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The Development of Student Worksheet Based on STEM Integrated Blended Learning to Improve Student's Science Argumentation Skills in the Covid-19 Pandemic Era

Mohd Zaidi Bin Amiruddin[1], Eka Putri Dian Nata Sari[1], Wadhifah Qiyyamul Lailli Arrafi'[1], M.Samsul Ma'arif[2], and Setyo Admoko[1*]
[1]Study Program of Physics Education, Faculty of Mathematics and Nature Science
Universitas Negeri Surabaya, Surabaya, Indonesia
[2]Departemen of Physics, Faculty of Mathematics and Nature Science
Universitas Negeri Surabaya, Surabaya, Indonesia
Setyoadmoko@unesa.ac.id

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Abstract

The year 2020, until now, is a year that changes all aspects of life. The spread of Covid-19 causes changes in the order in various fields ranging from health to education. The impact of the Covid-19has made students study online using existing devices. This situation needs to be addressed with the development of learning models that follow these conditions. This study aimed to determine the validity, practicality, and effectiveness of STEM-based Blended learning worksheets developed to improve students' scientific argumentation skills. This research uses the ADDIE development model (Analysis, design, develop, implement, and evaluate), which begins with analyzing needs, making student worksheet designs, developing, conducting validation tests, conducting usage tests, and managing data. Data collection uses pretest and posttest instruments consisting of 10 multiple choice questions and five essay questions. Then it was done with the student worksheet Ohm's Law practicum. Data is analyzed using validity tests, paired T-tests to test effectiveness, and questionnaires to test practicality. This research indicates that the student worksheet that was developed was validated with the content feasibility aspect obtained is very valid criteria, the linguistic aspect obtained is very valid criteria, the presentation aspect obtained is very valid criteria, and the graphic aspect obtained is very valid criteria. The results of the practicality of the student worksheet in terms of the results of the student response questionnaires and obtained with very practical criteria. Then, the results of the effectiveness of the student worksheet in terms of the pretest and posttest treatment obtained an average N-Gain value was included in the medium category. Lastly, the student worksheet is feasible and ready to be used as teaching material. In the future, it is hoped that further research related to learning scientific argumentation to train students' argumentation skills in line with technological developments.

Keywords: Blended Learning; Covid-19 Pandemic; Physics; Student's Scientific Arguments; Student Worksheet

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INTRODUCTION

2020 is a year that will significantly change all aspects of people's lives, both in Indonesia and the world. The spread of Coronavirus Disease, or what we usually call Covid-19, has caused changes in the order in various fields ranging from health to education (Amiruddin, 2022). According to Purnama (2020), the difference is felt significantly at the kindergarten and college levels. For more than a year, the learning process has changed from face-to-face learning to distance learning by relying on internet technology. There are still many problems in the implementation of the learning process.

Problems that arise with distance learning can be complex because these problems can be present in teachers, students, and parents. The problem of learning for teachers is to find a way of learning that is not monotonous and boring. The problem for students is that the signal quality is different, so it can interfere with the learning process (Simamora, 2020). In addition, the use of more quotas than usual is also a learning challenge. Next is the problem of parents, as it is known that not all can assist students in the online learning process (Novianti & Garzia, 2020). This happens because there are parents who work, do much homework, and cannot guide and teach at home fully.

Online learning only increases insight and knowledge, so it still requires actual offline learning activities if you want to increase skills and attitudes (Pangondian et al., 2019; Visvizi & Daniela, 2019). According to Rahayu & Nuryata (2010), blended learning is a method that combines offline learning with online learning. Bawaneh (2011); Beers et al. (2009) stated that Blended Learning can improve student performance. Blended learning that combines offline and online methods allows for active feedback from students (Ardianti et al., 2019). Especially in the era of Covid-19, which forces students to study from home. However, there are several options related to learning which will be done in Hybrid. This is following the statement from the Mendikbud-Ristek that there is an offline learning plan, but it only applies in some areas according to the conditions of the spread of Covid-19.

Thus, learning will change slightly related to the systematics carried out when learning occurs but still with the 2013 curriculum. According to Admoko et al. (2021), the learning process in the 2013 curriculum is learning that includes the development of skills needed in the 21st century. Learning in the 21st century today does not only demand 4C skills (collaboration, communication, creative thinking, and critical thinking) but also must be able to master compassion and computation. For this reason, the capabilities required are no longer 4C but become 6C (Kemendikbud, 2020). Students are said to be able to think critically if, in each learning activity, they can analyze, understand, and evaluate arguments (Erdoğan, 2019). However, students' argumentation skills are decreasing due to the Covid-19 pandemic. Therefore, one solution is to develop a student worksheet adapted to current conditions.

Scientific arguments play a role in building students' knowledge based on their beliefs and reasons (Enduran, 2008). Scientific arguments in science have characteristics, especially in the relationship between statements (claims), evidence and considerations (justification). "Statement" is a descriptive statement that answers the research problem. "Evidence" results

from measurements and observations in research collected, analyzed, and interpreted (Kreps & Kriner, 2020). The argument component is ultimately obtained from a statement that explains a phenomenon accompanied by relevant supporting evidence and based on the underlying concept or assumption. A good scientific argument must meet empirical, theoretical, and analytical criteria (Probosari et al., 2016).

In line with Trianto (2014), Fachri (2020), and Syaiful et al. (2018) say that a learning media that can support teaching and learning activities between teachers and students is the student worksheet. Using student worksheets in line with the STEM integrated blended learning model to improve scientific arguments can produce a pleasant learning atmosphere (Lestari et al., 2018). This is because physics subjects are considered a "scourge" for students. The right Student Worksheet is expected to achieve the desired goals (Ariani & Meutiawati, 2020).

The fundamental difference from the student worksheets developed in this research is that the learning model is based on blended learning, integrated with STEM to improve students' scientific argumentation skills. Based on the description above, this research aims to (1) determine the validity of the STEM-based blended learning worksheet, which was developed to improve students' scientific argumentation skills; (2) Knowing the practicality of student's worksheet based on STEM integrated blended learning which was developed to improve students' science argumentation skills; and (3) Knowing the effectiveness of STEM-based blended learning worksheets to improve students' science argumentation skills.

METHOD

This research uses R&D (research and development) using the ADDIE development method (Analysis, design, develop, implement, evaluate) (Sugiyono, 2019; Sutarti & Irawan, 2017). This method was chosen because it follows the purpose of the study, namely to develop a Student Worksheet for class XII Mathematics and Natural Science MAN Competence (KD) 3.1 and 4.1 by applying blended learning that is integrated into STEM. The research design was selected using the one group pretest-posttest. The pretest will be conducted at the beginning lesson, while the posttest will be conducted at the end of the lesson. In addition, this research will also use a questionnaire method to get student responses about blended learning. The sampling technique in this study is a purposive sampling technique. The sample used in this study was class XII Mathematics and Natural Science 2 at MAN Sidoarjo.

This research uses several research instruments: student worksheet instruments' validity, practicality, and effectiveness. The research instrument was used to analyze the data obtained. Student Worksheet is declared valid when it reaches a minimum validity criterion 61. Validity score criteria can be seen in Table 1.

Table 1 Interpretation Criteria of Validity Score

Range (%)	Category
0-20	Invalid
21-40	Less valid
41-60	Fairly valid
61-80	Valid
81-100	Very valid

(Riduwan, 2015)

In the practicality of the student worksheet in terms of the results of the questionnaire using a Likert scale with four answer choices, namely Strongly Agree (SA), Agree (A), Disagree (D), and Low Disagree (LD). Student's worksheet is declared practical if it meets the minimum practical criteria,

namely 61. Practicality score criteria can be seen in Table 2.

Table 2 Interpretation Criteria Score Practical

Range of scores (%)	Category
0-20	Impractical
21-40	Less practical
41-60	Fairly
61-80	Practical
81-100	Very practical

(Riduwan, 2015)

The effectiveness of student worksheets in terms of increasing or not scientific argumentation skills student. Analysis of the effectiveness of student worksheets obtained from the pretest and posttest. Then the N-gain test and paired T-test were carried out to calculate the increase obtained. The effectiveness score criteria can be seen in Table 3.

Table 3 Interpretation Criteria N-gain

Score Gain score (%)	Category
g < 0.3	Low
0.3 g < 0.7	Medium
g 0.7	High

RESULT AND DISCUSSION

This research was conducted in class XII Mathematics And Natural Science at MAN Sidoarjo. In addition, this study uses one class as an experimental class and applies blended learning to improve students' scientific argumentation skills. This learning model was chosen based on current conditions, making it impossible for everyone to socialize due to movement restrictions due to the Covid-19pandemic. According to Misbah et al. (2018) student worksheets can be an alternative to learning in an emergency condition. This pandemic has limited all activities, including learning, at this time. In this research, researchers chose Dynamic Electricity to improve students' scientific argumentation skills. This material was chosen because many students still do not understand the concept of the material in detail. A survey conducted on the physics teachers in Man Sidoarjo suggest doing this material. So, the researchers prepared a research design for the Dynamic Electricity material.

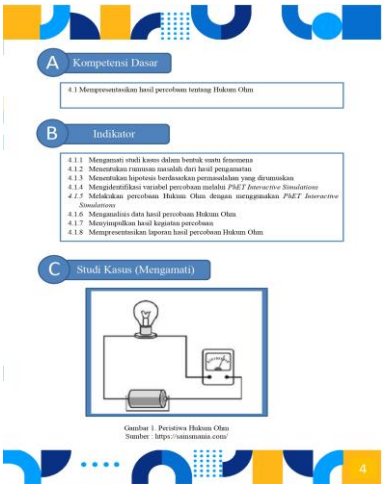
The blended learning model is used because it follows technological developments that force society, especially students in the 21st century, to master technology. If students or the public do not need a master's / do not understand technology, then they will be left behind in the development of the era of globalization. Learning with the Blended Learning is applied by giving pretest questions to students. Material as online and offline practical implementation offline using the PhET Simulation. After that, students are given a student worksheet provided by the researcher to be filled in based on the results of the practicum that the students have done. The results of the student worksheet filled out by students are then communicated to other students online at the presentation stage. After being given the treatment, students were given a posttest. The student worksheet that students have filled out will be assessed using the skills assessment rubric.

This research is unique from previous studies. This is because the researchers integrated Blended Learning with STEM to train students' scientific argumentation skills in this study. Banggur et al. (2018) revealed that blended learning is a combination of learning development between the face-to-face learning system and learning does not face to face. According to Beers et al. (2009) the STEM curriculum contains four skills, namely collaboration (collaboration), creativity (creativity), six critical thinking (critical thinking) and communication (communication). The four skills are called 21st-century skills. This STEM-integrated learning model is carried out because today's learning requires innovations that can make students not

bored to keep the spirit of learning. In addition, it is also necessary to choose a learning model to be adapted to current developments. STEM is a learning model that is very suitable for science-based students. This follows the researcher's sample, namely the students of class XII Mathematics and Natural Science Man Sidoarjo.

Before making student worksheet development. Researchers conduct many scientific studies, and other scientific sources that align with the research carried out. That way, innovations emerge that make student worksheets more attractive in physics learning, especially in Dynamic Electricity materials. The following is the cover of the developed student worksheets:

(a)



(b)

Figure1 (a) Design cover of student worksheet and (b) One of content for learning

Student Worksheet Validity

Analysis of student worksheet validity (Student Worksheet) was carried out to obtain a valid student worksheet. This validation was carried out by two expert lecturers of the Physics Education Study Program, Faculty of Mathematics and Natural Sciences, State University of Surabaya. Validation data is obtained by providing a validation sheet that includes aspects of the feasibility of content, language, presentation, and graphics with 22 questions. The validator sees and corrects the student worksheet that has been developed and then provides suggestions and comments as development guidelines in making revisions. After that, the results of the revised student worksheet are submitted back to the lecturers and then provided validation results.

The validity of the student worksheet, which two expert lecturers had validated, got results in content feasibility and got an average value of 84.50% with very valid criteria. The average score is 92.50%, with very valid criteria in the linguistic aspect. In the aspect of serving, it gets an average value of 95.83% with very valid criteria. The average value is 93.75%, with very valid criteria in the visual aspect. The average result of the overall validity of the student worksheet obtained a value of 91.65% with very valid criteria. In comparison, the remaining 8.35% was used to improve the student worksheet following the suggestions given by the validator. These criteria are based on the rubric of internal validity assessment, according to Sugiyono (2019). Several things must be improved, including Student Worksheet sheets using contrasting text and background colours; in practicum learning, it is better to use practical tools in real laboratories and

preferably in student worksheets with a sub-chapter of practice questions after the conclusion. Based on the data obtained, it can be concluded that the development of the student worksheet developed is very valid for dynamic electrical materials and can be used in physics learning.

The effectiveness of the Student Worksheet

It is not only given to the validator to determine the effectiveness of the student worksheet that the researchers have made. It also needs a response from students related to the student worksheet that has been made. The researcher gave three treatments to find out, namely pretest test, treatment, and posttest test. At the initial stage, the researcher gave a pretest about Dynamic Electricity. The data in this study is quantitative, which is then analyzed using statistical analysis. Table 4 shows the initial sample data obtained.

Table 4 Initial Data Sample of Students' Science Argumentation Skills

No	Name	Pretest Score
1	AL	44
2	AR	30
3	AE	30
4	AR	31
5	AKA	28
6	ANP	15
7	AKP	19
8	JDW	38
9	K	15
10	MA	15
Total		265
Average		26,5
Highest Score		44
Lowest Score		15

Table 4 shows that the average science argumentation skills of class XII Mathematics And Natural Science 2 MAN Sidoarjo students before treatment were still relatively low, with an average pretest score of 26,5. Data analysis to determine the effectiveness of student worksheets using the N-gain test and paired t-test. The data used to determine the effectiveness of this student worksheet comes from initial data, as in Table 4, and final data, namely data taken after the treatment is given. Table 5 shows the final data on the students' scientific argumentation skills obtained.

Table 5 Final Data Sample of Students' Science Argumentation Skills

No	Name	Pretest Score
1	AL	77
2	AR	74
3	AE	74
4	AR	75
5	AKA	69
6	ANP	63
7	PPA	66
8	JDW	76
9	K	62
10	MA	60
Total		696
Average		69,6
Highest Score		77
Lowest Score		60

Table 5 shows that the average scientific argumentation skills of class XII Mathematics and Natural Science 2 MAN Sidoarjo students have increased with an average posttest value of 69,6. The increase was influenced by the STEM integrated blended learning model on students' science argumentation skills, and it can be calculated using the paired t-test. The paired t-test was used to determine the effect of the treatment given to the sample on the students' scientific argumentation skills. The paired t-test used was paired t-test to test the difference in the mean of two variables for a single sample group that received treatment. The hypotheses taken are:

a. H_0: There is no effect of blended learning on students' science argumentation skills.
b. H_a: There is an effect of blended learning on students' science argumentation skills.

T-test analysis was performed with the help of Microsoft Excel, T-test

analysis was performed with the help of Microsoft Excel so that the standard deviation (SD) was 4.63, the t-count was 29.52, and the t-table was 1.83. Decision-making means that if t-count t-table, then H0 is rejected and Ha is accepted, whereas if t-count t-table, then H0 is accepted, and Ha is rejected. Based on Microsoft Excel calculations, the t-count value is 29.52; based on the statistical table, and the t-table value is 1.83. Because the value of the t-count is greater than the t-table (29.52>1.83), then H0 is rejected, or Ha is accepted, it can be seen that there is an effect of the blended learning on students' scientific argumentation skills.

The influence of the STEM integrated blended learning model on students' scientific argumentation skills can be determined by calculating the initial data and the final sample data using the normalized gain (N-gain) test. Table 6. shows the results of the N-gain test calculation with the help of Microsoft Excel. Table 6 shows that students' science argumentation skills increased after being given the treatment. Based on table 6, the N-gain value is 0.56 in the medium category. Thus, blended learning can improve students' scientific argumentation skills.

Table 6 N-Gain Test

No	Name	Value		Ngain
		Pretest Value	Value Posttest	
1	AL	44	77	0.59
2	AR	30	74	0.63
3	AE	30	74	0.63
4	AR	31	75	0.64
5	AKA	28	69	0.57
6	ANP	15	63	0.56
7	PPA	19	66	0.58
8	JDW	38	76	0.61
9	K	15	62	0.55
10	MA	15	60	0.53
Average N-gain				0.56

The Practicality of Student worksheets

One hope is the higher the ability of one's mathematical argument, the better the ability to give reasons for a solution or answer (Soekisno, 2015). The practicality of student worksheets can be known by providing response questionnaires distributed using google forms to students. The response questionnaire contains 15 questions regarding whether the development of student worksheets with blended learning can motivate learning activities, improve material understanding, make it easier to connect material in daily activities, and can solve scientific problems on dynamic electricity material. The results of the student worksheet practicality questionnaire are presented in Table 7.

Table 7 Practicality Results of Student Worksheet

Questions	Percentage Analysis	Category
1	80%	Practical
2	85%	Very Practical
3	67.5%	Practical
4	85%	Very Practical
5	85%	Very Practical
6	80%	Practical
7	85%	Very Practical
8	82.5%	Very Practical
9	80%	Practical
10	80%	Practical
11	82.5%	Very Practical
12	85%	Very Practical
13	87.5%	Very Practical
14	85%	Very Practical
15	85%	Very Practical
Average	82.3%	Very Practical

This student worksheet practicality calculation model is carried out per question by calculating the total score on each question and then dividing by the product of the number of respondents and the maximum score. Based on table 8. about the results of the practicality of the student worksheet, it can be seen that from the questions, ten questions state that the student worksheet is "very practical", then there are five questions that state that the Student Worksheet is "practical". Table 7 shows that the average value obtained for the practicality of the student worksheet is 82.3%, with the category: very practical. Based on Table 7, it can be concluded that the development of STEM-based blended learning worksheets is very practical in improving students' scientific argumentation skills.

CONCLUSION

Based on the research that has been done, it can be concluded that the student worksheet based on Blended Learning that was developed was validated with the content feasibility aspect obtained an average of 84.50% with very valid criteria, linguistic aspect obtained 92.50% with very valid criteria, presentation aspect obtained 95.83% with very valid criteria. The graphic aspect obtained 93.75% with very valid criteria. Student Worksheet based on Blended Learning in terms of pretest and posttest treatment, the average N-Gain value is 0.58 and is in the medium category. Student Worksheet based on Blended Learning in terms of the results of the student response questionnaire and obtained an average score of 82.33% with very practical criteria. Based on the results of the N-gain of 0.58 with a medium category, the student worksheet that has been made can improve students' scientific argumentation skills on dynamic electricity material. The limitation of this study is that it only focuses on dynamic fluid material by developing student worksheets to determine students' scientific argumentation skills.

There are several implications for the future. (1) For researchers, it can be the basis for further research in scientific argumentation, especially to train students' argumentation skills. (2) For librarians, it can be a source of new research and knowledge related to developing students' learning using the developed worksheets to know students' scientific argumentation skills. (3) To policymakers, it can provide sources of information related to the efforts of students and lecturers in developing student worksheets to improve the quality of students in high school

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