Design of Student Worksheet to Accommodate Learning Style and Initial Knowledge and Reduce The Differences of Scientific Reasoning and Argumentation Performance

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ABSTRACT

This study aims to design student worksheets with STEM approaches that accommodate student's learning styles and initial knowledge so that it has the potential to reduce differences in scientific reasoning and student argumentation performance on wind energy and water energy materials. The development model refers to the stage of the ADDIE model: Analyze, Design, Develop, and Implementation. The stages of development reported in this article are only the analysis and design stages. Needs analysis data obtained through questionnaire distribution, interviews, and document reviews sourced from high school students and teachers in Lampung. Data were analyzed using descriptive qualitative analysis. The results of this study are teachers and students need student worksheet designs that have the potential to reduce differences in scientific reasoning and student argumentation performance. Student worksheet designs have the potential to reduce differences in scientific reasoning and argumentation performance on wind and water energy materials that are developed using the PjBl (Project Based Learning) steps and integrated of STEM (Science, Technology, Engineering, and Mathematics) to facilitate students doing problem-solving activities, gathering information, preparing project plans, making projects, and communicating. The results of the suitability of the activities in the student worksheets with the STEM approach obtained an average value of 4.3 and the effectiveness of the student worksheets with an average score of 4.3. Based on the results of the assessment, it shows that all components are assessed to get a score of 4.20-4.5, so the design of this student worksheet is declared very appropriate and can be used to accommodate learning styles and initial knowledge and reduce differences in scientific reasoning and argumentation performance.

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CCS CONCEPTS

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KEYWORDS

Student Worksheet, Scientific Reasoning, Argumentation Performance, Learning Style, Initial Knowledge, Wind Energy, and Water Energy.

1. Introduction

Learning in the 21st century requires a variety of skills that must be mastered by students, so it is hoped that physics teachers today can prepare students to master a variety of skills. Important skills in the 21st century are still relevant to the four pillars of life which include *learning to know,* that is knowing mastery of the material*, learning to do,* that is, students must learn to work*, learning to be,* that students who have the fundamental cognitive competence are qualified individuals and identity, and *learning to live together* is learning together will provide opportunities for students to be actively involved in discussions, constantly monitoring their learning strategies and achievements and becoming critical thinkers [1]. In this 21st century students are required to have learning abilities and to master science and technology.

In fact, in the learning process, not all students master the four competencies allegedly caused by learning styles [2]. Each individual has a different learning style [3]. Research results obtained [4] that learning styles that are often used are visual, auditory, and kinesthetic. The results showed that physics learning activities cannot facilitate the concepts of physics. This has the effect of the level of scientific reasoning of students in schools is still low. students' ability to provide answers and reasons for solving problems is still weak [5]. Scientific reasoning is the ability to use scientific concepts and assist students in understanding the science being studied, scientific reasoning is the main key in the success of the learning process [6], [7]. The next cause is the difference in students' initial knowledge [8]. Student initial knowledge is the ability that students have before they take part in learning. It is useful to know whether the students have the prerequisite knowledge *(prerequisite)*to follow the learning and the extent to which students have learned the material to be

presented so that teachers can design better learning [9]. Students 'initial knowledge influences the quality of scientific reasoning [10] and student argumentation performance [11], The arguments that are known to students so far are only limited to refuting opinions which are still not accompanied by strong evidence to support them. The argumentation skills possessed by students are one of the abilities that can be used in understanding the learning process. Learning by building student arguments will make it more active and make the learning process take place interactively between students and teachers [12], Scientists use argumentation skills to develop and support scientific conclusions in social science issues, but argumentation skills become weak if students only discuss socio-scientific issues [13], so teachers need to design student worksheets that can accommodate students' learning styles and initial knowledge.

Based on preliminary research conducted by researchers in high schools located in Lampung Province through Google Form, 100% of teachers have used student worksheets in learning physics, but 60% of student worksheets used by teachers are considered to be unpleasant and make students inactive in learning. As many as 55% of teachers teaching physics have not used a model that suits students' learning styles, so the student worksheets that are used do not accommodate learning styles and initial knowledge and reduce scientific reasoning, and student argumentation performance. Even though students' learning styles are very different, 40% of students understand better when learning accompanied by pictures and videos, 50% of students better understand when learning is accompanied by experimental activities, and 10% of students understand if learning is explained verbally by the teacher. As many as 40% of students still feel that learning in school cannot reduce the differences in their scientific reasoning and their argumentative performance. Then 60% of students who have not been able to answer the teacher's initial questions as a stimulus in learning and 40% of students have not been able to identify and construct hypotheses in observation, and 40% of students also have not dared to express their own opinions or refute the answers of other students when the answers are given are not according to theory. So, most students are not actively learning in learning physics. Thus, students' worksheets must be able to reduce differences in scientific reasoning and student argumentation performance.

The problem currently faced is also the relatively low ability of physics teachers to design student worksheets that reduce differences in scientific reasoning and student argumentation performance, so the teacher's task should be to design student worksheets to stimulate 21st-century competence, namely 4C on learning to the achievement of competence through a variety of appropriate student learning experiences. Student worksheets are guidelines that students use for learning activities carried out in class [14]. Student worksheets contain the steps or actions needed to be taken by students to maximize understanding to form important skills that are appropriate for learning in the 21st century and maximize the achievement of learning outcomes. One that supports the required student worksheets, the teacher must prepare a learning model and approach that can achieve the desired learning goals. One learning model that can support this student worksheet is project-based. The *Project-Based Learning* model is one of the learning models that are relevant for implementing the 2013 curriculum and can deal effectively with problems in the classroom [15]. Learning using this model makes students accustomed to discovering their concepts of physics through a given project by constructing knowledge in students [16]. A suitable approach for this student worksheet is *STEM* (*Science, Technology, Engineering, and Mathematics*) with the PjBL-*STEM* combined with student worksheets, students are not only cognitive but also affective and psychomotor charged, so that there is a mix between attitude, intelligence, and skills [17]. The approach is *STEM* also able to improve the mastery of knowledge, apply knowledge to solve problems, and improve students' creative thinking abilities, so students can reason, think critically, and logically in solving problems in the real world [18]. This study aims to design student worksheets with a STEM approach that accommodates students' learning styles and prior knowledge so that it has the potential to reduce differences in scientific reasoning and *performance* student argumentation wind and water energy. Based on the description above, it can be seen that the urgency of this research is that it is very important to design-based student worksheets to accommodate differences in student learning styles, initial knowledge, and reduce differences in scientific reasoning and argumentation performance. on the material of wind energy and water energy because the characteristics of this material are suitable for learning with PjBL-STEM-based student worksheets.

2. Method

The research method uses development design *research and development* (R&D)using the ADDIE model which consists of five stages, namely: *analysis, design, development, implementation, and evaluation*. In this article, researchers only report the first two stages, namely the analysis and design of student worksheets. The analysis phase is carried out to analyze the needs of physics teachers and students as well as analyze the needs of student worksheets. The subjects in this study were 144 students and 20 physics teachers using Google Form to analyze the needs of students and teachers and determine the criteria for student worksheet design needed to accommodate learning styles and initial knowledge.

The data obtained were analyzed descriptively quantitatively using percentage techniques. The second step after conducting the analysis phase is product design. The results of the analysis are used as a reference in making student worksheet designs that aim to accommodate learning styles and initial knowledge and reduce differences in scientific reasoning and *student argumentation performance*. The student worksheet design was subsequently confirmed to suit the 20 physics teachers. The instrument used was a Likert scale questionnaire with five choices: (1) strongly disagree, (2) disagree, (3) quite agree, (4) agree, (5) Strongly agree. Students' worksheet designs are given in full in the form of a file as an attachment to the assessment instrument. Design

assessment instruments are provided in the form of Google. The results of the assessment of respondents were analyzed by calculating the average score obtained for each component of the student worksheet design, then converted to a qualitative statement according to Table 1.

Table 1. Score Conversion

Average Score	Decision
4,20- 5,00	Students Worksheets design is very suitable
3,40- 4,19	Students Worksheets design is appropriate
2,60- 3,39	Students Worksheets design is quite appropriate
1,80- 2,59	Students Worksheets design is not appropriate
1,00- 1,79	Students Worksheets design is not suitable

3. Result and Discussion

Preliminary research results based on needs analysis were obtained from the google form filled out by physics teachers and students can be seen in Table 2 and Table 3.

Table 2. Results of need analysis regarding Students Worksheets

No	Teacher's Statement	%
1	Physics teachers use student worksheets in physics learning	100
2	Student worksheets that Physics teachers use are fun and make students actively learn	94
3	Physics teachers use student worksheets that are relevant to a material	100
4	Physics teachers use student worksheets to invite students to actively investigate physics phenomena	81
5	Teachers Physics uses student worksheets to deliver physics material by utilizing technology that supports	100
6	Physics teachers use student worksheets to introduce technology	100
7	Physics teachers use student worksheets to guide investigating engineering techniques	77
8	Physics teachers use student worksheets to guide students to develop science literacy	100
9	Physics teachers use student worksheets to train students to make engineering engineering	81
10	Physics teachers use student worksheets to develop science process skills	100
11	Physics teachers use student worksheets to facilitate students designing observation steps related to a physics phenomenon	100
12	Physics teachers use student worksheets to facilitate students finding answers to observations related to physical phenomena	100
13	Physics teachers use student worksheets to facilitate experiencing the process of observing physical phenomena directly.	100
14	Physics teachers use student worksheets to allow students to evaluate their observations	100
15	Physics teachers use student worksheets to model problems and predictions through mathematics	94
16	Physics teachers use student worksheets to guide students formulate mathematical experimental results	100
17	Physics teachers use student worksheets to integrate science, technology, engineering, and mathematics in the learning process that makes it easier for students to understand physics concepts	94
18	Physics teachers teach physics with explanations with pictures, and videos	100
19	Physics teachers are accustomed to teaching physics by giving oral explanations	70
20	Physics teachers teach physics with experimental activities	100
21	Physics teachers teach physics using models that accommodate all student learning styles	81
22	All students with different learning styles can understand the concepts Physics Teachers convey	75
23	Physics teachers are accustomed to teaching ask students to study physics material before being taught at school	100
24	Physics teachers give questions before starting physics learning	94
25	Physics teachers can direct students to answer teacher questions	100
26	Explanations that Physics teachers convey can add to the information students have before the learning process	100
27	Physics teachers can direct students to understand the material taught	100
28	Physics teachers train students to analyze physics concepts and relationships between variables in a physical phenomenon	100
29	Physics teachers facilitate students to be able to identify relationships between physical phenomena	88
30	Physics teachers train students to form hypotheses	100
31	Teachers Physics trains students to conclude a physics concept by using various information	100
32	All students with different scientific skills can understand the concepts that the physics teacher teaches	81
33	Physics teachers allow students to make statements based on their name	100
34	Physics teacher trains students to present observational data in the form of numbers and words	100
35	Physics teachers can train students to express opinions about the relationships between variables in a phenomenon	94
36	Physics teachers provide opportunities for students to refute statements made by their friends	100

37	Physics teachers allow students to express their opinions about natural phenomena based on relevant theories	100
38	All students with *performances* different argumentation can understand the concepts that physics teachers teach	88

Table 3. Results of need analysis regarding Students Worksheets

No	Student's Statement	%
1	The teacher uses student worksheets in physics learning	98
2	Student worksheets are fun and make me active learning	40
3	Teachers use student worksheets that are relevant to the material	98
4	Teachers use Student worksheets to invite students to actively investigate physics phenomena	50
5	Teachers use student worksheets to deliver physics material by utilizing technology that supports	100
6	Teachers use student worksheets to introduce technology	97
7	Teachers use student worksheets to guide investigate engineering	60
8	Teachers use student worksheets to guide students to develop scientific literacy	70
9	Teachers use student worksheets to train students to make engineering	55
10	Teachers use student worksheets to develop science process skills	60
11	Teachers use student worksheets to facilitate citation students design steps of observation related to the phenomenon of physics	60
12	Teachers use student worksheets to facilitate students find answers to observations related to physics phenomena	65
13	Teachers use student worksheets to facilitate experiencing the process of observing physical phenomena directly.	70
14	Teachers use student worksheets to allow students to evaluate observations	80
15	Teachers use student worksheets to model problems and predictions through mathematics	86
16	Teachers use student worksheets to guide students formulate experimental results mathematically	89
17	Teachers use student worksheets to integrate science, technology, engineering, and mathematics in the learning process that makes it easier for me to understand the concepts of physics	70
18	I have a visual learning style, which is easier to understand the material when explanations are accompanied by pictures and videos	60
19	I have an auditory learning style, which is easier to understand the material taught when listening to the teacher's explanation or learning by listening to music	69
20	I have a kinesthetic learning style, which is easier to understand the material through experimental activities	50
21	Teachers teach physics using models that fit the style learn me	45
22	I can understand the material presented by the teacher, with the learning style that I have	60
23	I am accustomed to studying physics material before being taught at school	48
24	teacher gives questions before starting physics learning	54
25	I can answer the teacher's question	40
26	Explanations delivered by the teacher can add to the information I have before the learning process	70
27	I can understand the material taught by the teacher like other students	50
28	I can analyze the physical concepts of a phenomenon	45
29	I can identify the relationship between physical phenomena	60
30	I can construct hypotheses	55
31	I can conclude a physics concept using various information	65
32	Based on the skills I have, I can understand the material delivered by the teacher	60
33	I can present questions based on observations	65
34	I can present observational data in the form numbers and words	70
35	I can deliver a contention about the relationship between variables in a phenomenon	60
36	I am used to refuting statements made by friends	59
37	I am used to expressing opinions about natural phenomena, about how or why a phenomenon can occur	60
38	I can understand the material taught by the teacher based on the ability and skills that I have	67

Based on table 2 shows that 100% of teachers already use student worksheets in physics learning, 100% of teachers already think the worksheets of students provided can accommodate students' learning styles and initial knowledge and reduce differences in scientific reasoning and student argumentation performance, but based on table 3 that 60% of the student worksheets that the teacher uses are considered to be unpleasant and make students inactive in learning even though 100% of teachers have used student worksheets that are relevant to the material. 100% of teachers have also used technology to teach physics, although 70% of teachers still teach using verbal even though technology such as LCD has been used even without pictures and videos. As many as 55% of teachers teaching physics have not used a model that suits students' learning styles, so the student worksheets that are used do not accommodate learning styles and initial knowledge and reduce scientific reasoning, and *student argumentation performance*. Even though students' learning styles are very different, 40% of students understand better when learning accompanied by pictures and videos, 50% of students better understand when learning is accompanied by experimental activities, and 10% of students understand if learning is explained

verbally by the teacher. As many as 40% of students still feel that learning in school cannot reduce the differences in their scientific reasoning and their argumentative performance. Then 60% of students who have not been able to answer the teacher's initial questions as a stimulus in learning and 40% of students have not been able to identify and construct hypotheses in observation, and 40% of students also have not dared to express their own opinions or refute the answers of other students when the answers are given are not according to theory. So, most students are not actively learning in learning physics. This is also following the results of research by [5], that learning physics activity cannot facilitate the concept of physics because students are not active in learning. This has an impact on the level of student scientific reasoning in schools that is still low. The aspect of scientific reasoning with correlational reasoning does not have a relationship category, so the ability of students to provide answers and reasons to solve problems is still weak. This is also supported by research [12] that the overall argumentation skills provided by students, obtained for skills are *rebuttal* still in the poor category. This is because there are still many students who have not mastered the concepts of physics in the material they are studying. After all, in making a *rebuttal the* things needed include a strong mastery of concepts so that students can provide alternative answers. Based on research by [19] that students tend to focus on empowering *claims* without empowering all elements of argumentation skills, this has an impact on students' weak understanding of the concept of floating and immersed material. Ideally, the empowerment of argumentation skills as a whole has an impact on expanding students' conceptual understanding. The results of the study become a reference in making improvements in subsequent research to obtain positive changes by empowering argumentation skills which directly improve students' conceptual understanding for the better. Thus, student worksheets must accommodate learning styles and initial knowledge and reduce differences in scientific reasoning and argumentation performance.

The student worksheet design developed contains the following PjBL-STEM syntax:

Reflection: it contains stimulus activities and reflects material that has been previously obtained with what will be studied. The teacher gives a question *ill-defining* about examples of renewable and non-renewable energy in everyday life.

Research: it includes observing activities and classifying energy. Students gather the information that supports the research to be made. The teacher provides science learning, chooses readings, or other methods to gather relevant information sources. Students look for relevant information sources and the teacher leads students to find relevant concepts.

Discovery: students conduct virtual experiments and students discuss project assignments to be made regarding simple energy devices for wind and water.

Application: Students work on project assignments with a group of friends based on the design they made.

Communication: Students communicate between friends and the class scope of the product that has been designed through a presentation in front of the class.

Each step of learning and activities in the student worksheet contains the STEM approach and in it accommodates student learning styles such as visual, auditory, and kinesthetic. Accommodate the initial knowledge of different students. So that the student worksheet has the potential to reduce differences in scientific reasoning and student argumentation performance.

Assessment of student worksheet designs is carried out on the suitability of student worksheets, the design of learning activities, the suitability of existing STEM components in learning activities, the feasibility, and effectiveness of student worksheet designs with Pjbl-STEM to accommodate learning styles and initial knowledge and reduce differences in scientific reasoning and argumentation performance. The results of the assessment of the student worksheet design are presented in Table 4.

Table 4. Results of the assessment of student worksheet design

No	Students Worksheets Design	Score
1	Conformity Student worksheet	
	Activities in students worksheets are developed by the syntax of *Project-Based Learning* (PjBL)	4,35
	The images presented are by the context of the material and facilitate student learning styles, namely visual	4,3
2	Teaching and Learning Activities	
	Stimulation activities are undertaken to have the potential to accommodate students who have low initial knowledge of	4,2
	Observation activities facilitate students who have a visual learning style of	4,45
	Classification activities can educate students' scientific reasoning in the form of conservation reasoning	4,25
	Classification activities can train students in making initial statements *(claim)*	4,5
	Discussion activities can educate students' scientific reasoning in the form of proportional reasoning, probabilistic reasoning, and deductive hypothesis	4,2
	Discussion activities can train students in reinforcing statements that have been disclosed (*claims*) based on information obtained	4,3
	Experimental activities can accommodate students who have kinesthetic learning styles	4,3
	Through experimental activities, able to train students in collecting data	4,5
	Experimental activities can train students in	4,3

	determining experiment variables	
	Presentation activities can accommodate students with auditory and visual learning styles	4,45
	Presentation activities can educate students' skills in delivering objections to something different from what they understand	4,35
3	STEM Approach	
	The various learning activities compiled have contained STEM components *(science, technology, engineering, mathematic)*	4,3
4	Effectiveness of Student Worksheets	
	The range of activities that have been designed has the potential to accommodate students' learning styles and initial knowledge	4,2
	The variety of learning activities that are designed can reduce differences in scientific reasoning and *performance* student argumentation	4,35

Based on the results of the assessment of student worksheet designs in Table 4 shows that the suitability of student worksheets is by the syntax of the PBL learning model with an average value of 4,35. Teaching and learning activities of students which include stimulus activities, observation, classification, discussion, virtual experiments, and making simple tools, as well as presentations with an average value of 4,35. The results of the suitability of the activities in the student worksheets with the STEM approach obtained an average value of 4,3 and the effectiveness of student worksheets with an average value of 4,3. Based on the results of the assessment showed all components assessed scored at 4,20-4,5. Concerning Table 1, the student worksheet design is declared to be very appropriate and can be used to accommodate learning styles and initial knowledge and reduce differences in scientific reasoning and argumentation performance. This is relevant to the research that has been conducted by [20] that student worksheets are very feasible to use because they have received a very positive response from students and physics teachers, so students will be active in learning and student worksheets can reduce differences learning styles and scientific reasoning among students. Based on the results of the design assessment, a student worksheet design chart is created as shown in Figure 1.

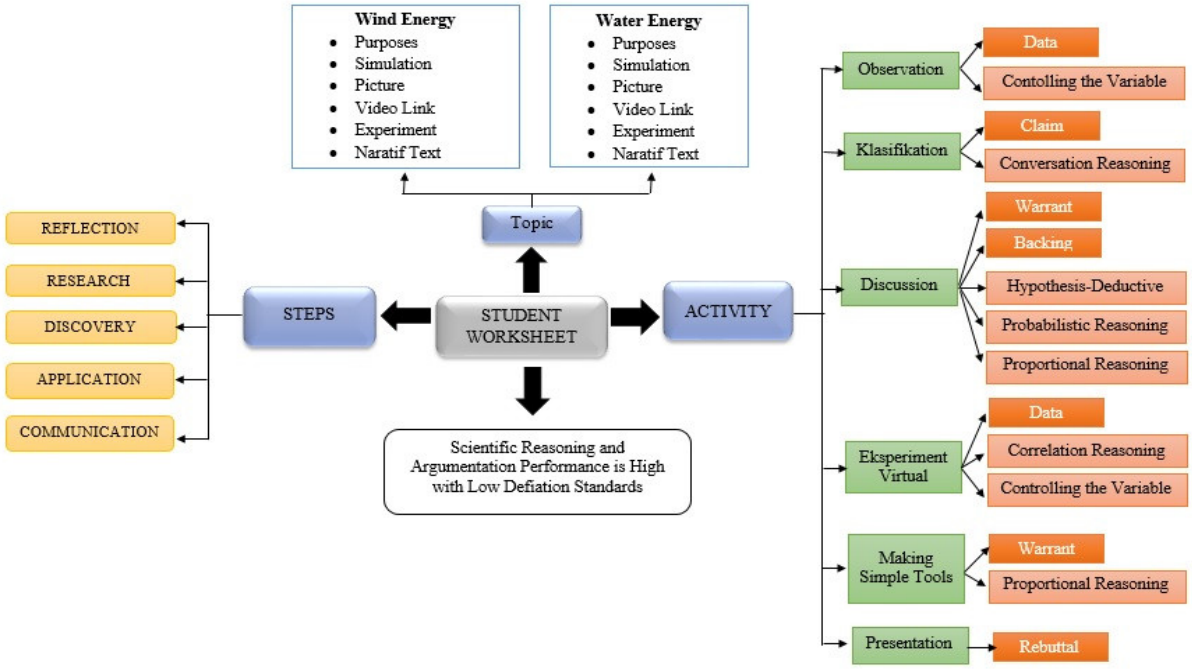

Figure 1. Student Worksheet Design Chart

The student worksheet design in Figure 1 was designed by containing several learning activities with PjBL syntax and using the STEM approach. The PjBl syntax includes reflection, research, discovery, application, communication. Learning activities have undertaken aim to accommodate learning styles and initial knowledge so that with the use of these student worksheets, it is expected that there are no differences in scientific reasoning and *argumentation performance* between students, all students have scientific reasoning and *performance* the same high argumentation even though they have a style Different learning and initial knowledge.

4. Conclusion

Physics learning, in general, has used student worksheets, but the learning process is assessed by students not to accommodate learning styles and initial knowledge, so the student worksheets provided by the teacher have not been able to reduce differences in scientific reasoning and argumentation performance among students, including due to the unavailability of learning resources which is designed to accommodate students' learning styles and initial knowledge. Therefore, respondents agreed to need student worksheets designed to accommodate learning styles and initial knowledge, and reduce differences in scientific reasoning and argumentation performance on wind energy and water energy.

Design student worksheets that have the potential to reduce differences in scientific reasoning and student argumentation performance on wind energy and water energy with learning steps, namely reflection, research, discovery, application, and communication. In each learning activity on the student, the worksheet contains all the STEM components. Learning activities in student worksheets include stimuli, observing examples of energy in daily life, classifying renewable and non-renewable energy, discussion of simple experiments, virtual experiments, making simple devices for wind energy and water energy, and presentation of the results of discussions and trial. Learning with this design will make students active in learning, so that the design of this student worksheet will accommodate learning styles and initial knowledge, and can reduce differences in scientific reasoning and performance of student arguments on wind energy and water energy, so there is no difference scientific reasoning and argumentation performance among students.

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