

Student Worksheets Based on STEM Integrated Inquiry Based Learning: Needs Analysis

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Abstract: The research aimed to determine teaching materials that matched the characteristics of students to provide a stimulus to critical thinking skills to solve problems in learning science. In science learning, critical thinking is an important basic competency because it is a skill developed through an educational process that begins with analyzing classroom problems, analyzing curriculum, analyzing student characteristics, and analyzing natural science learning resources. The research conducted is descriptive qualitative. Researchers describe the data obtained related to the object to obtain conclusions. Researchers apply the interactive model put forward by Miles and Huberman including data reduction, data presentation, and drawing conclusions. The subjects of this study included class VIII students at SMPN 5 Padang. Data collection was carried out through interviews with teachers and student observation in order to obtain information related to student characteristics, learning models, and views on students' needs in teaching materials. The findings show that students and teachers need learning tools in the form of student worksheets teaching materials to stimulate critical thinking skills using the STEM integrated inquiry based learning model.

Keywords: Inquiry based learning; STEM; Student worksheets

Introduction

21st century learning is able to integrate technology, one of which is using learning media to develop various kinds of skills. Students need to understand the importance of using technology in their learning process. In addition, teaching and learning can improve inventive thinking, effective communication, high productivity, and spiritual skills (Rahayu et al., 2022). Indonesian society in facing the 21st Century must be able to balance the demands and challenges of the times so that life can develop, one of which is the development of education. Character education is one of the things that is needed to offset the challenges of the 21st Century, through learning in which 21st Century learning is characterized by the integration of students' literacy abilities, knowledge, skills, attitudes, and mastery of technology (Angga et al., 2022). The government is trying to develop the 2013 Curriculum to

increase the education quality in Indonesia. Implementation of the 2013 curriculum applies student-centered learning (Student Centered). Learning is a process of direction and guidance given to students in carrying out the learning programs (Nofianti et al., 2020). Critical thinking is an ability of someone to deal with problems in personal and social life. Critical thinking is explained by Facione (2011) as self-regulation when making decisions on something that results in analysis, interpretation, inference, evaluation and presentation using concepts, evidence, criteria, methodology or contextual considerations as a basis for making a decision. Bezanilla et al. (2019) suggests critical thinking is a complex process that requires high-level processing of cognitive information. Ennis (2011) further explains critical thinking as the ability to think reflectively and reasoning that has a focus on what is done or believed. Critical thinking skills include basic skills of clarification, concluding, basic decision making,

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estimation, providing further explanation, integration, and additional abilities.

From the researchers' observations during teaching practices at Padang 5 Public Middle School, the teacher did not direct students to think critically. Furthermore, the teacher's learning model used is not varied and monotonous. As for the use of teaching materials, namely student worksheets obtained from the Subject Teacher Conference. The existing student worksheets is still simple which only contains solving cognitive problems. Student worksheets are less attractive so they are not enthusiastic and do not understand the material being taught. The student worksheets used by the teacher has not linked science material with science, engineering technology and mathematics in everyday life. Student activities rely more on student worksheets which is always the same from year to year, so it will be difficult to measure the maximum competence of students per individual, especially if the questions in student worksheets are done at home for assignments at home. Student worksheets should be done when learning takes place so that the teacher can guide students. This is what makes it difficult for teachers to identify students who have critical thinking in solving problems. Students have never been invited to experience the learning process firsthand. Such a learning process causes students to depend on teachers or students who are smarter. Therefore, it is essential to develop the teaching materials that are combined with appropriate learning models and learning materials so that they can stimulate students' thinking abilities.

Contained in the student worksheet grid, namely titles, learning instructions, competency indexes, supporting information, work steps, and assessments. Student worksheets is better done by using the right learning model, the goal is that the teacher can carry out efficient learning and make students active in learning. (Nurjanah et al., 2022).

Based on the learning problems above, a solution is needed, namely the teacher innovates in learning. The innovation of student worksheets using Science, Technology, Engineering, and Mathematics (STEM) with an inquiry approach to learning science in junior high schools (SMP). Teaching materials are a collection of learning materials that are systematically arranged in accordance with the established curriculum guidelines, and also enable students to study (Salampessy & Suparrman, 2019). Science, Technology, Engineering, and Mathematics (STEM) is an approach that consists of various disciplines (Thibaut, et.al., 2018). Collaboration aims to collect, analyze, and solve problems that occur as well as the existence of a relationship between a problem and other problems (Nugroho et al., 2019).

This was reinforced by Firdaus et al. in 2018 which succeeded in proving that student worksheets, which refers to the inquiry model, has a fairly high influence on increasing the level of critical thinking skills of students (Mahanal, 2019). Also revealed the same results that critical thinking skills increase after applying inquiry learning. Another research conducted by Lestari et al. in 2018, showed that implementing student worksheets by incorporating STEM elements in it can foster students' critical thinking skills. Teaching materials sets are arranged systematically to assist teachers in learning activities and enable students to teach (Rahmadani et al., 2018). Therefore the available teaching materials must meet several of these components. Teaching materials in research are teaching materials that create interest and interest in learning in students using STEM Integrated Inquiry Based Learning Worksheets.

Student worksheets as a means of conveying a concept to students both individually and in small groups, including instructions for implementing several activities. Student worksheets is written simply by using sentences that are easy for students to understand. Student worksheets can be structured or independent to discover the concepts of learning materials for themselves, optimize the achievement of learning outcomes, improve students' skills and activities (Samudra et al., 2019). The benefits of Student Worksheets is to activate students in their learning, help develop process skills, as a guide for students and teachers in the learning process (Suryaningsih et. al., 2021). According to Silvia et al. (2020) the effectiveness of the teaching materials used can be increased through collaboration with the STEM approach. Science learning can also be carried out effectively by using learning models or methods. The learning model as a conceptual framework compiled with systematic procedures to organize learning experiences in realizing learning objectives (Ningsih et al., 2022). This is what makes STEM-based learning with the aim of preparing its citizens to have the multidimensional skills of knowledge and technology needed in modern life (Pimthong & Williams, 2020).

Inquiry Based Learning teaching materials are defined as developing teaching and learning processes in class and process skills by providing guidance to students in understanding their own concepts (Sarumaha et al., 2022). One learning model that can be used to involve students actively and in developing science process skills, building knowledge and experiences of students is to use the guided inquiry model. The guided inquiry model approach (Guided Inquiry) is a teacher approach which will guide students to carry out activities by asking questions to students and later will also lead to discussion. The teacher has an

active role in determining existing problems and also the stages of their completion (Parawansa et al., 2022). The use of IBL models can increase students' competence to think critically, creatively and innovatively. Inquiry learning allows students to find a new concept from the results of experiments carried out. In general, the inquiry method has several stages including problem formulation, designing an experiment, collecting, analyzing data and being able to make your own decisions.

The purpose of implementing the STEM approach to Mulyani (2019) is to be able to encourage students to design, develop and utilize technology, hone knowledge and attitudes, and apply their knowledge. STEM is expected to produce students used in developing competencies that are applied in various problems and situations in everyday life and face the challenges and demands of the times (Widayoko et al., 2018). STEM is an engineering design-based approach that deliberately integrates the content and processes of STEM disciplines and can expand the concept to be integrated with other school subjects to develop students' creativity through the process of solving problems (Mahjatia et al., 2021). The integration of STEM has a positive effect on the learning process, especially improving the learning outcomes of students in science and technology. Therefore, the STEM learning approach is very suitable to increase student learning outcomes. STEM education is very relevant to the development of 21st century skills (4C), namely communication, critical thinking, collaboration, and creativity (Hamdu et al., 2020). In addition, research (Abdurrahman et al., 2019) found that STEM-based inquiry can be a powerful alternative solution to achieve all the skills in the 21st century. Through inquiry learning, students are given the opportunity to have real and active learning experiences, students are trained to solve problems and make decisions about the problems they face (Jaya et al., 2022). Student worksheets using STEM the information obtained with everyday life. Because LKPD with this basis is specifically designed so that students can interpret learning well. However, in the process of learning activities in schools, especially in junior high schools, researchers found the fact that teachers had not used LKPD based on STEM.

Method

The focus of the research used describe the needs of STEM Integrated Inquiry Based Learning Science Worksheets to Stimulate Critical Thinking Ability. The researcher describes or provides an overview of the data obtained about the object so that the result is a conclusion. Qualitative data is used to gain research

focus, determine information that is the source of data, collect data, provide an assessment of data quality, analyze data and draw conclusions from the data.

When the research was conducted in October 2022. The research subjects were class VIII students and 2 science teachers. The research location was conducted at SMP Country 5 Padang. Data collection techniques using data collection instruments include observation and interview guidelines. Observation guidelines are used to limit the things to be observed so that they are in accordance with the initial purpose of carrying out the observation. The interview guide is used to interview teachers to gather information about critical thinking skills of students and learning models to stimulate students' and views about students' needs for science student worksheets.

The stages of development that researchers took in this development research can be explained using figure 1.

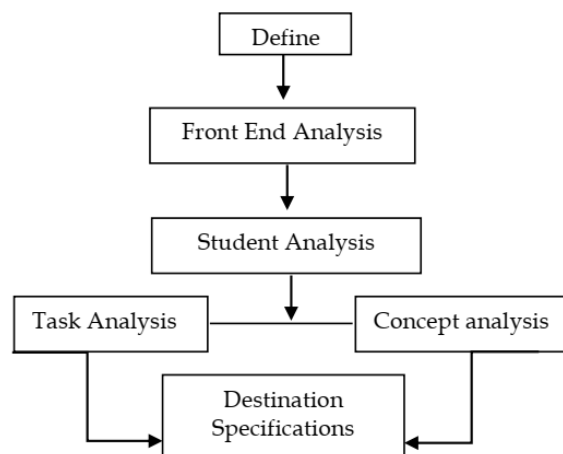


Figure 1. Modified define stage 4D development design flowchart

At the analysis stage, data collection was carried out with observation and interviews using the observation guidelines and interview guidelines that had been prepared. Activities carried out in the observation stage are observing learning activities, analyzing lesson plans, and learning resources used in learning. Meanwhile, at the interview stage with the science teacher to explore information about the curriculum, the characteristics of students, the need for learning resources, the learning models applied in schools, and related to critical thinking skills of students. The type of data generated is qualitative data related to the curriculum used in schools, the characteristics of students, learning resources, and problems that exist in the learning process. Data were analyzed using data reduction, presentation, and also conclusion (Miles et al., 1994). After that, the data is analyzed by the researcher to get the best solution to the existing constraints.

According to this type of research, the researcher used the Define stage in the 4-D model from Thiagarajan and Sammel (1974) in determining the initial phase. The initial phase is mostly analytical. The 5 stages of analysis in Define are as follows:

The first stage is front end analysis: Front end analysis is an analysis of the basic problems. At this stage, facts and alternatives are raised in the settlement, determine the initial steps related to development. Then the second stage is student analysis: Student analysis is carried out by observing the characteristics of students taking into account the student's experience, academic ability, age and motivation towards learning. Next is the third stage, namely task analysis: Task analysis consists of an analysis of Core Competencies (KI) and Basic Competencies (KD) related to learning materials. Then the fourth stage is Concept analysis: Concept Analysis is carried out to identify the main concepts that will later be used as a means of certain competencies by identifying and systematically compiling the main parts of learning. Finally, the fifth stage is determining objectives: Objective analysis is carried out to determine indicators of learning achievement.

Result and Discussion

This research aimed to determine teaching materials that match with student's to stimulate critical thinking skills with solving problems in the learning science. Starting with front end analysis, concept analysis, task analysis, student analysis, and determining students' goals in learning science.

The *first stage front end analysis*. This analysis aims to identify the problems encountered in the learning process. This stage is carried out by making observations namely; (1) Analysis of the curriculum used in science subjects at SMP Negeri 5 Padang, (2) Analysis of the teachers and students' problems in the learning process, (3) Analysis of learning resources.

Curriculum Analysis. This analysis aims to identify learning education plans for students because the curriculum is the content of learning objectives. The learning aims to get changes in the behavior of students after joining the learning process. According to the results of observations that researchers conducted with science subject teachers for class VIII SMP Negeri 5 Padang, it was found that the curriculum used was the 2013 curriculum.

In the interview the teacher said that "When viewed from the learning interaction and activeness of students in the 2013 Curriculum class it is much better than the previous curriculum." However, the 2013 Curriculum cannot be applied optimally in science learning in the classroom. One of the causes is the low critical thinking

skills of students. As a result, students are less able to solve problems related to the environment independently. So often science learning in the classroom is still teacher-centered.

Analysis of the Problems Faced by Teachers and Students. The use of teaching materials is only obtained from the subject teacher conference and textbooks from the government which can be borrowed from the school library. Then when the teacher teaches only using the discovery learning model which is still dominantly applied in class, sometimes using make a match. This can also be seen from the students in the class who are not enthusiastic and pay less attention to the teacher which makes them less understand the material. Students need teaching material that is easy to understand for learning.

Student activities rely more on student worksheets which is always the same from year to year, so it will be difficult to measure the maximum competence of students per individual, especially if the questions in student worksheets are done at home for assignments at home. Student worksheets should be done when learning takes place so that the teacher can guide students. This is what makes it difficult for teachers to know students with critical thinking skills in solving problems. Students have never been invited to experience the learning process firsthand. Such a learning process causes students to depend on teachers or students who are smarter. In the learning process the teacher is also constrained in developing teaching materials due to a lack of understanding of technology so that the teacher only presents learning media in the form of Microsoft PowerPoint (PPT). One of the innovations that plays an important role in increasing the competence of students is developing teaching materials that are combined with appropriate learning models and learning materials, thus they can stimulate the thinking skills of students.

Then, Learning Resource Analysis. Based on the results of observations made during teaching practice, the learning resources used during the learning process were Microsoft PowerPoint (PPT) as a summary of the material to be studied, school textbooks and Student Worksheets obtained from the MGMP IPA team throughout Padang city. However, learning resources have not facilitated critical thinking skills of students in solving science problems. Akhwani et al. (2021) argued that learning resources were the key to the success of the 2013 curriculum.

The material that the researchers raised in this study was business material and simple machines contained in KD of syllabus 3.3 Explaining business concepts, simple machines, and their application in Therefore, it is necessary to have teaching materials in

the form of learning tools in the form of lesson plans, worksheets and assessment instruments that can develop critical thinking skills of students in solving scientific problems using STEM Integrated Inquiry Based Learning.

According to Nurmayani (2018) learning using the inquiry model can stimulate students to think critically, activities in the inquiry step provide opportunities for students to make an observation which will provide experience in the learning process so as to enable students to be more critical. The application of STEM involves creativity, critical thinking, collaboration and communication (4C) (Astuti, 2018), so that students can find diverse and innovative solutions to real problems faced (Beers, 2011). STEM learning helps students to solve problems, and also draw conclusions based on previous learning. Problem solving solutions are obtained by applying the learning that has been obtained through STEM activities (Roberts et al., 2012).

Student Analysis. According to the observations during science learning in class VIII, most of the students had followed the lesson well. But there were also students who did not pay close attention and only a few students were active to answer the questions. When the teacher explains the material through Microsoft PowerPoint (PPT), and on the blackboard it can be seen that some students don't pay attention in the learning process, resulting in an understanding that is not understood by students because it only contains a few writings and pictures. The more information that is dug up does not make the child's mind more advanced. Analysis of student characteristics is used to find out how the student's characteristics in the science learning process in class.

Data on student characteristics were obtained through interviews and observation. The interview results in class VIII science teachers at SMP Negeri 5 Padang obtained information that students often experience difficulties in solving calculation questions if

there are no examples of the work. Students can understand the steps for solving math problems when they have been explained and given examples by the teacher. From the observations findings, the students prefer science questions that are similar to examples of questions by the teacher, students experience difficulties and do not seem interested in working on science questions in the form of calculations and theory of memorizing concepts that are not there are examples of solutions, and some students stop trying to work on new problems that don't have examples of solutions. The low student's critique is indicated by student's answers who are only fixated on the answers in the book so that students only memorize without interpreting the answers and students are less able to bring their own ideas that are new and different from usual. From the interviews and observations, it shows that critical thinking skills of student's are still low.

The finding from the interviews with the students obtained information that they wanted learning resources that were colorful, pictorial, with interesting reasons, not boring, easy to understand, cheap. Knowing this condition, student worksheets based on the STEM-integrated IBL model can help students learn independently. So are learning tools, one of which is student worksheets as an innovative independent learning resource for students.

Task Analysis. The material chosen by the researcher is Business and Simple Machines. Task analysis aims to determine the tasks of students. In observations during teaching practice the teacher gave student worksheets at the end of the lesson as homework, this caused students not to know the suitable strategy to solve the problems and could not find problems or know the problems presented. As a result, it causes students to not hone their critical thinking skills. The task analysis from the material and sub-materials are:

Table 1. Basic Competency (KD) and Competency Achievement Indicators (GPA)

Basic Competency (KD)	Competency Achievement Indicators (GPA)
3.3 Explain the concept of work, simple machines, and their application in everyday life including the work of muscles in the human skeletal structure	3.3.1 Explain the concept of work/business 3.3.2 Explain the types of simple machines 3.3.3 Understand the principle and application of pulleys 3.3.4 Understand the principle and application of wheels and axles 3.3.5 Describe the application of the working principle of simple machines to the human muscles and skeleton

Concept Analysis. The concept analysis is to increase the understanding of science learning concepts, especially business materials and simple machines, a method or model is needed so that it attracts students' interests and desires in learning so as to stimulate students' critical thinking skills. In providing

explanations and understanding in science learning, teachers should direct students to solve the problems in everyday life so they can stimulate students' thinking. To encourage thinking students must use appropriate learning models. The STEM Integrated Inquiry Based Learning Model is an appropriate model for learning

natural sciences, business materials and simple machines. The following table analyzes the concept of STEM learning.

Table 2. Analysis of STEM Learning Concepts

Science	Explain business materials and simple machines Explain the relationship between energy and work Explain the concepts of potential and kinetic energy in relation to work Explain the concept of power
Technology	Observing archery, rowing a boat, cutting Using the internet to get complete information about examples that apply the principle of a simple machine
Engineering	Observing how simple machines work in archery, rowing a boat, and cutting Make a tool design based on the principle of a simple plane to move large and heavy objects
Mathematics	Calculate the time required when using a simple machine Calculating mathematically the relationship between energy and work Calculating mathematically the relationship between energy and potential energy Calculating mathematically the relationship between energy and kinetic energy

Based on the results of some of the analyzes above, researchers want to provide solutions to solve the problems that have been described, namely developing tools in the form of lesson plans, worksheets, also critical thinking assessment instruments, learning that combines technology and engineering. Then the teaching materials that will be developed are learning tools, namely student worksheets teaching materials using the STEM-integrated IBL model. The advantages of STEM-integrated inquiry-based learning student worksheets are: First, it can train students to work scientifically and be critical, so that students have the opportunity to discover concepts in their own learning process and play a more active role in a learning process. Second, student worksheets is selected to facilitate and facilitate the learning process. LKPD can provide directions to students to find concepts and carry out experimental and non-experimental learning (Lusiana et al., 2021). This student worksheets was designed with the aim of stimulating critical thinking skills of students in solving science problems and combined with STEM Integrated IBL. student worksheets with the inquiry based learning model can help students to more easily find the concept of meaning through activities carried out alone or studying in groups which will make the learning process more meaningful (Latifah et al., 2016). This means that learning that is structured according to the observation step and involves all the senses, namely learning by seeing, observing directly and making observations will be easier for students to remember compared to just reading or taking notes. With learning using teaching materials equipped with STEM aspects, it will have a positive influence on students on their abilities because learning using these teaching materials focuses on learning for students to try to find solutions to problems that have many solutions (Phungsuk et al., 2017). This student worksheets has the motivation to

study and motivate the thinking skills of students and help students to try hard in solving problems given by the educator.

Conclusion

According to the results of the research, the conclusion are: First, the learning methods and teaching materials used do not stimulate students' thinking skills in solving problems; second, students' critical thinking skills in problem solving are still low; Third, teachers and students need science teaching materials in the form of Inquiry Based Learning Integrated STEM based LKPD to stimulate critical thinking skills in solving problems; Finally, teachers need teaching materials in the form of LKPD as an alternative solution to improve students' critical thinking skills in solving science problems.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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