Exploring teacher perception about STEM learning material to foster students understanding of dispersion concept

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Abstract. In the 21st century, the required human resources must be of high quality and possess high-level thinking skills, including critical, creative, innovative. Thus, the teacher's role is needed to develop these skills in preparing appropriate learning. The design of a learning plan must be able to accommodate the needs associated with the learning process in class. Activities undertaken as well as the results to be achieved through indicators of achievement must be fully reflected in the learning plans. This research was conducted to analyze teacher perceptions of STEM learning to improve understanding of diffraction concepts. The research method used qualitative methods. Data obtained from document analysis and in-depth interviews. This study involved 75 respondents/educators in physics who were scattered throughout the region in Lampung Province. The results showed the tendency of teachers to still use conventional learning methods. This was identified from the learning implementation plan and student worksheets compiled by the teacher had not developed learning innovations that can train students improving the understanding of concepts. So in future research, it is necessary to develop teaching materials that are integrated with STEM, so that they can improve students' conceptualization and skills..

1. Introduction

21st century education is oriented towards developing human potential, which not only focuses only on technical abilities in exploitation, but is oriented towards students' abilities. In the 21st century, students must have the ability to solve problems, think critically, find and evaluate information and be able to collaboratively collaborate and communicate. Achievement of these various skills becomes an important thing to deal with various problems that arise, complex and interrelated for students with logical reasoning, and appropriate solutions. So that the human resources prepared must be of high quality and possess high-level thinking skills such as critical, creative, innovative and so on [1-4]. Education must make improvements to keep up with current trends and needs, teachers must make changes and innovate the curriculum and teaching. So students can learn 21st century knowledge and skills well, which can help students get high academic achievement, a better life, and work in the future. A study of effective teacher professional development methods for 21st century education includes assessing teacher professional development, peer assistance, building collaboration, creating positive school culture, developing 21st century skills, teaching strategies for active learning, instill

core values, sustainable professional development, and research-based projects [5-7]. The education curriculum in Indonesia has been structured systematically in such a way as to be in line with the challenges of the 21st century. The main problem is how to apply learning so that the competencies contained in the curriculum can be achieved optimally. However, in learning there are still some problems related to the low ability to solve problems because the teacher is less accustomed to students to think more creatively in solving problems related to everyday problems and learning resources that do not include content on improving problem solving that have an impact on competencies that should be mastered by students [8] [9]. Several alternative learning strategies have been investigated sequentially to improve students' abilities in accordance with 21st century learning. Responding to pedagogical challenges in 21st century education, STEM-based learning has become a common practice in schools, and universities. So the teacher's role is needed to develop 21st century skills with appropriate learning strategies and approaches [10]. Such research is conducted by REU (Research Experiences for Undergraduates) which gives important points that (1) a large number of topics on competency can be achieved by applying the STEM approach (2) it is very important for teachers to apply innovative learning to improve the quality of teaching, and (3) It is possible for teachers to conduct Education research, although it is not easy [11] [12].

The teacher must design a learning plan, prepare a variety of learning media, and appropriate strategies for delivering a subject matter. Teachers must carry out various stages of preparation, such as the preparation of learning implementation plans along with complete tools such as student worksheets, practical guides and assessment instruments. Basically, the purpose of preparing a learning implementation plan is to design student learning experiences so that learning can run smoothly and evaluation of learning gets maximum results, it can be fulfilled if the learning planning is performed well, because this stage is the main function of the success of the stages next stage [13] [14]. The teacher is obliged to design and implement the learning process in a professional manner, so that in carrying out their duties, the learning tool becomes a guide in implementing, assessing and measuring the success of the learning process [15].

The design of a learning plan must be able to accommodate the needs associated with the learning process in class. The activities carried out as well as the results to be achieved through indicators of achievement must be described in the learning implementation plan. Achievement of the implementation of learning in the 2013 curriculum is strongly influenced by the availability of learning tools that can activate students, one of which is the Student Worksheet (LKPD) [16] [17]. Students' understanding of science must be built through the level of education so that as adults, they can make decisions related to various issues and can address these issues scientifically, so that to meet these needs an effort is needed to prepare students with a significant proportion in the fields the field of science technology that is now much needed [18] [19].

Physics learning activities do not only require cognitive mastery skills but are holistic, both in the process of introduction in the form of elaboration of concepts and scientific literacy, the ability to use technology and its development, designing various experimental devices as well as the ability to analyze and mathematical solutions. These four aspects are packages that should be able to be mastered by students today in accordance with the skills requirements that must be achieved in accordance with the applied curriculum. Various methods/techniques taken by the teacher to be able to provide understanding to students both in terms of cognitive abilities and skills. Studying science, especially physics, is not just about remembering, understanding concepts found by scientists before, but it is very important to familiarize students with the behaviour of scientists in discovering concepts carried out through experiments or practicum and scientific research that could be initiated by open-ended questioning or problems [20].

STEM provides opportunities for learning to students, where they must be able to combine skills and knowledge in the fields of science, technology, engineering, and mathematics to be able to create, produce and criticize a product [21]. This approach is able to create a learning system that is integrated with one another and is active learning because all four aspects are needed simultaneously to solve problems. The STEM learning approach provides an opportunity for teachers to guide students in

mastering concepts, principles, science, technology, engineering, and mathematics that are integrated into the development of products, processes, and systems used in everyday life [22]. Unlike the project-based learning model because the products produced by STEM do not have to be in the form of projects such as tools, prototypes, or designs but the emphasis is on students being able to understand concepts and be able to explain problems. Students can freely play and experiment also strengthen connections explicitly on mathematical, scientific and technological links as well as end products or artifacts [23].

Physics is a part of science that has been arranged systematically, organized, obtained through observation and experimentation that was developed to provide the fulfilment of human needs [24]. In learning physics, there are various materials that are difficult to understand, one of them is material about light, so students need to get scientific concepts correctly to understand various related physics concepts that can be applied and developed in the future, for example: interference, diffraction and light spectrum [25-26].

The purpose of this study was to determine the extent of STEM that is integrated in learning as an approach with the learning model so that it is able to design a learning plan as outlined in the learning tools, especially LKPD. In addition, this research also explored information on the extent of STEM needed in a study.

2. Research method

This type of research was qualitative. Qualitative research is a scientific investigation carried out systematically to develop holistically, mostly in the form of narratives, descriptions to inform researchers' understanding of information, circumstances, social culture or phenomena. Qualitative research is also a general term for a variety of approaches and methods [27]. Qualitative research begins with the assumption and use of a theoretical / analytical framework that forms or influences the study of the problem of inquiry in an individual or group (respondents) on a problem issue [28].

Data obtained from the analysis of learning documents and in-depth interviews. This study involved 75 respondents spread throughout the region in Lampung province. Documents analyzed were learning plans, student worksheets, modules, laboratory guides, and assessment instruments (written assessment of both essay and multiple choices, oral assessment, performance assessment, portfolio assessment, and project assessment to find out the learning tools used and the influences) from the use of these devices related to the achievement of student learning outcomes, while interviews were conducted to explore information about the teaching and learning process carried out, the use of learning methods, difficulties in delivering material about diffraction of light, enthusiasm on student worksheets, and the level of teacher needs learning process with the STEM approach.

3. Result and discussion

The results of the analysis of teacher documents on physics subjects are as follows:

Table 1. Analysis of learning plans, student worksheets, modules, laboratory guides, and assessment instruments

No	Document	Component	Number (n)	Percentage (%)
1	Lesson plans	IntegratedSTEM	10	13.3
		Not yet integrated STEM	65	86.7
2	Student worksheets	IntegratedSTEM	10	13.3
		Not yet integrated STEM	65	86.7
3	Modules	Relevance, consistency and adequacy	25	33.3
		Only fulfil the relevance principle	55	66.7

4	Laboratory Guides	Meet the principles of laboratory learning strategies	30	40.0
		Meet the principles of laboratory learning strategies in part	45	60.0
5	Assessment instrument	The Assessment Instrument is complete and contains STEM literacy elements	10	13.3
		The Assessment Instrument is incomplete and does not yet contain the STEM literacy element	65	86.7

Table 1 represents the results of the analysis of documents related to learning plans, student worksheets, modules, laboratory guides, and assessment instruments. Based on Table 1, Documents 1, 2, and 5 showed that 86.7% of teachers: (1) had not fully integrated with STEM in their learning. Most of the learning implementation plans prepared used discovery learning as the choice of learning models. (2) the student worksheets as well as the modules compiled did not fully integrate with STEM. Student worksheets only contained material summaries and practice exercises with several types of question types, for example problem descriptions, plural choices and pairings. While most modules contained content (only fulfilling the principle of relevance), there are even some modules directly explained the topic of material without an introduction to phenomena.

The results of the analysis of the document about the laboratory guide showed that not all of the principles of laboratory learning strategies had been met, the creative, inspirational and innovative principles were not met. The laboratory guidelines compiled for the most part follow laboratory experiment procedures with materials that become general standards, but this is not appropriate when found in schools that do not have complete laboratory facilities. A small number of respondents (teachers) have developed STEM in their learning, integrating through learning implementation plans and student worksheets that have been developed as well as in modules designed to meet the principles of relevance to the material, consistency and adequacy seen from the needs of the module itself. Besides that, the laboratory guides that have been made also contain the principles of laboratory learning strategies. Whereas in the assessment instrument document, there were still many teachers/respondents who were incomplete and have not yet integrated STEM literacy in their assessment instruments.

Seeing the ability of students to be fulfilled in relation to the achievement of 21st century skills, and the scarcity of skilled labor who understand science, technological, engineering, and mathematical (STEM)[29], then based on the analysis of documents obtained by the teacher had not been able to make planning and implementation based on student worksheets arranged. The researchers found a strong relationship between teacher Pedagogical content knowledge (PCK) and their ability to teach effectively how to make plans, teachings, and perceptions/reflections on classroom learning activities. Recent research in mathematics and science subjects, teacher's pedagogical content knowledge (PCK) as one of the most influential factors that contribute to student learning and learning achievement [30] [31] [32] [33].

The interviews concluded that the teaching and learning process carried out was still dominated by conventional methods, as expressed by DM and ER that when starting learning activities, the first thing delivered was to write the title of the learning material, then deliver the objectives and immediately convey the contents, practice exercises and end learning. Some teachers assumed that the process of students in discovering a phenomenon will require a long time and ultimately the learning objectives are not achieved. Unlike the case with the method used by SR who at the beginning of learning expressed the phenomenon or events encountered in daily life, SR often asks students through

the phenomena encountered. It gives a different atmosphere that occurs in the classroom. SR revealed the class became warm with a small discussion between students, they tried to express what they knew based on the phenomena discussed. The activity continued at the core of learning, delivering material until the end of learning.

Furthermore, the results of the interview also found that there were still many difficulties when delivering material, especially in light diffraction material. As happened to NE who revealed when teaching the students about the diffraction material directly to the question to students, have you ever seen a light entering a narrow gap? The question was spontaneously answered "Ever" after that, as expressed by NE the learning continued by explaining what is called diffraction of light, expressing equations, and giving examples of problems. Then what's the difference with interference? RJ revealed and gave the same learning pattern as NE. RJ explained the difference between diffraction and interference lies in the definition, not from the invention. Slightly different from what was expressed by AN who used the animated video PHET simulation to help students understand the event but AN did not invite students to do activities to try to recognize, investigate diffraction events directly. AN continued the activities to the core of learning as NE and RJ do.

The enthusiasm of students towards the student worksheets showed that most students gave positive responses, especially on student worksheets that included experimental and discovery activities. As NL said, students were very happy when the teacher assigned to bring a simple experiment tool. Then, when learning takes place, NL distributed student worksheets that contain learning activities. Active students both individuals and groups, they ask questions, express answers, provide simple definitions, and solve problems. As stated by AM who used student worksheets which contain a summary of the material and a collection of questions. Students were interested in the worksheets, but finally as revealed by AM, students only know the mathematical solutions but lack understanding the concept they learn. Most of the other respondents as stated by AR, teachers used student worksheets that they get from previous student worksheet publications. Not infrequently they encounter some writing errors, sample problems, and are less relevant to learning that should be done at this time. DL and other respondents expressed the use of worksheets was very helpful to teachers and students in the learning process, and expressed the need to design a worksheet of students who could practice science process skills so as to be able to achieve learning objectives, and invite students to be more active. Observing the results of the analysis of documents and interviews on the use of learning tools, student worksheets and various other supporting documents, showed that educators need scaffolding in the design of learning media and as an effort to increase the development of professionalism of educators [34-36].

As said before, the integration of STEM in learning can increase the activeness and creativity of students which is quite high, because they are trained to analyze a technology engineering and understand concepts well [37]. STEM integrated student worksheets begin by providing a problem or phenomenon either experienced by students or just being observed to be able to practice creative thinking skills of students so that STEM learning can develop and realize learning experienced by students in daily life [38-39]. Student worksheets become one of the important learning media because they can be one of the guidelines used by students in learning activities in the class that contain steps of activities, both individual and group. In addition, on the student worksheets the teacher can also assess during learning, direct students in conducting investigations and be able to identify student weaknesses.

The STEM integrated student worksheet implemented requires students to connect different STEM subjects, integrating the subject which begins by identifying real problems that occur in the student environment by using high-level thinking and problem solving skills so that conclusions can be drawn as efforts to resolve various problems [40-41].

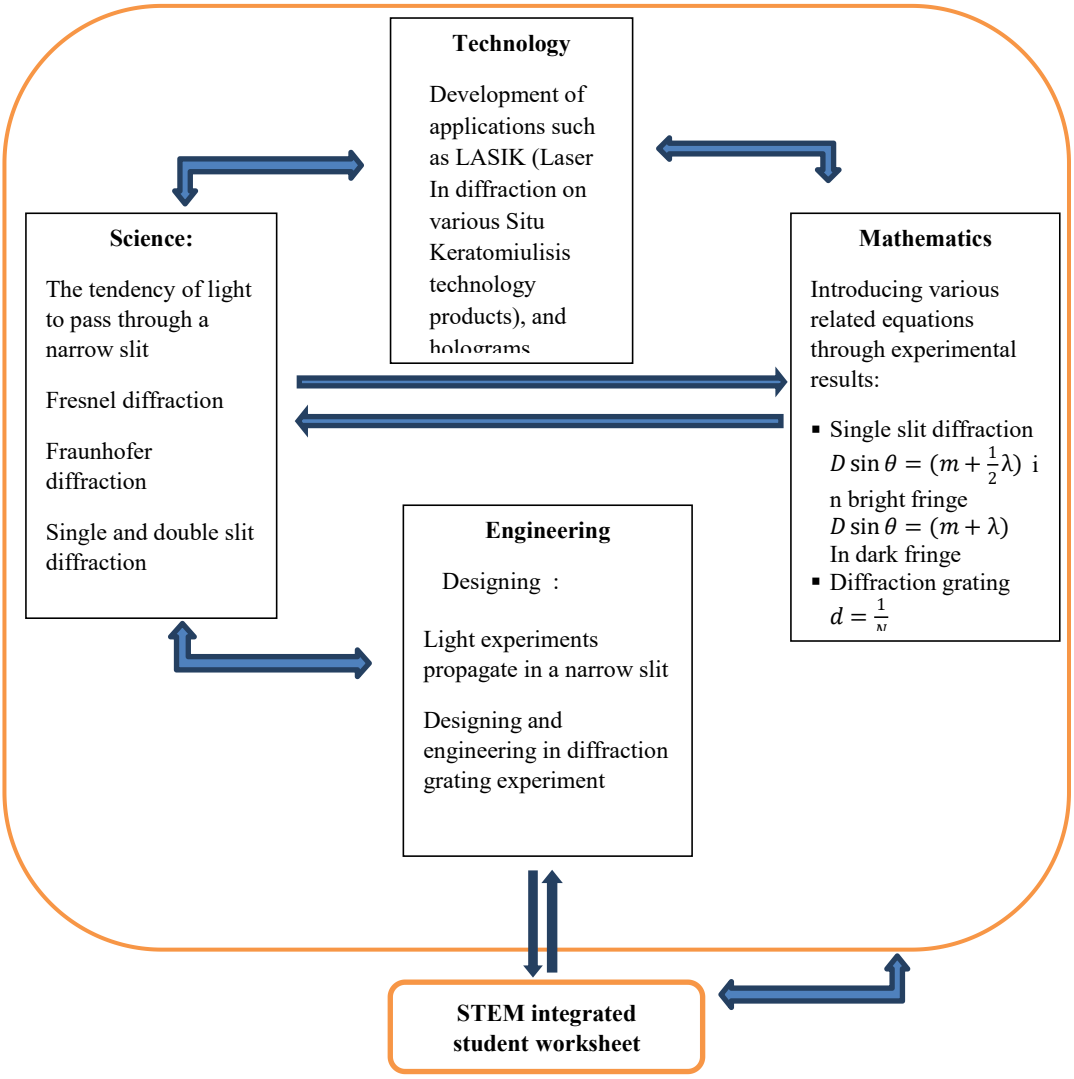

Figure 1. The hypothetical model of the STEM integrated student worksheet about light diffraction

In Figure 1 it is explained that learning about diffraction can be started by observing phenomena, digging information about diffraction technology developed and the various benefits obtained. Then students observe how a beam of light enters through the slit, the teacher can model by using a laser beam that is directed through a narrow slit then students conduct a simple experiment. Students are directed to look for literature on how a diffraction event occurs. Classifying various theories, such as what Fresnel diffraction, Fraunhofer diffraction, single slit diffraction, and double slit diffraction. Then, students begin to develop experiments, to engineer and design an experiment with the creativity and ideas they have for example an investigation of what is meant by a diffraction grating, how patterns are produced in the different grating. Students try a variety of media that they design themselves, compare results, and interpret what they get. The teacher directs student inquiry activities and provides assistance to individuals or groups who experience difficulties or make mistakes. Furthermore, students can draw a sketch of the results of the experiment and direct them to mention the related variables and formulate in equations, using equations in mathematical solutions. In addition, teachers reflect on what they conclude, directing them to make the right decision.

In a learning plan, the teacher needs to formulate what steps should be taken during the learning, as illustrated in the STEM integrated hypothetical model above. The four components described are all

interrelated. The results of the learning plan will be able to produce a student worksheet which can then be applied.

4. Conclusion

This research showed that the majority of teachers have not yet developed lesson plans and STEM integrated student worksheets. Learning was still dominated by conventional methods. Reflecting on all activities, the lack of achievement of the desired results of learning achievement required an improvement in terms of plans, instruments and the learning process. The design of learning activities carried out greatly determined the achievement of learning objectives, so it is very necessary that student worksheets arranged systematicallyby integrating STEM. So for future research, it is necessary to develop an integrated STEM student worksheet that is expected to train students to develop creativity, independence and improve their various skills

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