10(2), 95. <https://doi.org/10.20961/jmpf.v10i2.46463>
- Alamer, A., Al Khateeb, A., & Jenó, L. M. (2023). Using WhatsApp increases language students' self-motivation and achievement and decreases learning anxiety: A self-determination theory approach. *Journal of Computer Assisted Learning*, 39(2), 417–431. <https://doi.org/10.1111/jcal.12753>
- Anggreni, Y. D., & Yohandri, Y. (2022). Pengembangan e-book berbasis discovery learning terintegrasi keterampilan 4c untuk pembelajaran fisika SMA. *Jurnal Eksakta Pendidikan (JEP)*, 6(2), 117–127. <https://doi.org/10.24036/jep/vol6-iss2/695>
- Astuti, S. I., Arso, S. P., & Wigati, P. A. (2015). Analisis standar pelayanan minimal pada instalasi rawat jalan di RSUD Kota Semarang. *Jurnal Kesehatan Masyarakat*, 3(1), 103–111. <https://doi.org/10.14710/jkm.v3i1.11129>
- Asy'Ari, M., Prayogi, S., Mirawati, B., Syarifuddin, Hunaepi, Syahrir, & Suhirman. (2021). Development of physics learning tools based on inquiry to increase creative thinking skills. *Journal of Physics: Conference Series*, 1816(1). <https://doi.org/10.1088/1742-6596/1816/1/012094>
- Chairunnisa, N. A., Mursalin, M., & Ntobuo, N. E. (2022). Pengembangan perangkat pembelajaran model kolaboratif jire berbasis it (information and technology) materi suhu dan kalor fisika. *Ideas: Jurnal Pendidikan, Sosial, Dan Budaya*, 8(3), 805. <https://doi.org/10.32884/ideas.v8i3.712>
- Chalisah, N., Istiyadji, M., Irhasyuarna, Y., & Kusasi, M. (2022). Scientific literacy on the topic of light and optical instruments in the innovation of science teaching materials. *Jurnal Inovasi Pendidikan IPA*, 8(2), 154–163. <https://doi.org/10.21831/jipi.v8i2.41343>

- Chowdhury, N., Katsikas, S., & Gkioulos, V. (2022). Modeling effective cybersecurity training frameworks: A delphi method-based study. *Computers and Security*, 113, 102551. <https://doi.org/10.1016/j.cose.2021.102551>
- De Fauw, J., Ledsam, J. R., Romera-Paredes, B., Nikolov, S., Tomasev, N., Blackwell, S., Askham, H., Glorot, X., O'Donoghue, B., Visentin, D., van den Driessche, G., Lakshminarayanan, B., Meyer, C., Mackinder, F., Bouton, S., Ayoub, K., Chopra, R., King, D., Karthikesalingam, A., ... Ronneberger, O. (2018). Clinically applicable deep learning for diagnosis and referral in retinal disease. *Nature Medicine*, 24(9), 1342–1350. <https://doi.org/10.1038/s41591-018-0107-6>
- Dismarianti, I., Anggun, D. P., Riswanda, J., Maretha, D. E., & Ulfa, K. (2020). Pengembangan media pembelajaran biologi berbasis modul elektronik (e-modul) pada materi struktur dan fungsi tumbuhan kelas VIII SMP/MTS. *Prosiding Seminar Nasional Pendidikan Biologi 2020*, 110–119.
- Edelson, D. C., Reiser, B. J., McNeill, K. L., Mohan, A., Novak, M., Mohan, L., Affolter, R., McGill, T. A. W., Buck Bracey, Z. E., Deutch Noll, J., Kowalski, S. M., Novak, D., Lo, A. S., Landel, C., Krumm, A., Penuel, W. R., Van Horne, K., González-Howard, M., & Suárez, E. (2021). Developing research-based instructional materials to support large-scale transformation of science teaching and learning: the approach of the openscienced middle school program. *Journal of Science Teacher Education*, 32(7), 780–804. <https://doi.org/10.1080/1046560X.2021.1877457>
- Elyas, A. H. (2018). Penggunaan model pembelajaran e-learning dalam meningkatkan kualitas pembelajaran. *Majalah Ilmiah Warta Dharmawangsa*, 56. <https://doi.org/10.46576/wdw.v0i56.4>
- Fadilah, S., Jatmiko, B., & Prastowo, T. (2020). Validity and effectiveness of argument-driven inquiry model with contextual approaches to improve critical thinking skills in science learning. *Studies in Learning and Teaching*, 1(2), 66–75. <https://doi.org/10.46627/silet.v1i2.32>
- Fithriani, S., Halim, A., & Khaldun, I. (2016). Penggunaan media simulasi phet dengan pendekatan inkuiri terbimbing untuk meningkatkan keterampilan berpikir kritis siswa pada pokok bahasan kalor di sma negeri 12 banda aceh. *Jurnal Pendidikan Sains Indonesia*, 4(2), 45–52.
- Gazali, M., & Pransisca, M. A. (2020). Pentingnya penguasaan literasi teknologi informasi dan komunikasi bagi guru madrasah ibtidaiyah dalam menyiapkan siswa menghadapi revolusi industry 4.0. *Jurnal Ilmiah Global Education*, 2(1), 87–95. <https://doi.org/10.55681/jige.v2i1.76>
- Gitadewi, A. J., Prabowo, Supardi, Z. A. I., & Maryuni, W. (2022). Student's concept understanding and motivation to learn through flipped classroom learning integrated with nested model. *Studies in Learning and Teaching*, 3(1), 62–73. <https://doi.org/10.46627/silet.v3i1.105>
- Gola, N., Subiki, S., & Nuraini, L. (2022). Profil respon siswa penggunaan e-modul fisika berbasis android (Andromo). *Jurnal Pembelajaran Fisika*, 11(2), 53. <https://doi.org/10.19184/jpf.v11i2.31558>
- Gunawan, G., Harjono, A., & Sutrio, S. (2017). Multimedia interaktif dalam pembelajaran konsep listrik bagi calon guru. *Jurnal Pendidikan Fisika Dan Teknologi*, 1(1), 9–14. <https://doi.org/10.29303/jpft.v1i1.230>
- Hadisi, L., & Muna, W. (2015). Pengelolaan teknologi informasi dalam menciptakan model inovasi pembelajaran (E-learning). *Jurnal Al-Ta'dib*, 8(1), 117–140.
- Hadromi, & Susanto, D. (2020). Penerapan alat peraga sistem stater konvensional berbasis audio untuk meningkatkan hasil belajar peserta didik. *Journal of Mechanical Engineering Learning (JMEL)*, 9(20), 50–57.
- Harti, N. D. (2022). Pengembangan materi ajar fisika berbasis multirepresentasi untuk meningkatkan kemampuan berpikir analisis peserta didik di MAN 2 Makassar. *Educenter: Jurnal Ilmiah Pendidikan*, 1(7), 719–730.

- Haryono, H. E. (2020). The implementation of cognitive conflict learning strategy in efforts to reduce heat misconception in junior high school students. *Jurnal Pendidikan Fisika Universitas Muhammadiyah Makassar*, 8, 319–327. <https://doi.org/10.26618/jpf.v8i3.3950>
- Haryono, H., Aini, K., Samsudin, A., & Siahaan, P. (2021). Comprehensive teaching materials based on cognitive conflict strategies to reduce misconception of calories for junior high school students. *Jurnal Pendidikan Fisika*, 9(3), 221–230. <https://doi.org/10.26618/jpf.v9i3.5224>
- Herayanti, L., Fuaddunnazmi, M., & Habibi, H. (2017). Pengembangan perangkat pembelajaran fisika berbasis moodle. *Jurnal Pendidikan Fisika Dan Teknologi*, 3(2), 197–206. <https://doi.org/10.29303/jpft.v3i2.412>
- Herayanti, L., & Habibi, H. (2017). Model pembelajaran berbasis masalah berbantuan simulasi komputer untuk meningkatkan keterampilan berpikir kritis calon guru fisika. *Jurnal Pendidikan Fisika Dan Teknologi*, 1(1), 61–66. <https://doi.org/10.29303/jpft.v1i1.236>
- Indarta, Y., Jalinus, N., Waskito, W., Samala, A. D., Riyanda, A. R., & Adi, N. H. (2022). Relevansi kurikulum merdeka belajar dengan model pembelajaran abad 21 dalam perkembangan era society 5.0. *Edukatif: Jurnal Ilmu Pendidikan*, 4(2), 3011–3024. <https://doi.org/10.31004/edukatif.v4i2.2589>
- Kusumastuti, E. C., Prihandono, T., & Supriadi, B. (2012). Penerapan model pembelajaran kolaboratif dengan media sederhana pada pembelajaran fisika di SMP. *Jurnal Pembelajaran Fisika*, 1(2), 200–205.
- Lainata, R. P., Damai, I. W., & Pesik, A. (2021). Development of two variable linear equation system learning development with a problem-based learning model. *Journal of Physics: Conference Series*, 1968(1). <https://doi.org/10.1088/1742-6596/1968/1/012052>
- Layyina, N., Agustini, R., & Indana, S. (2021). Efektifitas perangkat pembelajaran ipa berorientasi model inkuiri untuk melatih keterampilan berpikir kreatif siswa. *JPPS (Jurnal Penelitian Pendidikan Sains)*, 10(2), 2005–2015. <https://doi.org/10.26740/jpps.v10n2.p2005-2015>
- Martini, S., Supardi, Z. I., & Agustini, R. (2017). Pengembangan perangkat pembelajaran fisika model penemuan terbimbing untuk melatih keterampilan proses sains pada materi pokok suhu dan kalor. *JPPS (Jurnal Penelitian Pendidikan Sains)*, 1(2), 74. <https://doi.org/10.26740/jpps.v1n2.p74-79>
- Mufida, A., & Qosyim, A. (2020). Implementasi experiential learning pada materi pemanasan global untuk meningkatkan pemahaman konsep siswa SMP. *Pensa E-Jurnal: Pendidikan Sains*, 8(3), 307–314.
- Utariadi, N. K. D., Gunamantha, I. M., & Suastika, I. N. (2021). Pengembangan LKPD berbasis pendekatan saintifik untuk meningkatkan sikap ilmiah siswa pada tema 9 subtema 1 muatan pelajaran IPA kelas V. *Jurnal Penelitian Dan Evaluasi Pendidikan Indonesia*, 11(2), 129–137. <https://doi.org/10.23887/jpepi.v11i2.671>
- Rohmaya, N., Suardana, I. N., & Tika, I. N. (2023). Efektifitas E-LKPD kimia SMA/MA dengan model pembelajaran berbasis masalah berkonteks isu-isu sosial sains dalam meningkatkan literasi sains peserta didik. *Jurnal Pendidikan Mipa*, 13(1), 25–33. <https://doi.org/10.37630/jpm.v13i1.825>
- Ntobuo, N. E., Arbie, A., & Amali, L. N. (2018). The development of gravity comic learning media based on gorontalo culture. *Jurnal Pendidikan IPA Indonesia*, 7(2), 246–251. <https://doi.org/10.15294/jpii.v7i2.14344>
- Palupi, S. W., & Ningsih, S. C. (2017). Pengembangan bahan ajar English mathematics berbasis SCORM melalui E-Learning. 553–560.
- Putra, D. P. (2021). Pengembangan media pembelajaran fisika menggunakan kartun 3d. *Jurnal Literasi Digital*, 1(2), 88–93. <https://doi.org/10.54065/jld.1.2.2021.17>
- Putri, M. H., Suryajaya, & Irhasyurna, Y. (2020). Development of science learning tools to train critical thinking skills of junior high school students in static electricity topics. *Journal of*

- Advances in Education and Philosophy*, 4(11), 458–462.  
<https://doi.org/10.36348/jaep.2020.v04i11.004>
- Riani, L., Misdalina, M., & Sugiarti, S. (2021). Pengembangan LKS berbasis inkuiri terbimbing berbantuan edmodo untuk meningkatkan pemahaman konsep fisika siswa kelas X IPA. *Jurnal Penelitian Pembelajaran Fisika*, 12(1), 90–99. <https://doi.org/10.26877/jp2f.v12i1.7552>
- Sari, C. R. C., Mayasari, T., & Sasono, M. (2020). Implementasi problem based learning untuk meningkatkan kemampuan penalaran siswa pada materi gerak lurus. *Jurnal Pendidikan Fisika*, 8(2), 108–117.
- Sasmita, R. S. (2020). Research & learning in primary education pemanfaatan internet sebagai sumber belajar. *Jurnal Pendidikan dan Konseling*, 1, 1–5.
- Siregar, L. Y., & Nasution, M. I. P. (2020). Perkembangan teknologi informasi terhadap peningkatan bisnis online. *HIRARKI Jurnal Ilmiah Manajemen Dan Bisnis (HJIMB)*, 2(1), 71–75.
- Sudaryanto, D. H. (2017). Pemanfaatan e-learning sebagai media pembelajaran mandiri. *Forum Diklat*, 6(4), 2.
- Suhandi, A., Linuwih, S., Kaniawati, I., Fauzi, D. M., Aminudin, A. H., Fratiwi, N. J., & Adimayuda, R. (2023). Preliminary development of simulation on refutational-text (sort) to change conception of physics: Rasch and nvivo analysis. *AIP Conf. Proc. 16 June 2023*, 2614 (1), 050063. <https://doi.org/10.1063/5.0125826>
- Taufiqurrahman, M., Setiawan, D. B., Fitriah, R. A., & Hidayat, D. (2022). Penggunaan model cipp (context, input, process, dan product) dalam evaluasi program asistensi mengajar di TK Miftakhul Jannah. *MATHEdunesa*, 11(3), 677–683. <https://doi.org/10.26740/mathedunesa.v11n3.p677-683>
- Utami, L., & Amiruddin, A. (2018). Pengembangan media laboratorium virtual model 4d pada mata kuliah fisika. *Jurnal Fisika Dan Pembelajarannya*, 1(1), 7–14. <https://doi.org/10.31605/phy.v1i1.212>
- Vali, I. (2013). The role of education in the knowledge-based society. *Procedia - Social and Behavioral Sciences*, 76, 388–392. <https://doi.org/10.1016/j.sbspro.2013.04.133>
- Wahyudi, I. (2017). Pengembangan program pembelajaran fisika sma berbasis e-learning dengan schoology. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, 6(2), 187–199. <https://doi.org/10.24042/jipfalbiruni.v6i2.1850>
- Winget, M., & Persky, A. M. (2022). A practical review of mastery learning. *American Journal of Pharmaceutical Education*, 86(10), 1114–1122. <https://doi.org/10.5688/ajpe8906>

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