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An Introduction to the Level of Inquiry Model: Validity and Practicality of Inquiry STEM-Based Learning Sequence e-Worksheet to Stimulate Student Communication Skill

Ghani Fadhil Rabbani [1*)], Abdurrahman [2], Hervin Maulina [3], Kartini Herlina [4], Septina Sri Haryanti [5]
University of Lampung, Indonesia[1,2,3,4,5]
[*)]Corresponding E-mail: ghanirabbani.10@gmail.com

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ABSTRACT
This study aims to describe an Inquiry-Based Learning (IBL) Sequence-based e-Worksheet with a valid STEM approach to stimulate students' communication skills in challenging learning through the Google Classroom platform and its practicality. The development research model is ADDIE, consisting of analysis, design, development, implementation, and evaluation stages. The data from this research are the results of validation and practicality, analyzed using mixed methods (quantitative and qualitative). The results of the data analysis show that the average e-worksheet validity is 3.77 in the very valid category, and the practicality proportion is 93.6% in the very practical category. Based on the results of data analysis, it can be concluded that; 1) an e-Worksheet based on an IBL Sequence with a valid STEM approach to stimulate students' communication skills in bold learning through the Google Classroom platform, which contains stages of IBL learning with a STEM approach containing activities that stimulate indicators of students' communication skills; and 2) Practicality of the IBL Sequence-based e-Worksheet with the STEM approach to stimulate students' communication skills in daring learning through the Google Classroom platform which is categorized as very practical, so that it can be used in high school Physics learning, class X odd semester, materials for Changing Straight Motion Order.

INTRODUCTION

The distinctive characteristic of 21st-century learning is digital communication, meaning that the learning process is no longer face-to-face (face-to-face course) directly between teachers and students but is more modern internet-based learning (e-learning) [1] [2] [3] [4]. 21st-century learning

emphasizes skills called the 4 C's, including creativity, critical thinking, communication, and collaboration [5] [6] [7] [8].

In the era of the industrial revolution 4.0 where IOT (Internet of Things) plays an important role in everything. The world of education must follow these developments because online learning methods or e-learning have shifted conventional learning. Many of the benefits obtained include learning not constrained by space and time. It can be done anywhere and anytime [9] [10]. E-learning has become very popular among students worldwide, particularly during the lockdown period due to the COVID-19 pandemic [11] [12]. According to Soni [13], online learning is one of the steps to prevent the spread of the crippling COVID-19 activity globally, especially in education, which has changed from an offline learning process into an online learning process.

Implementing online learning requires the right learning approach so students can still be actively involved and participate in the learning process. One learning approach that can accommodate this is the STEM (science, technology, engineering, and mathematics) approach. Abdurrahman et al [14] says that STEM implementation can fulfil skills integration and content in the 21st century. The STEM approach can also be applied to several fields of science, one of which is physics. However, there are problems in learning physics, like misconceptions. Misconceptions in physics learning activities are often experienced, so they become obstacles for students in learning to understand and relate the concepts being studied; this can lead to errors and difficulties in studying physics [15]. Reinforced by Sutrisno [16], misconceptions still occur in students' learning activities in thUniform Straight Motion and Uniformly Changing Straight Motion material.

One of the learning models that can improve students' understanding of concepts is inquiry-based learning (IBL) [17] [18]. Inquiry-Based Learning (IBL) is a learning that considers the development of intellectual abilities and scientific process skills systematically through the selection of inquiry with a comprehensive pattern. Wenning [19] explains that the purpose of inquiry learning is that task stimulates students to actively seek and research their problem-solving and resources together in groups. In addition, the level of inquiry model (levels of inquiry) states that experience and investigation aim to improve the ability of students to find what they want to learn at school [20].

In the context of online learning, it takes many learning content that can help students to learn more independently. Worksheets designed for online learning activities lead to cran ease needed to increase student activity individually and in groups. This is in line with the opinion of Irwansyah et al [21] that in today's technological developments, most students are more interested in teaching materials that use other media such as computers/laptops and even smartphones that printed worksheets from teaching physical materials. One of the alternative teaching materials is a worksheet. Worksheets can be more active for students because they contain things they must do with a material [22]. Worksheets can be presented in electronic form or called e-worksheets (electronic worksheets). E-worksheet is one solution for enriching students' mastery of the material.

Researchers have conducted preliminary research by distributing questionnaires and interviews to teachers and students. Based on interviews with teachers regarding how to deliver material in a straight line that changes uniformly in schools, data were obtained from different high schools. Among them, teachers in general still use the lecture method in conveying the material in uniform, straight motion and uniformly changing straight motion material, so students' communication skills have not been trained. Then, in general, teachers have not used worksheets in the learning process on uniformly changing straight-motion material. Based on the questionnaire that was distributed to 21 students from 3 different schools, it obtained data that there're 57.1% of students do not use uniformly changing straight motion material worksheets, there're 61.9% of students taught the material of uniformly changing straight motion by the teacher using textbooks, and there're 57.1% of students have difficulty understanding the material of uniformly changing straight motion.

Researchers also did a literature review, and it was found that there had been research on the development of e-worksheets, including project-based learning-based e-worksheets [23] [24], problem-based learning e-worksheets, and inquiry-based learning-based e-worksheets with a scientific approach [25]. However, there has been no development of an inquiry-based learning (IBL) sequence-based e-worksheet with a STEM approach, so it is very important to develop an inquiry-based learning (IBL) sequence-based e-worksheet with a STEM approach. This is because there is a need for the development of STEM-based teaching materials to support the national curriculum [26]. Based on the description that has been explained, it is crucial to research to describe an IBL Sequence-based e-Worksheet with a valid STEM approach to stimulate students' communication skills in daring learning through the Google Classroom platform and its practicality.

METHOD

This research is development research using an IBL sequence-based E-Worksheet with a STEM approach to stimulate students' communication skills. Product development uses the ADDIE model, which consists of five stages according to Branch [27]: analysis, design, development, implementation, and evaluation, as shown in Figure 1.

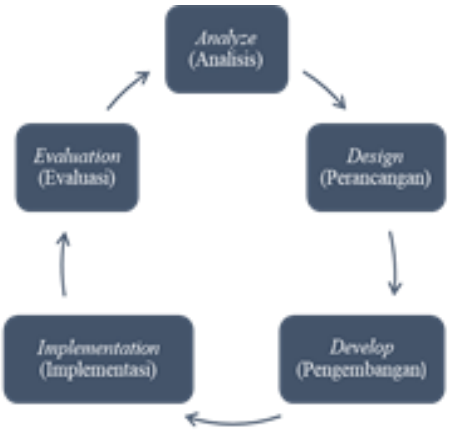

Fig 1. *Stages of ADDIE Model Research*

An analysis is the first stage in development research. The activities carried out were a needs analysis in several schools in Lampung and a literature review. A needs analysis was conducted by interviewing and completing questionnaires to Grade X students and teachers. The second stage of this development research is design. At this stage, the e-worksheet begins to be designed, which will be developed according to the results of the analysis that has been done previously. In addition, at this stage, the instrument that will be used to assess the developed e-worksheet is also carried out. The instruments compiled are a validation test questionnaire and a practicality test of e-worksheet by experts.

The validity test questionnaire was given to three experts. The validity test questionnaire contains a design expert test sheet and a material expert test sheet. The scoring system uses a Likert scale adapted from Ratumanan & Laurent [20] using four choices in Table 1.

Table 1. Likert Scale on Validation Questionnaire

Percentage	Criteria
Very valid	4
Valid	3
Not valid	2
Not valid	1

The practicality test questionnaire consists of a readability questionnaire, a teacher's perception test (implementation), and a student response test. The scoring system uses a Likert scale adapted by Ratumanan & Laurent [20].

Table 2. Likert Scale on Practicality Test Questionnaire

Percentage	Criteria
Very good	4
Good	3
Not good	2
Not good	1

Data analysis of this development research used a mixed method, namely qualitative and quantitative. E-Worksheet validation data were analyzed using percentages with the following equation:

$$p = \frac{the\ average\ score\ obtained}{\sum Total} \quad (1)$$

The score (p) results were converted into categories adapted from Ratumanan & Laurent [20], as shown in Table 3.

Table 3. Validation Score Conversion

Score Interval Assessment Results	Criteria
3.25 < score < 4.00	Very valid
2.50 < score < 3.25	Valid
1.75 < score < 2.50	Not valid
1.00 < score < 1.75	Not valid

Practicality data (readability, teacher perceptions, and student responses) were analyzed using percentages adapted from Sudjana [21].

$$\%p = \frac{score\ obtained}{\sum\ Total} \times 100\% \quad (2)$$

The score (p) results are converted into categories, as in Table 4.

Table 4. Conversion of Practicality Score

Score Interval Assessment Results	Criteria
0.00% - 20%	Very low practicality/ impractical
20.1% - 40%	Low practicality/ less practical
40.1% - 60%	Moderate practicality/pretty practical
60.1% - 80%	High practicality/ practical
80.1% - 100%	Very high practicality / very practical

The communication skill stimulus assessment data was processed using an equation adapted from Arikunto [22].

$$NP = \frac{\Sigma}{Indicator\ Max\ Score} \times 100\% \quad (3)$$

Description;
NP = Value searched
Σ = Number of indicators that appear
Indicator Max Score = Indicator Maximum Score

The score (p) results are converted into categories, as in Table 5.

Table 5. Conversion of Communication Skills Stimulus Assessment Score

Score Interval Assessment Results	Criteria
0.00% - 20%	Not stimulated
20.1% - 40%	Less stimulated
40.1% - 60%	Sufficiently stimulated
60.1% - 80%	Stimulated
80.1% - 100%	Very stimulated

The next stage is development. At this stage, the e-worksheet is developed according to the design. Then the e-worksheet will be validated by material experts and design experts. Validation is carried out until finally, the e-worksheet is declared feasible to use.

After that, proceed to the implementation stage. The activity at the implementation stage is by testing the product on a small group of 12 (twelve) students who have received the material for Uniform Straight Motion and Uniformly Changing Straight Motion. The developed e-worksheet is used in learning to avoid misconceptions that occur in students.

The last stage is evaluation. The evaluation stage is carried out at the end of each development stage. The evaluation in question aims to improve the e-worksheet at every stage. It is intended that the developed e-worksheet is said to be valid and suitable for use in learning.

RESULTS AND DISCUSSIONS

This research presents a solution to stimulate students' communication skills during the Covid-19 pandemic through an Inquiry-Based Learning (IBL) Sequence-based E-Worksheet with a STEM approach. The results were obtained at each investigation stage based on the research conducted. The first study's results are in the needs analysis described in the introduction. In addition, in general, several high schools have never carried out practicum activities in a straight line changing regularly, so communication skills are also not trained. This shows that the demands of the 21st century on communication skills have not been gotten. The gaps in the problems and demands of the 21st century make researchers continue to the design stage. Therefore, the researchers developed an inquiry-based learning sequence-based e-worksheet with a STEM approach to stimulate students' communication skills that can be used as an alternative to online learning media.

Next is the design stage. At this stage, an inquiry-based learning sequence-based e-worksheet design contains several activities. An inquiry-based learning sequence-based e-worksheet was made with the help of Microsoft PowerPoint and Corel Draw applications to design the cover and layout. Then, the finished e-worksheet design is compiled in Flip PDF Professional.

Fig 2. *Display of E-Worksheet*

The e-Worksheet consists of 3 parts: the initial section consisting of a cover page, introduction, table

of contents, instructions for use, core competencies, basic competencies, indicators, and learning objectives. Furthermore, the content section contains learning activities which include 5 activities. The final section (closing) contains 1 activity and a bibliography.

Then, the development stage. At this stage, validation and practicality of the E-Worksheet are carried out, as well as an assessment of the stimulus for students' communication skills. The validation results, which consist of material and construct aspects as well as media and design, show an average of 3.77 which is qualitatively very valid, as in Table 6.

Table 6. E-Worksheet Validation Results

No.	Rated aspect	Average Examiner Score	Category
Media and Design Aspects			
1.	Cover Section	3.74	Very Valid
2.	Contents Section	3.90	Very Valid
Material and Construct Aspect			
1.	Conformity of Material Content	3.78	Very Valid
2.	Construction	3.67	Very Valid
Average		**3.77**	**Very Valid**

Then, the practical results consist of a readability test (table 7), a teacher perception test (implementation) (table 8), and a student response test (table 9). I obtained an average percentage of 93.6% with a very practical category, as in Table 10.

Table 7. Readability Test Results

No.	Statement	Total Score per statement	Max Score	%	Category
1.	The structure of the E-Worksheet is arranged systematically/sequentially so that it is easy for me to understand.	44	48	91%	Very Practical
2.	The spacing, type, and size of the letters on the E-Worksheet are suitable and comfortable to read.	45	48	93%	Very Practical
3.	The layout of the E-Worksheet is good and ideal so that I can easily read the sequence of material on the E-Worksheet.	44	48	91%	Very Practical
4.	The language used in the E-Worksheet is generally easy to understand.	46	48	95%	Very Practical
5.	The instructions for working on the E-Worksheet are clear and easy to understand.	45	48	93%	Very Practical
6.	The commands or questions presented in the E-Worksheet are clear so	45	48	93%	Very Practical

	that they are easy for me to understand.				
7.	The steps in the E-Worksheet are easy to understand.	46	48	95%	Very Practical
8.	The presentation of the E-Worksheet is equipped with pictures/illustrations and video links so that it helps me understand the material.	48	48	100%	Very Practical
9.	The phenomena presented in the E-Worksheet are easy to understand.	42	48	87%	Very Practical
10.	Images on the E-Worksheet can be observed clearly and well.	46	48	95%	Very Practical
Amount		**451**	**480**		
Average Overall Percentage				**93%**	**Very Practical**

Table 8. Teacher Perception Test Results (Implementation)

No.	Learning Activities	Amount Score Per Step	Max Score	%	Category
1.	Activity 1 (Let's Find Out!)	22	24	91%	Very Practical
2.	Activity 2 (Let's Observe!)	24	24	100%	Very Practical
3.	Activity 3 (Understand Again!)	23	24	90%	Very Practical
4.	Activity 4 (Time to Explore!)	12	12	100%	Very Practical
5.	Activity 5 (Time to get to work!)	23	24	95%	Very Practical
6.	Activity 6 (Test Time!)	81	84	96%	Very Practical
Amount		**185**	**192**		
Average Overall Percentage				**96%**	**Very Practical**

Table 9. Student Response Results

No.	Statement	Total Score per Statement	Max Score	%	Category
1.	I feel comfortable using the computer.	44	48	91%	Very Practical
2.	I am very skilled at using basic computers.	43	48	89%	Very Practical
3.	Internet access skills that I have enough to do web-based learning.	40	48	83%	Practical
4.	I feel comfortable learning through computers in online learning.	40	48	83%	Practical
5.	I feel comfortable communicating and sharing information with friends and teachers online.	46	48	95%	Very Practical
6.	I can search and access information from a variety of sources.	44	48	91%	Very Practical
7.	I can develop my problem-solving skills.	43	48	89%	Very Practical
8.	Guided inquiry-based learning can	46	48	95%	Very Practical

	practice my communication skills.				
9.	I can share my ideas clearly in the group during the discussion.	44	48	91%	Very Practical
10.	I can listen to my group members' different perspectives and points of view and keep an open mind to their views.	46	48	95%	Very Practical
11.	I do my fair share of work in my group.	46	48	95%	Very Practical
12.	I can learn new things during troubleshooting.	44	48	91%	Very Practical
13.	I am actively involved in learning activities with group members.	47	48	97%	Very Practical
14.	I'm more interested in using simple materials to make simple physics props.	48	48	100 %	Very Practical
15.	I am more interested in relating phenomena in everyday life to the concepts of physics.	42	48	87%	Very Practical
16.	Guided inquiry-based learning using E-Worksheet affects my communication skills.	44	48	91%	Very Practical
17.	Guided inquiry-based learning using E-Worksheet is suitable to be implemented on uniformly changing straight motion material.	45	48	93%	Very Practical
	Amount	**752**	**816**		
	Average Overall Percentage			**92%**	**Very Practical**

Table 10. Practical Results of E-Worksheet

No.	Rated aspect	Percentage	Category
1.	Legibility	93%	Very Practical
2.	Teacher's perception (exercise)	96%	Very Practical
3.	Student response	92%	Very Practical
Average		**93.6%**	**Very Practical**

Based on the practicality results, which consist of 3 aspects, namely readability 93%, teacher perception (implementation) 96%, and student response 92%, with an overall average percentage of 93.6% with a very practical category. This shows that the product developed is very practical.

After that, the student's communication skills were assessed. Students' communication skills are assessed based on small group test assessments conducted by students during and after working on the e-worksheet. The communication skill stimulus was assessed using a self-assessment questionnaire, teacher assessment questionnaire, and peer assessment questionnaire.

Table 11. Communication Skills Test Results

No.	Communication Skills	%	Category
1.	Self-assessment	82%	Very stimulated
2.	Teacher Assessment – Oral	87%	Very stimulated
3.	Teacher Rating - Write	87%	Very stimulated
4.	Peer Rating	76%	Stimulated
Average percentage		**83%**	**Very stimulated**

The processing of students' communication skills showed that the overall average percentage was 83%, categorized as highly stimulated. This shows that the product developed can stimulate the communication skills of students.

Next is the implementation stage. Small group test assessment activities are carried out at the implementation stage. The results of the small group test can be seen in Table 11. The results of the small group test show the assessment of communication skills with an average overall percentage of 83%, categorized as highly stimulated; this shows that the developed product can stimulate students' communication skills. This is in line with Sarah & Rani's [28] research which states that learning media in the form of student worksheets through online learning activities can effectively build student character, one of which is communication skills.

The last stage is evaluation. This evaluation stage is carried out at each stage of the development procedure, namely at the analysis, design, and development stages. Evaluation at the analysis stage adds a statement aspect to the needs analysis questionnaire. Evaluation at the design stage should use authentic and easy-to-understand library sources for students and an easy-to-use and interactive platform so that e-worksheets become interesting and effective learning media to use. Evaluation at the development stage is the e-worksheet validation test. In the validation test, improvements to the e-worksheet were made based on suggestions for improvement from the validator.

Based on the teacher's perception test results, it was stated that the e-worksheet developed was good and could be used in online and offline learning. Through evaluations and improvements made at each stage, this research produces an inquiry-based learning sequence-based e-worksheet with a STEM approach for online learning through the Google Classroom platform to stimulate valid and practical communication skills for use in online and offline learning.

Based on the research results obtained, the validity of e-worksheets as multimedia-based teaching materials, both in terms of material and constructs as well as media and design shown in Table 6, received an average of 3.77 in the very valid category. Material validity indicates that the developed e-Worksheet has clear essential competencies, core competencies, and learning indicators that are interrelated and follow the revised 2013 curriculum. The material presented is by KD, thus giving meaning to the KD formulated [29]. Learning activities with the stages of the IBL model contain activities that encourage student activity because they are directed to find the characteristics of straight motion with constant acceleration and the physical meaning of the phenomenon presented as a video of a man riding a motorcycle. Students are directed to observe the speedometer from the motor speed to identify the existing quantities and their causes. This allows students to solve problems and provides interaction between students according to the characteristics of learning Physics [30] [31] [32].

Furthermore, the media's and design's validity is reviewed on the cover and content. The cover section of the e-worksheet has a centre of view, a balance between the composition of the layout elements and the layout of the content, the size of the cover layout elements, the alignment of the cover design, the harmony of design and colour, and a good combination of fonts. The illustrations presented on the e-worksheet can describe the material and have proportional representatives following reality in terms of shape, size, and colour. Furthermore, the contents, the placement of the title, and the layout elements are consistent, the print area and margins are proportional, and the suitability of the layout elements' shape, color, and size are suitable. It has aspects of page numbers, illustrations, and descriptions of images, uses a combination of fonts, letters ornamental/decorative, and a good variety of letters. This positively impacts students' interest in learning because the presentation of learning material is not only in the form of text but consists of many media, including images, animations, and videos [33] [34].

The results of other studies show that the practicality of e-worksheets based on IBL sequences is 93.6%, which is in the very practice category, as shown in Table 10, so that it can be used in high school physics learning, class X odd semester, subject to Alternating Straight Motion. This practicality criterion is obtained because the IBL sequence-based e-Worksheet with the STEM approach can

increase student involvement in inquiry and self-discovery. Students can be actively involved in learning through a project in the form of a simple experimental tool like a Rubber Band Dragster Car. This inquiry-based learning activity encourages them to communicate actively with classmates and teachers [35]. Communication skills are developed in this e-worksheet when students are challenged to explore the concepts of uniformly changing rectilinear motion. In this process, they will learn to communicate ideas, share findings, and discuss experimental results with classmates and teachers. This helps students develop practical oral and written communication skills [36] [37] [38] [39]. In addition, this e-worksheet allows students to collaborate or work in groups to carry out each activity. This collaboration will enable students to communicate, share ideas, and better understand the studied topic. Through interactions with classmates, students will learn to listen, respect the opinions of others, and build strong arguments. This will improve students' interpersonal communication skills [40] [41] [42].

Furthermore, the use of technology in the IBL sequence-based e-Worksheet, namely in the form of a simple experimental tool (Rubber Band Dragster Car) which uses a DC-Motor, the use of the Internet to find information related to the Rubber Band Dragster Car, the use of a computer to make tables/graphs/diagrams of results observations and reports on the manufacture of the Rubber Band Dragster Car, as well as utilizing the tracker application. This technology will enrich students' learning experience and facilitate more effective communication [43] [44].

Finally, learning with the IBL sequence-based e-Wprksheet with the STEM approach involves students presenting the results of the experiments that have been carried out and making reports on the results of the experiments. This process encourages students to communicate clearly and organize as they present their findings and conclusions. In this process, students will learn to organize information logically, present their ideas effectively, and present compelling arguments [45] [46].

CONCLUSION AND SUGGESTION

Based on the results of data analysis, it can be concluded that; 1) an e-Worksheet based on an IBL Sequence with a valid STEM approach to stimulate students' communication skills in bold learning through the Google Classroom platform, which contains stages of IBL learning with a STEM approach containing activities that stimulate indicators of students' communication skills; and 2) Practicality of the IBL Sequence-based e-Worksheet with the STEM approach to stimulate students' communication skills in daring learning through the Google Classroom platform which is categorized as very practical, so that it can be used in high school Physics learning, class X odd semester, materials for Changing Straight Motion Order.

Based on the conclusions and development research that has been completed, the researcher suggests being able to use e-worksheets based on inquiry-based learning (IBL) sequences with the STEM approach in learning, especially on the topic of uniformly changing rectilinear motion because it is equipped with attractive features and is connected to the Internet so that it can become one of the teaching materials that can stimulate students' communication skills.

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REFERENCES

[1] Anggraeni, D. M., & Sole, F. B. (2018). E-learning moodle, media pembelajaran fisika abad 21. *Jurnal Penelitian Dan Pengkajian Ilmu Pendidikan: E-Saintika*, *1*(2), 57-65.

[2] Rahmatullah, A. S., Mulyasa, E., Syahrani, S., Pongpalilu, F., & Putri, R. E. (2022). Digital era 4.0: The contribution to education and student psychology. *Linguistics and Culture Review*, *6*(S3), 89-107.

[3] Tejedor, S., Cervi, L., Pérez-Escoda, A., & Jumbo, F. T. (2020). Digital literacy and higher education during COVID-19 lockdown: Spain, Italy, and Ecuador. *Publications*, *8*(4), 48.

[4] Dakhi, O., JAMA, J., & IRFAN, D. (2020). Blended learning: a 21st century learning model at college. *International Journal Of Multi Science*, *1*(08), 50-65.

[5] Erdoğan, V. (2019). Integrating 4C skills of 21st century into 4 language skills in EFL classes. *International Journal of Education and Research*, *7*(11), 113-124.

[6] Bialik, M., Fadel, C., Trilling, B., Nilsson, P., & Groff, J. (2015). Skills for the 21st century: What should students learn. *Center for Curriculum Redesign*, *3*(4), 29.

[7] Erdoğan, V. (2019). Integrating 4C skills of 21st century into 4 language skills in EFL classes. *International Journal of Education and Research*, *7*(11), 113-124.

[8] Limna, P., Siripipatthanakul, S., Phayaphrom, B., & Siripipattanakul, S. (2022). The relationship between twenty-first-century learning model (4Cs), student satisfaction and student performance-effectiveness. *International Journal of Behavioral Analytics*, *2*(1), 1-18.

[9] Majid, M., Habib, S., Javed, A. R., Rizwan, M., Srivastava, G., Gadekallu, T. R., & Lin, J. C. W. (2022). Applications of wireless sensor networks and internet of things frameworks in the industry revolution 4.0: A systematic literature review. *Sensors*, *22*(6), 2087.

[10] Limna, P., Siripipatthanakul, S., Phayaphrom, B., & Siripipattanakul, S. (2022). The relationship between twenty-first-century learning model (4Cs), student satisfaction and student performance-effectiveness. *International Journal of Behavioral Analytics*, *2*(1), 1-18.

[11] Razeeth, M. S. S., Kariapper, R. K. A. R., Pirapuraj, P., Nafrees, A. C. M., Rishan, U. M., & Nusrath Ali, S. (2019). E-learning at home vs traditional learning among higher education students: a survey based analysis.

[12] Falfushynska, H. I., Buyak, B. B., Tereshchuk, H. V., Torbin, G. M., & Kasianchuk, M. M. (2021, March). Strengthening of e-learning at the leading Ukrainian pedagogical universities in the time of COVID-19 pandemic. In *CTE Workshop Proceedings* (Vol. 8, pp. 261-273).

[13] Subedi, S., Nayaju, S., Subedi, S., Shah, S. K., & Shah, J. M. (2020). Impact of E-learning during COVID-19 pandemic among nursing students and teachers of Nepal. *International Journal of Science and Healthcare Research*, *5*(3), 68-76.

[14] Abdurrahman, A., Ariyani, F., & Nurulsari, N. (2019). Designing an Inquiry-based STEM Learning strategy as a Powerful Alternative Solution to Enhance Students' 21st-century Skills: A Preliminary Research. In *Journal of Physics: Conference Series* (Vol. 1155, No. 1). IOP Publishing.

[15] Taufiq, M., Muntamah, S., & Parmin, P. (2020, March). Remediation of misconception on straight line motion concept using guided inquiry model assisted by student worksheet based on science technology engineering and mathematics (STEM) on junior high school students. In *Journal of Physics: Conference Series* (Vol. 1521, No. 4, p. 042039). IOP Publishing.

[16] Sutrisno, A. D. (2019). Survey pemahaman konsep dan identifikasi miskonsepsi siswa SMA pada materi kinematika gerak. *WaPFi (Wahana Pendidikan Fisika)*, *4*(1), 106-112.

[17] Ibrohim, I., Sutopo, S., Muntholib, M., Prihatnawati, Y., & Mufidah, I. A. (2020, April). Implementation of inquiry-based learning (IBL) to improve students' understanding of nature of science (NOS). In *AIP Conference Proceedings* (Vol. 2215, No. 1). AIP Publishing.

[18] Hastuti, P. W., Setianingsih, W., & Widodo, E. (2019, November). Integrating inquiry based learning and Ethnoscience to enhance students' scientific skills and science literacy. In *Journal of Physics: Conference Series* (Vol. 1387, No. 1, p. 012059). IOP Publishing.

[19] Wenning, C. J., & Vieyra, R. E. (2020). Levels of Inquiry Model for Physics Teaching. In *Teaching High School Physics: The Nature of Physics Teaching* (pp. 7-1). Melville, New York: AIP Publishing LLC.

[20] Wenning, C. J. (2011). The levels of inquiry model of science teaching. *Journal of Physics*

Teacher Education Online, *6*(2), 9-16.
[21] Irwansyah, F. S., Lubab, I., Farida, I., & Ramdhani, M. A. (2017, September). Designing interactive electronic module in chemistry lessons. In *Journal of Physics: Conference Series* (Vol. 895, No. 1, p. 012009). IOP Publishing.
[22] Hastuti, P. W., Setianingsih, W., & Widodo, E. (2019, November). Integrating inquiry based learning and Ethnoscience to enhance students' scientific skills and science literacy. In *Journal of Physics: Conference Series* (Vol. 1387, No. 1, p. 012059). IOP Publishing.
[23] Ware, K., Tiring, S. S. N., & Dei, F. B. (2022). Pengembangan LKS Berbasis Project Based Learning Pada Materi Elektrolit dan Non Elektrolit Kelas X SMA. *JURNAL EDUSCIENCE*, *9*(3), 673-687.
[24] Ernawati, T., & Sujatmika, S. (2018). Pengembangan LKS berbasis project based learning untuk meningkatkan keterampilan proses sains siswa SMP. *JIPVA (Jurnal Pendidikan IPA Veteran)*, *2*(2), 149-161.
[25] Yulkifli, Y., Jaafar, R., & Resnita, L. (2020). Developing Student Worksheets Using Inquiry-based Learning Model with Scientific Approach to Improve Tenth Grade Students Physics Competence. *Jurnal Penelitian Fisika dan Aplikasinya (JPFA)*, *10*(1), 56-70.
[26] Suyatna, A. (2019, February). Future physics learning materials based on STEM education: Analysis of teachers and students perceptions. In *Journal of Physics: Conference Series* (Vol. 1155, No. 1, p. 012021). IOP Publishing.
[27] Branch, R. M. (2009). *Instructional design: The ADDIE approach* (Vol. 722). New York: Springer.
[28] Sarah, I., & Rani, S. (2020, April). Effectiveness of student worksheets on environmental project-based e-learning model in building student character. In *Journal of Physics: Conference Series* (Vol. 1521, No. 3, p. 032005). IOP Publishing.
[29] Fahrurrozi, M. (2020). *Pengembangan perangkat pembelajaran: tinjauan teoretis dan praktik* (Vol. 1). Universitas Hamzanwadi Press.
[30] Calmer, J. M. (2019). Teaching physics within a next generation science standards perspective. *Pedagogical Research*, *4*(4), em0041.
[31] Furtak, E. M., & Penuel, W. R. (2019). Coming to terms: Addressing the persistence of "hands-on" and other reform terminology in the era of science as practice. *Science education*, *103*(1), 167-186.
[32] Geller, B. D., Turpen, C., & Crouch, C. H. (2018). Sources of student engagement in Introductory Physics for Life Sciences. *Physical Review Physics Education Research*, *14*(1), 010118.
[33] Collins, J., Hammond, M., & Wellington, J. (2002). *Teaching and learning with multimedia*. Routledge.
[34] Mayer, R. E. (1999). Research-based principles for the design of instructional messages: The case of multimedia explanations. *Document design*, *1*(1), 7-19.
[35] Zalloum, S. N. (2018). The Impact of Using Inquiry-Based Learning on Developing Ninth Grade Students' Pragmatic Awareness (A Case Study).
[36] Sari, D. S., Widiyawati, Y., Nurwahidah, I., Masykuri, M., & Budiyanto, C. W. (2021, March). The Development of E-Worksheet Based on Project to Promote Student's Creative Thinking and Digital Literacy Skills. In *7th International Conference on Research, Implementation, and Education of Mathematics and Sciences (ICRIEMS 2020)* (pp. 647-654). Atlantis Press.
[37] Erna, M., & Dewi, C. A. (2021). The Development of E-Worksheet Using Kvisoft Flipbook Maker Software Based on Lesson Study to Improve Teacher's Critical Thinking Ability. *International Journal of Interactive Mobile Technologies*, *15*(1).
[38] Pratiwi, P., Hidayat, T., & Amprasto, A. (2022). Analysis of guided inquiry-based cladistic e-worksheet development to improve critical thinking in high school. *Jurnal Kependidikan: Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran*, *8*(3), 776-785.
[39] Mena Araya, A. E. (2020). Critical thinking for civic life in elementary education: Combining storytelling and thinking tools. *Revista Educación*, *44*(2), 24-45.
[40] Handayani, R. A. D., & Genisa, M. U. (2019). Empowering Physics Students' Performance in a Group Discussion through Two Types of Peer Assessment. *International Journal of Instruction*,

12(1), 655-668.
[41] Chung, Y., Yoo, J., Kim, S. W., Lee, H., & Zeidler, D. L. (2016). Enhancing Students'communication Skills In The Science Classroom Through Socioscientific Issues. *International Journal of Science and Mathematics Education*, *14*, 1-27.
[42] Henukh, A., & Astra, I. (2021, April). The use of Google classroom as ICT literacy to improve physics students collaboration skill in industrial revolution 4.0. In *AIP Conference Proceedings* (Vol. 2331, No. 1). AIP Publishing.
[43] Wijaya, R. E., Mustaji, M., & Sugiharto, H. (2021). Development of Mobile Learning in Learning Media to Improve Digital Literacy and Student Learning Outcomes in Physics Subjects: Systematic Literature Review. *Budapest International Research and Critics Institute (BIRCI-Journal): Humanities and Social Sciences*, *4*(2), 3087-3098.
[44] Yu, M. (2022). Technology-Enhanced Education: Improving Students' Learning Experience in the Higher Education Context. *The Wiley Handbook of Sustainability in Higher Education Learning and Teaching*, 133-151.
[45] Polhun, K., Kramarenko, T., Maloivan, M., & Tomilina, A. (2021, March). Shift from blended learning to distance one during the lockdown period using Moodle: test control of students' academic achievement and analysis of its results. In *Journal of physics: Conference series* (Vol. 1840, No. 1, p. 012053). IOP Publishing.
[46] Maknun, J. (2020). Implementation of Guided Inquiry Learning Model to Improve Understanding Physics Concepts and Critical Thinking Skill of Vocational High School Students. *International Education Studies*, *13*(6), 117-130.