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WhatsApp-Assisted JCL-Based Physics E-Book: Its Effect on Physics Learning Outcome in Senior High School

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Abstract: This research aims to develop physics e-book-based jigsaw cooperative learning (JCL) assisted by WhatsApp. This article describes the results of the validity and effectiveness of the developed media on physics learning outcomes in terms of student learning motivation. This article also describes the relationship between initial ability and learning motivation on student learning outcomes. This research is development research with a 4-D model. This research was implemented with a quasi-experimental using a pretest-posttest control group research design. The sample in this research was 70 students of 10th grade science class at one of the high schools in Yogyakarta. The results of this research indicate that the development of WhatsApp-assisted JCL-based Physics e-book on the topic of straight motion is valid and reliable. This is evidenced by the results of the validator where the average value of validity and reliability is 0.75 in the high category and 94 in the reliable category. The use of WhatsApp-assisted JCL-based Physics e-book has a significant effect on improving student learning outcomes. This is indicated by the significant value is 0.00 < 0.05. By analysis of covariance, initial ability and learning motivation have a relationship with student learning outcomes. This is indicated by the squared value of the regression coefficient is 38.6%.

Keywords: Jigsaw Cooperative Learning; Learning Motivation; Learning Outcomes; Physics E-Book; WhatsApp

Introduction

Education is currently experiencing a new phase in carrying out learning caused by an outbreak of a disease, namely coronavirus disease (COVID-19) (Chu et al., 2021). The disease outbreak that originally entered Indonesia resulted in limited all sectors of life including the education sector (Syafrida & Hartati, 2020). The learning process that originally took place face-to-face (offline) in schools, universities, tutoring and others must be transferred to learning carried out online (Sahu, 2020). The implementation of online learning is a good alternative in the continuity of the current educational process. However, because of the Covid-19 pandemic, online learning that has been implemented is still experiencing many obstacles. The constraints of online learning are caused by several factors.

Factors such as not knowing the technical tools that need to be used in learning, some institutions are not equipped with information technology facilities, teachers are not sufficiently prepared to teach online and the assignment of many tasks becomes an obstacle in online learning (Chu et al., 2021; Ichsan et al., 2020). These factors also have an impact on learning Physics, where learning returns to conventional learning and students become bored (Hidayatulloh, 2021). Learning with conventional learning models can have a negative impact on students' motivation and learning outcomes (Winata, 2021). Whereas motivation is one of the stimuli that is able to maintain stability and student effort in learning (Vanslambrouck et al., 2018). The application of conventional learning models in online learning resulted in decreased student motivation and learning outcomes.

An online interview has been conducted with a physics subject teacher at a public high school in

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Yogyakarta. This is done to obtain information about students' learning motivation in Physics subjects. The results of online interviews obtained information that students' learning motivation was low during online learning. Observations in learning Physics in class X were also carried out and obtained low student motivation. This is indicated by the delay of students when joining online learning. Students are also less active in asking questions and discussing with their peers. Whereas students can become peer tutors for their friends (Haftador et al., 2021). By asking and discussing students can get a lot of information and better understand learning.

Variations of learning models has been applied by teachers in learning. Learning models such as discovery learning have been implemented, but in practice many of the syntaxes of this learning model cannot be implemented. Students are more dependent on their friends who are more dominant in solving problems. In addition, the application of the discovery learning model takes a lot of time (Aryani et al., 2021; Khasinah, 2021). Finally, the teacher gave the task to the students. Giving a lot of homework makes students less understand the lesson. Another variation of learning model that can build student discussion processes and reduce homework assignments is the jigsaw type cooperative learning model (JCL).

Jigsaw cooperative learning model is a type of cooperative learning model that is designed by focusing on students' sense of responsibility for several learning divisions given individually and by others (Astalini et al., 2021; Mohammed, 2019). This Jigsaw cooperative learning model was chosen because it can train students to be more active in speaking and expressing opinions, the topic provided can be studied more deeply, increasing learning motivation and each student can fill in each other's shortcomings. In implementing this learning model, the WhatsApp application is used to communicate and discuss.

WhatsApp is a chat application that can be formed in groups and can gather many people from the same group to share information with each other. In its use, social media is often used only to send messages between individuals and create statuses by students. Even though the chat group feature that is available on WhatsApp social media can be used as a means of exchanging information and knowledge that is not only focused on learning in the classroom (Nuuyoma et al., 2020). Therefore, the Jigsaw type cooperative learning model assisted by WhatsApp is one of the alternative goals to increase students' learning motivation and learning outcomes.

Method

Development research with 4D models is the type of research that we use in this research. This research model was adapted from Thiangarajan and Semmel. The stages of this research are define, design, develop, and disseminate (Husna & Kuswanto, 2018; Kurniaman et al., 2018). This research also uses quantitative and qualitative approaches. The topic research in the development of this physics e-book is straight motion. The define stage is the first stage in this research. At this stage, the activities carried out by the researcher are analyzing the beginning, analyzing students, analyzing assignments, analyzing concepts, assessing the abilities to be studied, and reviewing the topic to be studied. The design stage is the second stage in this research after the define stage is carried out. At this stage, the activities carried out by the researcher were selecting media, selecting media formats, designing initial media designs, compiling media feasibility instruments, compiling learning outcomes assessment instruments, compiling learning motivation questionnaires, compiling lesson plans and lesson plan feasibility instruments.

The develop stage is the third stage in this research after the design stage is carried out. At this stage, the activities carried out by the researcher were developing the draft I e-book media, validating the learning outcomes assessment instrument, validating the lesson plans, validating the media, revising the draft I e-book media, limited testing, revising the second draft of the Physics e-book media, extensive testing, assessing learning outcomes and learning motivation questionnaires. The disseminate stage is the fourth stage in this research after the develop stage is carried out. At this stage, the activities carried out by the research are making research articles and managing the intellectual property rights of the product. The research stages of this research are shown in Figure 1.

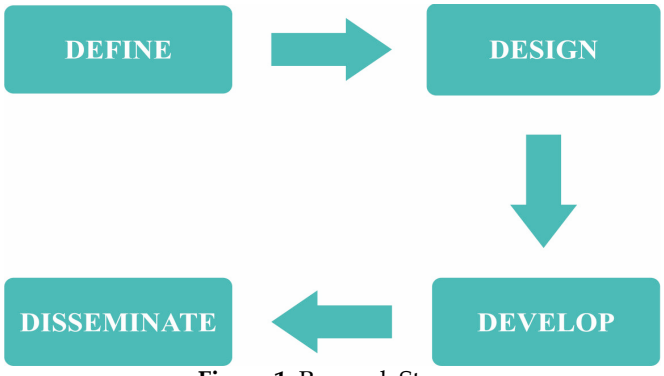

Figure 1. Research Stages

The implementation used type of quasi-experimental research was used in this research to determine the effect of WhatsApp-assisted JCL-based Physics E-Book on Physics learning outcomes in terms of students' learning motivation. The research design is shown in Table 1 (Hastjarjo, 2019; Taber, 2019).

Table 1. Pretest-posttest Control Group Design

Group	Pre	Treatment	Post
Experimental	I	T_1	F
Control	I	T_2	F

Where, T_1 refers to the implementation of the WhatsApp-assisted JCL-based Physics E-Book. T_2 refers to the implementation of conventional learning models. I refers to the results of the initial ability of the experimental and control group before being given treatment. F refers to the learning outcomes and learning motivation of the experimental and control group after being given treatment.

The subjects of this research consisted of 70 students of 10th grade science class at one of the Senior High School in Yogyakarta school year 2020/2021. Where 35 students of 10th grade science 1 class as the experimental group and 35 students of 10th grade science 3 class as the control group. Participants were selected using a cluster sampling technique (Bhardwaj, 2019; Jackson, 2018). The topic of physics lessons is limited to the topic of straight motion which is in 10th grade class odd semester. The topic of straight motion is still difficult for most students to understand (Busyairi et al., 2021; Ma'rifa et al., 2018). The topic is implemented with jigsaw cooperative learning.

Learning was carried out 5 times in both classes. In the first meeting, a pretest was conducted to obtain the students' initial ability scores. The second meeting carried out the learning process with the topic 1. The third meeting carried out the learning process with the topic 2. The fourth meeting carried out the learning process with the topic 3. The fifth meeting was conducted posttest and filling out questionnaires to obtain the value of learning outcomes and student motivation.

Data was collected using several instruments including pretest and posttest of physics learning outcomes, observation sheets of jigsaw cooperative learning model, and learning motivation questionnaire. Data analysis used several techniques including validity and reliability tests, percentage of lesson plan implementation, standard gain, analysis of covariance and effect size. The test is carried out using a computer program that is in accordance with statistical analysis.

Validity test is used to analyze the feasibility or validity of an instrument. The validity of the instrument was analyzed using the content validity of the V-Aiken. The V-Aiken equation is shown in equation 1 (Bashooir & Supahar, 2018; Tabachnick & Fidell, 2019).

$$V = \frac{\sum s}{n(c-1)} = \frac{\sum(r - l_0)}{n(c-1)} \quad (1)$$

Where, r refers to the score given by an evaluator. l_0 refers to the lowest score. c refers to the highest score. n refers to the number of raters (validators). The validity assessment criteria show in Table 2.

Table 2. Content Validity Assessment Criteria

Validity Score	Category
0.00 – 0.20	Very Low
0.20 – 0.40	Low
0.40 – 0.60	Enough
0.60 – 0.80	High
0.80 – 1.00	Very High

Reliability test is used to analyze the consistency or reliability of the measurement of an instrument. Instrument reliability was analyzed using the percentage of agreement. The percentage of agreement equation is shown in equation 2 (Astika et al., 2021; Makhrus, 2018).

$$PA = \left[1 - \frac{VH - VL}{VH + VL}\right] \times 100\% \quad (1)$$

Where, PA refers to the assessment agreement between validators. VH refers to the validator that gives the highest score. VL refers to the validator that gives the lowest score. If the percentage value of the agreement is 75%, an instrumen can be said to be reliable. The validity and reliability of the instrument is tested to determine the feasibility of the learning device instrument.

The implementation of learning in accordance with the lesson plans was observed by two observers by filling out the observation sheet. Assessment is given by ticking the answer choices in the yes or no column. The results of the implementation of this learning were tested using the percentage of implementation. Observations were made in the experimental class and the control class. The equation for the percentage of implementation is shown in equation 3 (Mufidah et al., 2021).

$$\%\ implementation = \frac{JSK}{JSM} \times 100\% \quad (3)$$

Where, JSK refers to the number of implementation scores. JSM refers to the maximum number of scores. The implementation of the lesson plan can be said to be well implemented if the value ranges from 61 to 100%. The criteria for implementing the lesson plan are shown in Table 3.

Table 3. Criteria for Implementation of Lesson Plan

Score (%)	Category
0 – 21	Very Bad
21 – 40	Bad
41 – 60	Enough
61 – 80	Good
81 – 100	Very Good

Measurement of the increase in student learning outcomes can be tested using the standard gain

equation. The gain standard is used to see whether the value of learning outcomes in the experimental and control class has increased or decreased. The standard gain equation is shown in equation 4 (Aprilia et al., 2020; Nuritha & Tsurayya, 2021).

$$\langle g \rangle = \frac{X_{post} - X_{pre}}{X_{max} - X_{pre}} \quad (4)$$

Where, ⟨g⟩ refers to the standard gain. X_{post} refers to the score after the test. X_{pre} refers to the score before the test. X_{max} refers to the maximum score. The standard gain value criteria are shown in Table 4.

Table 4. Standard Gain Value Criteria

Value ⟨g⟩	Category
⟨g⟩ > 0.7	High
0.3 < ⟨g⟩ ≤ 0.7	Medium
⟨g⟩ ≤ 0.3	Low

Covariance analysis test was used to determine the basic difference between groups for one or more confounding variables or covariates. Ancova test was conducted in this research to determine the effect of learning motivation (covariance) on learning outcomes. Covariance analysis test is data that has been normally distributed and homogeneous. Covariance analysis can be declared significant if the value of sig 0.05 and the value of F_{count}>F_{table} (Adah, 2021; Arina et al., 2020; Zimmermann et al., 2020).

The effect size test is used to determine the effectiveness between variables. The effectiveness of the learning model and learning motivation was tested using an effect size. The effect size test uses the partial eta-square equation. Partial eta square can identify the influence of other variables (covariance). The criteria for the size of the effect size are shown in Table 5 (Bakker et al., 2019; Istiqomah & Indarini, 2021).

Table 5. Effect Size Criteria

Effect Size	Category
d > 0.8	Big
0.2 ≤ d ≤ 0.8	Medium
d < 0.2	Small

Result and Discussion

Research on the effect of WhatsApp-assisted JCL-Based Physics E-Book has been carried out. There are several results that have been obtained from this research, such as the validity and reliability of learning tools, lesson plans, improvement of learning outcomes, and analysis of covariance.

The learning tools used in this research are lesson plan instruments, teacher, and student e-books, learning outcomes assessment instruments, and learning motivation questionnaires. This learning device has been declared valid and reliable by using the equation in the method section. The results of the validity and reliability of each learning device instrument are shown in Table 6 and Table 7.

Table 6. Summary of Learning Device Instruments Validity Results

Instruments	X	Category
Experimental Class Lesson Plan	0.81	Very High
Control Class Lesson Plan	0.78	High
Teacher's Book	0.76	High
Student's Book	0.74	High
Learning Outcomes Assessment Question	0.88	Very High
Learning Motivation Questionnaire	0.82	Very High

From the results in Table 6 each instrument has a high and very high validity value. These results explain that each instrument is suitable for use in learning. In addition, in Table 7 each instrument has a percentage of agreement (PA) value of 75%. These results explain that each instrument is reliable.

Table 7. Summary of Learning Device Instruments Reliability Results

Instrument	PA (%)	Category
Experimental Class Lesson Plan	92	Reliable
Control Class Lesson Plan	90	Reliable
Teacher's Book	95	Reliable
Student's Book	93	Reliable
Learning Outcomes Assessment Question	96	Reliable
Learning Motivation Questionnaire	90	Reliable

These results indicate that the developed WhatsApp-assisted JCL-based physics e-book is feasible to be used in physics learning activities in class. The developed WhatsApp-assisted JCL-based physics e-book is shown in Figure 2.

Figure 2. (a) Display of cover on JCL-based physics e-book (b) Display of topic on JCL-based physics e-book

The implementation of learning by adjusting the syntax in the lesson plans for the experimental class and the control class has been obtained. The results obtained are shown in Table 8.

Table 8. Summary of Average Implementation of Lesson Plan

Experimental Class	Control Class
91%	100%

From Table 8, the syntax in the jigsaw cooperative learning applied to the experimental class can be implemented by 91%. Setting the discussion time between groups is too long resulting in a lack of time at the end of learning. This is one of the weaknesses of the application of the jigsaw cooperative type (Mohammed, 2019).

The test was conducted before (pretest) and after (posttest) learning in both classes. The test instruments that were declared valid were 30 questions. The results of the pre and post tests in the experimental class were analyzed using standard gain. Descriptive analysis of learning outcomes tests in the experimental class is shown in Table 9.

Table 9. Summary of Descriptive Analysis of Experimental Class Learning Results

Average Score		Normalized	Criteria
Pretest	Posttest	Gain	
19.14	76.29	0.71	High

In Table 9 there is an increase in learning outcomes in the classroom with the implementation of WhatsApp-assisted jigsaw type cooperative learning model. The average pretest score of students is 19.14 and the average posttest score is 76.29 with a normalized gain of 0.71 in the high category. The average pre and post tests scores of the experimental class are easier to see in Figure 3.

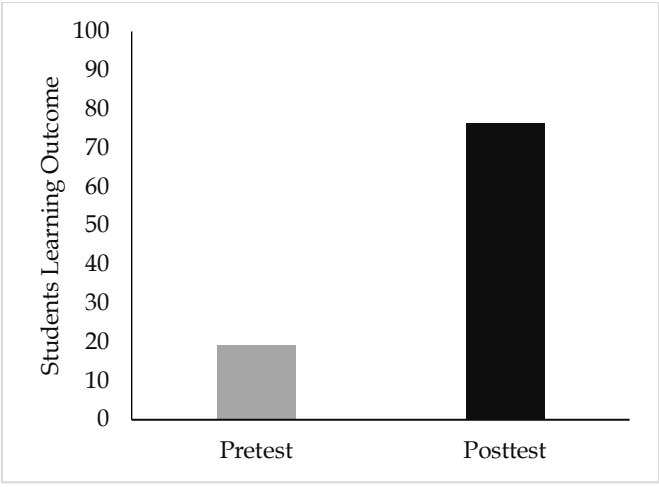

Figure 3. The average scores of the experimental class learning outcome

The results of the pre and post tests in the control class were analyzed using standard gain. Descriptive analysis of learning outcomes tests in the control class is shown in Table 10.

Table 10. Summary of Descriptive Analysis of Control Class Learning Results

Average Score		Normalized	Criteria
Pretest	Posttest	Gain	
23.14	38.46	0.20	Low

In Table 10 there is an increase in learning outcomes in the classroom with the implementation of conventional learning models. The average pretest score of students is 23.14 and the average posttest score is 38.46 with a normalized gain of 0.20 in the low category. The average pre and post tests scores of the control class are easier to see in Figure 4. In addition, the comparison of the improvement in learning outcomes of the two classes is easier to see in Figure 5.

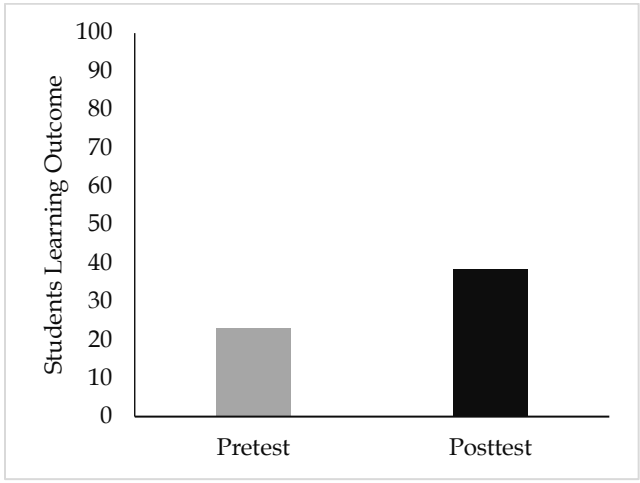

Figure 4. The average scores of the control class learning outcome

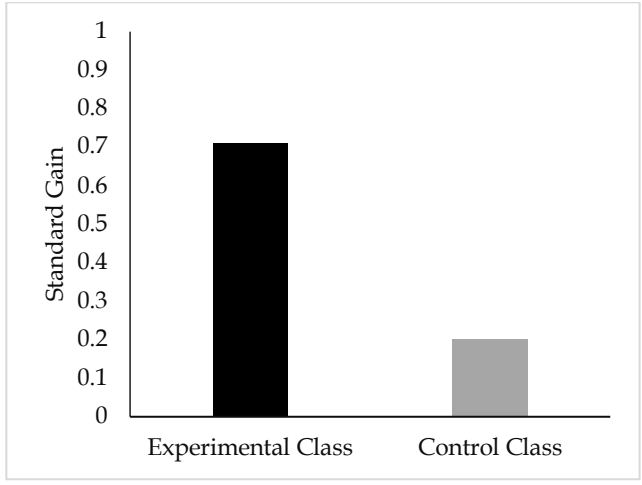

Figure 5. Standard gain analysis scores of experimental and control classes

The scores of learning outcomes in the experimental and control classes is controlled by the variables of initial ability and student motivation. Variable initial ability and motivation to learn is a covariate variable because it can control other variables. How much the covariate variable influences the independent variable, and the dependent variable is tested using analysis of covariance (ANCOVA).

Prerequisite tests such as normality and homogeneity tests were carried out before carrying out the ancova test. The test was carried out at a significant level of 0.05. The results of the prerequisite test are shown in Table 11.

In Table 11 the significance value of the normality test is 0.10, which means the sig value > 0.05. Therefore, it can be said that the data is normally distributed. The significance value of the homogeneity test is 0.95 which means the sig value > 0.05. Therefore, it can be said that the data is homogeneous. The prerequisite test has been fulfilled, then the ANCOVA test can be carried out. The results of the Ancova test are shown in Table 12.

Table 11. Summary of Prerequisite Test Results

Variable	Sig	
	Normality	Homogenity
Learning Outcome	0.10	0.95

Table 12. Summary of Ancova Test Results

Source	Sig	Partial Eta Squared
Corrected Model	0.000	0.386
Initial Ability	0.013	0.090
Learning Motivation	0.064	0.003
Group	0.000	0.329
R Squared = .386		

In Table 12 the significant value for the initial ability covariate is 0.013, meaning that the sig value is < 0.05. The significant value for the covariate of learning motivation is 0.639, meaning that the sig value is > 0.05. From the results obtained, it can be said that the initial ability covariate has a linear relationship to student learning outcomes. Meanwhile, the covariate of learning motivation has no linear relationship to student learning outcomes. This means that covariance analysis is able to explain the influence between a detailed variable, as found by (Arina et al., 2020) that covariance analysis has a good and more appropriate level of precision to use than analysis of variance.

Initial ability and learning motivation simultaneously affect student learning outcomes. This can be proven by the significance value in the Corrected Model section of 0.000, meaning that the value of sig < 0.05. In addition, it can also be seen that the group (class) significance value of 0.000 means that the sig value is < 0.05. So, it can be said that there is a significant difference between student learning outcomes with the WhatsApp-assisted JCL model and the conventional learning model. This increase is due to the advantages of the WhatsApp-assisted JCL model. Where students can discuss until they become tutors for their friends without having to wait for physics lessons (Mohammed, 2019).

From Table 12 it can also be seen that the R square value of 0.386 or 38.6% indicates that there is a simultaneous relationship between the independent variables and the dependent variable. Where, there is a relationship between WhatsApp-assisted JCL model on students' learning outcome. In addition, the value of the effect size partial eta square is 0.329 in the medium category. This ensures that there is an effect even if it is only moderate.

Conclusion

Results and discussion of this research concluded that the WhatsApp-assisted JCL-based physics e-book is feasible to use in learning. This is indicated by a validity values being 0.75 in the high category and reliablity values being 94 in the reliable category. WhatsApp-assisted JCL-based physics e-book has a significant effect on increasing student learning outcomes. This is indicated by the significance value is 0.00 which is smaller than the alpha value of 0.05. This research also shows that learning motivation as a covariate variable also affects student learning outcomes. This is indicated by the partial eta square value of 0.329 which is in the medium category. In addition, there is a simultaneous relationship between initial ability and learning motivation on student learning outcomes. This is indicated by the value of the squared regression coefficient is 0.386 or 38.6%. Therefore, this research can be a practical alternative for teachers in carrying out online learning. Students can discuss with their friends without being hindered by time and place.

References

Adah, I. S. (2021). Effect of rubrics assessment tool on students' achievement in basic science in Jalingo education zone, Taraba State, Nigeria. *Multidisciplinary International Journal*, (7), 64–76. Retrieved from https://mijournal.in/admin1/upload/07%20Igoh%20Sunday%20Adah%2001134.pdf

Aprilia, T., Sutrio, S., & Sahidu, H. (2020). Pengembangan Perangkat Pembelajaran Model Quantum Learning Untuk Meningkatkan Self-Efficacy Fisika Peserta Didik. *Jurnal Ilmiah Profesi Pendidikan*, *5*(2), 138–144. https://doi.org/10.31764/orbita.v7i1.3437

Arina, F., Ulfah, M., Trenggonowati, D. L., & Arina, F. (2020). Analysis of covariance for completely randomized design (case study: The life times of

cutting tools used with lathes). *IOP Conference Series: Materials Science and Engineering*, *909*(1). https://doi.org/10.1088/1757-899X/909/1/012089

Aryani, L., Widayat, E., & Sunardjo, S. (2021). Pengaruh model pembelajaran discovery learning dan cooperative learning tipe jigsaw terhadap aktivitas dan hasil belajar siswa. *Edudikara: Jurnal Pendidikan Dan Pembelajaran*, *6*(2), 62–72. https://doi.org/10.32585/edudikara.v6i2.234

Astalini, Kurniawan, D. A., Darmaji, Erika, Hoyi, R., & Sukarni, W. (2021). Description of student response on the implementation of cooperative learning models of jigsaw and role playing on the physics learning. *Jurnal Pendidikan Fisika Indonesia*, *17*(1), 77–85. https://doi.org/10.15294/jpfi.v17i1.24315

Astika, M., Hikmawati, H., Sutrio, S., & Gunawan. (2021). Pengembangan perangkat pembelajaran model discovery learning untuk meningkatkan kemampuan berpikir kritis fisika peserta didik. *Jurnal Penelitian Dan Pembelajaran Fisika Indonesia*, *3*(1), 1–5. Retrieved from https://jpfis.unram.ac.id/index.php/jppfi/article/view/114/89

Bakker, A., Cai, J., English, L., Kaiser, G., Mesa, V., & Van Dooren, W. (2019). Beyond small, medium, or large: points of consideration when interpreting effect sizes. *Educational Studies in Mathematics*, *102*(1), 1–8. https://doi.org/10.1007/s10649-019-09908-4

Bashooir, K., & Supahar. (2018). Validitas dan reliabilitas instrumen asesmen kinerja literasi sains pelajaran fisika berbasis STEM. *Jurnal Penelitian Dan Evaluasi Pendidikan*, *22*(2), 219–230. https://doi.org/10.21831/pep.v22i2.20270

Bhardwaj, P. (2019). Types of sampling in research. *Journal of the Practice of Cardiovascular Sciences*, *5*(3), 157–163. https://doi.org/10.4103/jpcs.jpcs_62_19

Busyairi, A., Sutrio, S., Gunada, I. W., Harjono, A., Doyan, A., & Munandar, R. (2021). Peningkatan pemahaman konsep calon guru fisika melalui pendekatan multipel representasi. *Jurnal Ilmiah Profesi Pendidikan*, *6*(3), 502–508. https://doi.org/10.29303/jipp.v6i3.229

Chu, A. M. Y., Liu, C. K. W., So, M. K. P., & Lam, B. S. Y. (2021). Factors for sustainable online learning in higher education during the COVID-19 pandemic. *Sustainability (Switzerland)*, *13*(9), 1–16. https://doi.org/10.3390/su13095038

Haftador, A. M., Shirazi, F., & Mohebbi, Z. (2021). Online class or flipped-jigsaw learning? Which one promotes academic motivation during the COVID-19 pandemic? *BMC Medical Education*, *21*(1), 1–8. https://doi.org/10.1186/s12909-021-02929-9

Hastjarjo, T. D. (2019). Rancangan eksperimen-kuasi. *Buletin Psikologi*, *27*(2), 187–203. https://doi.org/10.22146/buletinpsikologi.38619

Hidayatulloh, A. (2021). Persepsi siswa terhadap pembelajaran daring pada mata pelajaran fisika. *Jurnal Ilmiah Sangkareang Mataram*, *8*(1), 63–66. Retrieved from https://sangkareang.org/index.php/SANGKAREANG/article/view/368/297

Husna, M., & Kuswanto, H. (2018). Development of physics mobile learning based on local wisdom to improve vector and diagram representation abilities. *International Journal of Interactive Mobile Technologies*, *12*(6), 85–100. https://doi.org/10.3991/ijim.v12i6.8746

Ichsan, I. Z., Rahmayanti, H., Purwanto, A., Sigit, D. V., Kurniawan, E., Dewi, A. K., … Marhento, G. (2020). Covid-19 dan e-Learning: Perubahan strategi pembelajaran sains dan lingkungan di SMP. *Jurnal Inovasi Pembelajaran*, *6*(1), 50–61. https://doi.org/doi.org/10.22219/jinop.v6il.11791

Istiqomah, J. Y. N., & Indarini, E. (2021). Meta analisis efektivitas model pembelajaran problem based learning terhadap kemampuan berpikir kritis siswa SD. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *5*(1), 670–681. Retrieved from https://jurnal.unibrah.ac.id/index.php/JIWP

Jackson, E. A. (2018). Critical review of sampling procedures in the context of Sierra Leone's low literacy (and under-resourced) research communities. *Economic Insights - Trends and Challenges*, *8*(4), 35–44. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3520519

Khasinah, S. (2021). Discovery learning: Defnisi, sintaksis, keunggulan, dan kelemahan. *MUDARISUNA: Media Kajian Pendidikan Agama Islam*, *11*(3), 402–413. https://doi.org/10.22373/jm.v11i3.5821

Kurniaman, O., Noviana, E., Charlina, C., Simulyasih, S. B. N., Handayani, N. D., Sofyan, N. S., … Septyanti, E. (2018). Why should primary teachers develop learning material by directed reading thinking activity (DRTA) strategy? 4-D Model. *Advanced Science Letters*, *24*(11), 8389–8391. https://doi.org/10.1166/asl.2018.12570

Ma'rifa, Kamaludin, H., & Fihrin, H. (2018). Analisis pemahaman konsep gerak lurus pada siswa SMA negeri di Kota Palu. *Jurnal Pendidikan Fisika Tadulako (JPFT)*, *4*(3), 1–3. Retrieved from http://jurnal.untad.ac.id/jurnal/index.php/EPFT/article/view/6060/4809

Makhrus, M. (2018). Validitas model pembelajaran conceptual change model with cognitive conflict approach. *Jurnal Ilmiah Profesi Pendidikan*, *3*(1), 62–66. https://doi.org/10.29303/jipp.Vol3.Iss1.55

Mohammed, I. J. (2019). Using jigsaw cooperative

learning strategy to improve the EFL Iraqi students in writing skill. *Journal of Al-Frahedis Arts*, *11*(3), 504–524. Retrieved from https://www.iasj.net/iasj/download/8bd7149c3b5d811b

Mufidah, L., Fatayah, & Yuliana, I. F. (2021). Keterlaksanaan model pembelajaran science, technology, engineering, and mathematics (STEM) pada materi koloid. *UNESA Journal of Chemical Education*, *10*(3), 261–267. https://doi.org/https://doi.org/10.26740/ujced.v10n3.p261-267

Nuritha, C., & Tsurayya, A. (2021). Pengembangan video pembelajaran berbantuan Geogebra untuk meningkatkan kemandirian belajar siswa. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *5*(1), 48–64. https://doi.org/10.31004/cendekia.v5i1.430

Nuuyoma, V., Mhlope, N. J., & Chihururu, L. (2020). The use of WhatsApp as an educational communication tool in higher education: Experiences of nursing students in Kavango East, Namibia. *International Journal of Higher Education*, *9*(5), 105–114. https://doi.org/10.5430/ijhe.v9n5p105

Sahu, P. (2020). Closure of universities due to coronavirus disease 2019 (COVID-19): Impact on education and mental health of students and academic staff. *Cureus*, *2019*(4), 4–9. https://doi.org/10.7759/cureus.7541

Syafrida, & Hartati, R. (2020). Bersama melawan virus covid 19 di Indonesia. *SALAM: Jurnal Sosial Dan Budaya Syar-I*, *7*(6), 495–508. https://doi.org/10.15408/sjsbs.v7i6.15325

Tabachnick, B. G., & Fidell, L. S. (2019). *Using multivariate statistics* (7th ed.). Boston: Pearson Education.

Taber, K. S. (2019). Experimental research into teaching innovations: Responding to methodological and ethical challenges. *Studies in Science Education*, *55*(1), 69–119. https://doi.org/10.1080/03057267.2019.1658058

Vanslambrouck, S., Zhu, C., Lombaerts, K., Philipsen, B., & Tondeur, J. (2018). Students' motivation and subjective task value of participating in online and blended learning environments. *Internet and Higher Education*, *36*, 33–40. https://doi.org/10.1016/j.iheduc.2017.09.002

Winata, I. K. (2021). Konsentrasi dan motivasi belajar siswa terhadap pembelajaran online selama masa pandemi covid-19. *Jurnal Komunikasi Pendidikan*, *5*(1), 13–24. https://doi.org/10.32585/jkp.v5i1.1062

Zimmermann, G., Kieser, M., & Bathke, A. C. (2020). Sample size calculation and blinded recalculation for analysis of covariance models with multiple random covariates. *Journal of Biopharmaceutical Statistics*, *30*(1), 143–159. https://doi.org/10.1080/10543406.2019.1632871