Learn the measurement of unit length and style relations with motion accompanied by worksheets

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Abstract. This study aims to produce the design principles of Student Worksheets for material measuring length and the relationship of style to motion presented in STEM-based learning with an Outdoor atmosphere traditional game. The method used in this study is Design-Based Research (DBR). Results this study is a worksheet for length measurement material and the relationship between style and motion presented in STEM-based learning with outdoor atmosphere that was developed to fulfil aspects of validity, practicality, and effectiveness when used in the learning process in the current curriculum in Indonesia. Validated product design by two competent experts. After being revised based on the results of expert validation, the product was tested on fourth-grade elementary school students. The results of this study have implications for active, effective and efficient learning. But the results are meaningful for students guided by student worksheets in understanding the material measurement of length units and the relationship between force and motion presented in STEM-based learning.

1. Introduction
Mathematics is a teaching material for thinking, reasoning, is needed in everyday life to develop science and technology [1]. Science, technology, and mathematics are interrelated. Producing science-based technology products, generally always bridged by mathematics [2]. The main objective, kraft began teaching science at a basic level in the first grade of primary school in Science and Technology Program, and the material structure is described with an example [3]. Students must be introduced to science as an interesting subject because it can help understand the world and themselves [4]. That way a generation that will love science and technology will be formed. When learning science by doing adventures in the surrounding environment with careful observation, the results are recorded in the Observation Worksheet, aimed at developing a research culture since elementary school which in turn will form a generation of researchers who like science and technology [5]. Schools with a strong emphasis on STEM education often integrate science, technology, engineering, and mathematics into the entire curriculum [6]. STEM is designed to enhance scientific and mathematical talent and foster talent in students who might be scientists and engineers working on a global scale [7].

However, in understanding the concepts of mathematics and science there are still difficulties in learning. From the results of the related research, it was found that learning difficulties in measurement material and style relations with motion. In general, learning about Measurements is done directly on formal stage [8-10]. Learning about Measurements focuses mainly on the use of rulers as a form of procedure that instructors use. One result of this approach is that students do not understand the concept
of measurement and they will tend to take measurements as well as forms of instrumental procedures. The lack of understanding of the measurement concept is one of the causes of students’ inability to measure the length of objects or objects that are not placed in the position "0" in the ruler [9-11]. Measurement learning for elementary school students should start with a meaningful measure activity [8]. This shows how important it is the use of experience-based activities that contain the basic concepts of measurement. In science learning, a misconception is found that style always requires muscle strength [12].

Understanding the concept will be more meaningful by implementing the concept in everyday life. The implementation of STEM-based learning helps to increase the length of the student's memory. After students understand the concepts, students engineered to produce technology of mathematics and science concepts they’ve learned. In implementing the engineering process and concept discovery, students are assisted with worksheets that will guide them.

This article will describe more clearly the worksheets that guide students in understanding the material measurement of length units and the relationship between force and motion presented in the STEM-based learning process.

2. Method
This research is a qualitative research with design-based research (DBR) method by Revees [13].

![Diagram: Steps of design based research](image)

**Figure 1.** Steps of design based research.

The study was conducted in two elementary schools in Indonesia that implemented a curriculum that currently applies in Indonesia and has a place to carry out outdoor learning such as fields, parks, and others.

The subjects of the research data were 5 teachers and 20 fourth grade students consisting of 14 female students and 6 male students.

The data collection technique is done by interview, observation, documentation study, and questionnaire techniques. Interviews were conducted for 5 teachers and 4 fourth grade students in elementary schools in Indonesia. Observations were made when looking at the process of implementing learning (trial). Documentation studies are carried out on the documents that the teacher has related with material measuring unit length and the relation of force to motion. Documentation studies were also carried out in analyzing student worksheets to find out students' achievements in understanding material measurement of length units and the relationship of style to motion with the guideline of student worksheets. Questionnaires were conducted on the subject of data sources, namely 5 teachers and 20 students.

Data analysis included data collection, data reduction, data display, conclusion: drawing / verification [14].
3. Result and discussion

3.1. Analysis of problem
The problem analysis was carried out by studying documentation and interviewing fourth-grade teachers in five Indonesian elementary schools. The researcher got some data including:

3.1.1. Lack of student understanding in using standard unit measurement tools. The lack of understanding of the measurement concept is one of the causes of students' inability to measure the length of objects or objects that are not placed in the position "0" in the ruler [9-11].

3.1.2. Measurement material does not start with meaningful measuring activities. Understanding the measurement is started with the material meaningful measure [8]. This proves that measurement activities are very important in experience-based activities or trying directly and related to everyday life.

3.1.3. Misconception about the relationship of style and motion. Students' understanding of style is the pull/drive that always requires muscles [12]. Not all of these forces require muscle strength, for example, free fall motion caused by gravitational force, magnetic repulsion. The relationship of force and motion is fourfold, namely: the force causes the moving object to be stationary, the force causes the stationary object to move, the force causes the object to change shape and the force causes the object to change direction.

3.2. Solution by developing design principles
The design principle of student worksheets is made in the following formats: intervention, context, characteristics, procedures and arguments [15].

The solution to the problem of this research is that learning is accompanied by student worksheets. The main components in the Student Worksheet are the title of the experiment, a short theory of the material to be studied, tools and materials, experimental procedures, observation data and questions, and conclusions for discussion material [16]. In designing student worksheets, the learning flow is adjusted to the stages in implementing STEM learning in elementary schools [17], that is:

- Ask (define the problem and identify constraints);
- Imagine (brainstorm ideas and choose the best one);
- Plan (draw a diagram and collect materials);
- Create (follow the plan and test it);
- Improve (discuss possible improvements and repeat steps 1-5).

3.2.1. Lack of student understanding in using standard unit measurement tools. In the worksheet, there are steps for students to use a standard unit of measurement, namely a ruler and a meter. Students are introduced to songs related to the conversion of unit length measurements. After recognizing the sequence of conversion measurements of unit length, students are introduced to a standard unit of measurement such as tape meters, rulers and others. To provide knowledge on how to use a measuring instrument, a small wooden stick measuring 5 cm is presented. Also presented are 10 pieces of stick each 1 cm long. Then the sticks are arranged side by side with the log, after which count a lot of stick arranged. There are 5 sticks arranged, meaning the length of the stick is 5 cm. After that, use a ruler to measure the 5 sticks. To put the last stick on the number 5, then the position of the initial stick is at point 0.

3.2.2. Measurement material does not start with meaningful measuring activities. Meaningful learning is learning that brings students to experience interacting directly with the environment. In the material measurement of length units using a standard unit of measurement can be done with students measuring objects that are in the environment around students, for example in the class can by measuring tables, blackboards, notebooks, pencils, and others. Because the implementation of learning is carried out in an
outdoor atmosphere, then what is measured by students includes student notebooks, pencils, plants in pots, school fences, doors to classes, stairs, fields, pole net and others.

3.2.3. Misconception about the relationship of style and motion. Justifying the related misconceptions experienced by students about style is the pull / impulse that requires muscles by providing evidence to students to try to bring two bar magnets closer together. When a magnet that is pulling or rejecting refuses, students do not need to exert muscle power to make the magnet pull or reject it.

To prove the relationship between style and motion, students perform traditional games with concepts of style and motion. Traditional games are carried out in the field because learning is carried out in an outdoor atmosphere. Outdoor education develops knowledge about the environment (Head), skills with going out in the environment (Hands) which in turn creates the caring attitude needed for the environment (Heart) [18,19]. Activities outside the classroom can be in the form of games, stories, sports, experiments [20]. Serious games are suitable for mediating knowledge and through games, a child experiences directly, so learning is more permanent, safe and realistic [21,22].

- Style can cause moving objects to be silent when the top is rotating, then touched until the speed becomes slow and finally stops.
- Style can cause stationary objects to move when playing soccer, a student kicks the ball towards the goal, then the goalkeeper is captured.
- Styles can cause objects to change direction when playing hard, the ball is thrown by a thrower towards the bat. Then the bat is hit by the bat. So the direction is changed.
- Style can cause objects to change shape when playing clay to make pottery. From the initial form that is messy, then it is formed by students to be the right flower, place to drink, place to eat, animal form and others.

3.2.4. Integration with STEM learning is guided by student worksheets. The learning process is carried out by teachers and students [23]. The discovery process where students are the main agents. When students are actively involved, they learn more than when they are recipients of passive instruction [24]. The scope of effective learning for students learning to be meaningful, permanent and efficient. Worksheets help improve efficiency in the learning environment, and also provide concepts for students [25]. The Student Worksheet contains a series of basic activities that must be carried out by students to form basic abilities in accordance with the indicators of learning achievement that must be achieved [26]. Some worksheets are designed as exploratory activities for students and others are intended as teaching demonstration of the concept [27].

Students that learn and in solve Problem students given guidance compilation do investigation with use worksheet [25,28,29]. Worksheet defined as tool important including steps from that process should do students, help set information students in a manner independent and type tool ingredients for Search [3,29].

In the process of carrying out searches, students make adventures in the surrounding environment with careful observation, the results are recorded in the Observation Worksheet[5]. After making observations to find concepts, then students make an engineering to produce technology from the results of understanding the concept of measuring the length and the relationship of force to move, namely a hydraulic bridge. In the process of making a hydraulic bridge, students are guided by student worksheets to the conclusion of the learning results.

4. Conclusion
Finally, we can draw the conclusion that students' understanding of the measurement of unit length and the relationship of force to motion can be preceded by simple things and the measurement begins with meaningful measuring activities. Activity based on experience or try to direct and relate to everyday life will be more meaningful. Proof and observation activities also provide and help simplify concepts that
are formed by students independently. In this case, students are assisted by a worksheet to help guide each step of the activity to be carried out.

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