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Developing STEM Learning Design with Mini Projector Media in Grade V of Elementary School

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Abstract

The lack of innovation in process engineering and technology-based learning in primary schools results in suboptimal learning outcomes. Primary school education does not involve students directly in every learning process, leading to underdeveloped student competencies. One innovative learning approach that can be utilized by elementary school teachers is STEM (Science, Technology, Engineering, and Mathematics) education. The objective of this research is to develop a STEM learning design product to make primary school education more meaningful. The research method employed is Educational Design Research (EDR), which consists of three phases: analysis and exploration, design and construction, and evaluation and reflection. Data collection techniques include interviews, observations, documentary studies, and questionnaires. The subjects of this research are students from classes VB and VC at SDN 2 Pengadilan Kota Tasikmalaya. After conducting two trials of the STEM learning design, it was found that the developed learning design is valid, practical, and suitable for use in primary schools. STEM education can serve as an alternative for teachers to implement learning processes that involve engineering and technology, thus meeting the demands of 21st-century skills for students.
Keywords: Learning Design, STEM, EDR, 21th Century Skills

Abstrak

Kurangnya inovasi pembelajaran berbasis proses rekayasa dan teknologi di sekolah dasar mengakibatkan pembelajaran kurang optimal. Pembelajaran di sekolah dasar kurang melibatkan siswa secara langsung dalam setiap proses pembelajaran sehingga kompetensi yang dimiliki siswa kurang berkembang. Salah satu inovasi pembelajaran yang dapat digunakan guru sekolah dasar yaitu pembelajaran STEM. Tujuan penelitian ini adalah untuk mengembangkan produk desain pembelajaran STEM agar pembelajaran di sekolah dasar menjadi lebih bermakna. Metode penelitian yang digunakan yaitu metode Educational Design Research (EDR) Teknik pengumpulan data menggunakan wawancara, observasi, studi dokumentasi, dan kuesioner. Subjek dalam penelitian ini yaitu siswa kelas VB dan VC di SDN 2 Pengadilan Kota Tasikmalaya. Setelah dilakukan uji coba sebanyak dua kali terhadap desain pembelajaran STEM dinyatakan bahwa desain pembelajaran yang dikembangkan valid, praktis, dan layak digunakan di sekolah dasar. Pembelajaran STEM menjadi alternatif oleh guru dalam melaksanakan pembelajaran yang melibatkan proses rekayasa dan teknologi sehingga tuntutan keterampilan abad 21 siswa dapat terpenuhi.
Kata kunci: Desain Pembelajaran, STEM, EDR, Keterampilan abad 21

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INTRODUCTION

The term STEM was first introduced in the 1990s by the National Science Foundation in the United States to address educational issues (Chesky & Wolfmeyer, 2015). It originated from the term "SMET," which stands for "Science, Mathematics, Engineering, and Technology." However, this term generated controversy due to its phonetic similarity to "smut." As a result, the term was changed to "STEM" (Sanders, 2009). STEM is the integration of four disciplines to create a "meta-discipline" (Lidinillah et al., 2019).The STEM approach is a new approach to integrated science and mathematics education (Mann et al., 2011). In the context of elementary and secondary education, the goals of STEM learning are as follows: a) students should have the knowledge, attitudes, and skills to identify questions and problems in their everyday lives, explain natural phenomena, design and draw conclusions based on human-generated evidence; b) understand the specific characteristics of STEM disciplines as forms of knowledge, inquiry, and design generated by humans; c) have an understanding of how STEM disciplines shape the material, intellectual, and cultural environment; d) have a desire to engage in the study of STEM issues (such as energy efficiency, environmental quality, limited natural resources) as constructive, caring, and reflective citizens, using ideas from science, technology, engineering, and mathematics (Bybee, 2013). As defined by Cunningham (2018) the roles in the STEM fields are as follows: (1) Science is a collection of knowledge about the physical and natural world. Scientists strive to describe, explain, and predict the nature and physical properties of the world; (2) Technology is a collection of knowledge, processes, and systems generated through engineering. Technology is created by humans to solve problems or meet needs and is the product of the engineering process; (3) Engineering is the application of knowledge to creatively design, build, and maintain technology through the engineering process; (4) Mathematics is the science of numbers, quantities, and the relationships between them. Mathematics uses numbers and symbols to describe relationships between concepts. They apply mathematical principles and reasoning to solve problems in various fields, including science, technology, and engineering.

The Science, Technology, Engineering, and Mathematics (STEM) program has become an integral part of elementary school curricula (Brown, 2012). Nowadays, STEM has gained popularity in several countries, such as Taiwan, where the curriculum has started integrating STEM learning and placing students at the center of learning activities (Khoiriyah et al., 2018). Indeed, countries like Finland, Japan, Australia, China, Malaysia, and several others, including Indonesia, have been developing STEM education for the past three decades, and it has continued to grow in recent years (Musnidar, 2018). These countries recognize the importance of STEM education in equipping students with the necessary skills and knowledge for the demands of the 21st century. By integrating science, technology, engineering, and mathematics, STEM education aims to foster critical thinking, problem-solving abilities, creativity, and collaboration among students, preparing them for future challenges and opportunities in various fields. It is true that STEM education is not yet widely popular in Indonesia, and specifically in elementary schools, it is not well recognized by teachers (Bunyamin, 2015). STEM education has not been fully integrated into the curriculum of elementary schools in Indonesia, as teachers still predominantly implement integrated thematic learning models and scientific approaches. This situation is influenced by several factors: (1) the lack of teacher competence regarding STEM learning, (2) inadequate school facilities and infrastructure, particularly for practical activities, and (3) the elementary school curriculum that has not fully integrated mathematics and science subjects. Mathematics education in elementary schools follows separate policies and is not integrated with other subjects (Lidinillah et al., 2019).

STEM learning encourages and supports students to become critical thinkers, problem solvers, and creative individuals (Baber, 2015). Then, there are several reasons why engineering can be introduced to students at the elementary school level. First, engineering can help children expand their understanding and enhance their worldly experiences. Second, engineering can foster problem-solving skills and attitudes. Third, engineering can also enhance motivation, engagement, responsibility, and provide freedom for students to choose their learning methods. Fourth, introducing engineering can improve achievements in mathematics and science subjects. Fifth, engineering education can promote equality in education. Lastly, engineering has the potential to transform teaching methods and can be integrated into state and national educational standards (Blackley & Howell, 2015). Involving engineering in elementary education can encourage students to be more aware of their roles and existence in society, as well as assist them in applying solutions to real-world problems (Katehi et al., 2009). For elementary school students, the Engineering Design Process (EDP) can be conducted in five steps that guide them to: ask (define the problem and identify constraints); imagine (generate ideas through brainstorming sessions and select the best one); plan (create diagrams and gather necessary materials); create (follow the plan and test the outcomes); and improve (discuss possible enhancements and iterate steps 1-5) (Cunningham, 2018).

In its implementation, there are three common approaches to STEM learning: the silo approach (separate), the embedded approach (integrated), and the integrated approach (fully integrated) (Roberts & Cantu, 2012). The silo approach in STEM learning refers to the separate teaching of the science, technology, engineering, and mathematics subjects (Dugger, 2010). The embedded approach in STEM learning is characterized by emphasizing real-world situations and problem-solving techniques within social, cultural, and functional contexts (Chen, 2001). The integrated approach in STEM learning involves combining the four disciplines of science, technology, engineering, and mathematics as a cohesive subject (Breiner et al., 2012). All three STEM approaches can be considered for implementation in the elementary school curriculum in Indonesia (Lidinillah et al., 2019). Based on the explanation above, STEM education is highly suitable to be implemented in the elementary school curriculum in Indonesia, particularly within the current context of the Merdeka Curriculum. The Merdeka Curriculum is developed to be more flexible and focuses on essential subjects, character development, and student competence. The key characteristic of the Merdeka Curriculum is to support the recovery of learning through project-based learning to develop students' soft skills and character (Kemendikbudristek, 2022).

The lack of theoretical sources, instructional material development, and examples, as well as teachers' understanding of how to create instructional materials, is still considered insufficient (Hamdu, et al, 2016). Recently, there have been several developments in STEM learning tools and designs. For example, Sulistia, et al (2019) developed a STEM learning design using Lakakarya technology as the engineering process. Additionally, Artobatama, et al (2020) developed a STEM learning design using Lighting Tamiya Car as the technological component in the engineering process. Haryati, et al (2020) focused on the development of a STEM learning design using a steam-powered boat as the medium, while Oktapiani & Hamdu (2020) developed a STEM learning design using Electrical Tandem Roller as the technological component in the engineering process. These examples highlight the diverse applications of STEM learning designs with different technological components.

Although there have been numerous research studies focusing on the development of STEM learning tools and designs, STEM education is still relatively unfamiliar to educators. This was evident in an interview conducted with the Principal of SDN Pengadilan 2 in Tasikmalaya City, where it was revealed that teachers have not yet implemented STEM-based learning. The teachers also expressed unfamiliarity with the concept of STEM, and project-based learning has not been effectively implemented. Furthermore, the teachers mentioned that they have not designed specific lesson plans for STEM learning. However, STEM education is crucial in preparing students with 21st-century skills and fostering innovation in the field of education. Therefore, a proposed solution in the conducted research at SDN Pengadilan 2 is to develop a STEM learning design using a Mini Projector as a medium in 5th-grade elementary school classrooms.

METHOD

This research falls into the category of development research using the Educational Design Research (EDR) model, which consists of three stages: analysis and exploration, design and construction, and evaluation and reflection.

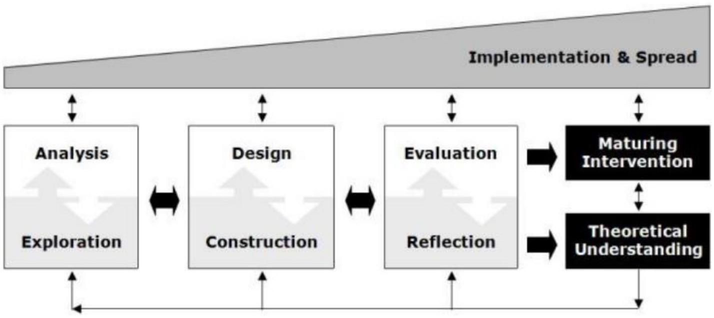

Figure 1. Generik Model EDR

The subjects of this development research are students from class VB and VC of SDN 2 Pengadilan in Tasikmalaya City. Data collection methods were obtained through (1) interviews, (2) observations, (3) documentation study, and (4) questionnaires. Interviews were conducted with the teachers of class V in SDN Pengadilan 2 to gather data during the preliminary study phase to identify the research problems. In addition to interviews, the researcher also collected data through observation activities. The observation method used in this research is participant observation, where the researcher directly participates in the activities being observed (Sugiyono, 2021). Furthermore, the researcher conducted a documentation study of the lesson plans prepared by the teachers as a guide for implementing the learning process using a checklist. The researcher also used questionnaires given to the teachers and students of class VB and VC to determine their response to the implemented learning process. Before the STEM learning design product is used in elementary schools, a validity test is conducted by expert validators to assess the suitability of the product. The validation process involves three expert validators, including one mathematics expert and two science experts. The data analysis technique used in this research consists of three stages: data reduction, data display, and conclusion drawing/verification. This research is a collaborative study that includes the development of learning designs, the development of instructional media, the development of student worksheets (LKPD), and the development of a 4C assessment rubric, all of which are based on STEM learning.

In this study, the researcher used a qualitative data analysis method developed by Miles and Huberman. This method involves a series of interactive and iterative steps to analyze the collected data. The analysis process is conducted repeatedly until data saturation is reached, which means that the data provides a deep and comprehensive understanding of the phenomenon under investigation (Miles&Huberman, 2016) In qualitative data analysis, the researcher identifies patterns, themes, and relationships among the collected data.

RESULTS AND DISCUSSION

Analysis and Exploration

The result of this research is a STEM learning design in the form of Lesson Implementation Plans (RPP) for Grade V in elementary school, specifically for the subjects of Science (IPA) and Mathematics, focusing on the topics of light properties and rectangular prisms. The development of this STEM learning design was carried out using the Educational Design Research (EDR) method. The first stage conducted was analysis and exploration. The aim was to identify the existing problems in the school by conducting literature reviews and field studies at the elementary school. Based on the literature review findings, it can be concluded that the implementation of STEM-based learning in elementary schools is generally lacking. The field study conducted at SDN Pengadilan 2 revealed that the design of a lesson plan in the form of RPP is crucial in preparing for the learning process in the classroom to achieve optimal learning outcomes. However, teachers expressed difficulties in designing a lesson plan due to time constraints. Other factors that hindered teachers in designing RPP were the lack of available resources and facilities in the school, such as teaching materials that were not readily available. Teachers also faced challenges in integrating two subjects simultaneously, which made it difficult for them to innovate in their teaching practices. Teachers mentioned that STEM learning is highly suitable for elementary schools as it allows students to learn through play. They also stated that STEM learning aligns well with the "Kurikulum Merdeka" (Freedom Curriculum) in developing 21st-century skills, in line with the current goals of elementary school curricula, which aim to develop the 4C skills (critical thinking, communication, collaboration, and creativity). In addition to the literature review and field study, the documentation of the RPP created by teachers at SDN 2 Pengadilan was also conducted during this stage. While the components of the RPP complied with the regulations stated in Permendikbud, it was found that experimental methods and other methods involving overall student engagement were rarely utilized, with a greater reliance on lecturing methods.

The findings of this research, based on the analysis and exploration of the problem conducted, indicate that adequate and optimal preparation is necessary before implementing the learning process in the classroom. One crucial aspect of the preparation is the presence of a well-designed learning plan. By having a learning design documented in the Lesson Plan (RPP), it is expected that the learning process can run optimally and as intended. This aligns with the viewpoint of Chatib (2016) that the quality of a teacher's teaching using a Lesson Plan from the beginning will differ from a teacher who does not create a Lesson Plan from the beginning. To make instructional design an essential element for quality learning, teachers must prepare it before commencing the teaching and learning process in the classroom. Additionally, the findings from the analysis and exploration indicate that engineering-oriented and technology-infused learning approaches are highly supportive of 21st-century development and can empower students to acquire 21st-century skills. Therefore, it is crucial to implement relevant teaching methods that can encourage students to develop these skills, commonly known as the 4Cs: critical thinking, communication, collaboration, and creativity. By cultivating these skills, students will be better prepared to compete in the future, as the demands of the world necessitate children to possess thinking and learning skills. These skills include problem-solving, critical thinking, collaboration, and creativity and innovation skills, as emphasized by (Hosnan, 2014).

Design and Construction

The second stage is the design and construction phase. In this stage, the activity involves designing the STEM learning design to be developed. The focus of this stage in developing the STEM learning design includes: creating design principles, determining learning outcomes, establishing the flow of instructional goals (ATP), setting learning objectives, determining teaching materials, determining the hypothetical learning trajectory (HLT), and designing an initial prototype of the STEM learning design. The design principles, learning outcomes, and the conceptual framework of the initial prototype of the STEM learning design are presented in more detail in the following table 1, table 2, tabel 3:

Table 1. Design Principle

Design Principle Component	Description
Intervention x	Mini projector engineering project in STEM learning for 5th-grade students. t The mini projector engineering project in STEM learning in 5th grade
Purpose/function Y	- Students can present experimental reports on the properties of light using the mini projector (Science). - Students can understand the functions of each component of the mini projector that apply the concepts of light properties

Design Principle Component	**Description**
	(Technology). - Students can design and develop a simple mini projector and use it (Engineering). - Students can use the concept of cube nets to design and develop the mini projector (Mathematics).
Context Z	The mini projector engineering project is one of the STEM projects for 5th-grade students in elementary school as part of STEM education in the elementary school curriculum.
Characteristics C1,C2,...C3 (substantive emphasis)	STEM learning for Projector Mini project uses: - Integrative approach - Context integration - The phases: Ask, Imagine, Plan, Crate, and Improve - Collaborative - Simple and safe materials and tools
Procedures P1, P2,… (methodological emphasis)	- Prepare a prototype mini projector - Test prototype mini projector to one group of students - Prepare a guide for making mini projector - Prepare teaching materials for making mini projector - Prepare assessment instruments - Develop a lesson plan - Conduct testing and evaluation
Theoretical argument T1, T2... T3	Note: Theoretical arguments can refer to the result of literature study Theoretical arguments can refer to the result of literature reviews
Empirical argument E1, E2...Eq	Note: Empirical arguments can be developed from empirical findings

Table 1. shows that the design principles are temporary drafts that can be improved after the testing process is conducted. The final outcome of this research will be in the form of design principles, which are a form of knowledge generated in addition to the complete STEM product in the form of instructional design. There are general design principles that apply to all STEM projects in elementary schools, as well as specific design principles that are tailored to each project.

Table 2. Analysis of Learning Outcomes and Learning Objectives

Learning Outcomes	**Learning Objectives**
a. Students can understand the properties of light through the mini projector engineering project. b. Students can present a report on the experiments conducted with the mini projector regarding the properties of light (Science). c. Students can comprehend the function of each component of the mini projector that applies the concepts of light properties (Technology). d. Students can design and develop a simple mini projector and use it (Engineering).	a. Enhance students' understanding of light properties through the use of a mini projector. b. Encourage students to conduct experiments and present the results of the mini projector experiments scientifically. c. Introduce students to the concept of technology and the functions of the components of the mini projector. d. Develop students' skills in designing and using a simple mini projector. e. Integrate the concept of rectangular prisms into the development of the mini projector.

e. Students can utilize the concept of rectangular prisms to design and develop the mini projector (Mathematics).	

Table 3. STEM Learning Design Framework

Stage 1: Asking (Identifying problems and setting boundaries)
1. Students are divided into 5 groups, with each group consisting of 5-6 students, and each group receives a group name tag. 2. Each student gathers with their respective group. 3. Students are guided by the teacher to divide tasks within their groups, including a group leader, a secretary, and other group members. 4. Each group receives a Student Worksheet (LKPD). 5. With the guidance of the teacher, students read the instructions provided in the LKPD. 6. Students observe a video provided by the teacher about the cube nets (observation). 7. The teacher directs students to ask questions based on their observations from the video (inquiry). Expected questions: Are all objects with a box shape considered cubes? Are cube nets and cubes the same? What is the difference between cube nets and cubes? How many different types of cube nets are there? 8. Students listen to the teacher's explanation of the cube nets that they observed earlier. 9. Students are instructed to pay attention to the examples of cube nets shown by the teacher and match them with the pictures in the LKPD. 10. Students observe a video provided by the teacher about light and its properties **(observation).** 11. The teacher directs students to ask questions based on their observations from the video **(inquiry).** Expected questions: Why can light pass through a window but not through a wall? Why does a pencil appear broken when we put it in a glass of water? Why do we see rainbows after rain?. 12. Students, together with the guidance of the teacher, engage in a question-and-answer session about the properties of light in everyday life. 13. Students, along with the teacher, sing the song "Light and Its Properties" found in the LKPD.
Stage 2: Imagining (Exploring ideas and selecting the best ones)
1. The teacher brings a Mini Projector device and places it in front of the class where all students can see it (observation). 2. Students listen to the teacher's explanation that the Mini Projector device in front of the class is the device they will create. 3. With the guidance of the teacher, students are directed to observe the teacher's demonstration of how to create the framework of the Mini Projector using cube nets (observation). 4. Each group observes the teacher's demonstration of how to create the framework of the Mini Projector using different cube net patterns (observation). 5. The teacher instructs each group to redesign the framework of the Mini Projector using different cube net patterns. 6. Each group is asked to design 2 cube net patterns.
Stage 3: Planning (Drawing diagrams and gathering materials)
1. Each group is guided to discuss with all group members about the cube net patterns they will use to create the Mini Projector. **2.** Students are directed by the teacher to redistribute tasks within their groups for the creation of the Mini Projector. **3.** Each group is directed to prepare the necessary tools and materials for creating the cube nets according to the instructions provided by the teacher.
Stage 4: Creating (Following the plan and testing)
1. Each group prepares two cardboard sheets measuring 60x40 and forms the cube net patterns as previously designed. 2. Each group prepares scissors/cutters and glue to assemble the cube nets as instructed in the LKPD.

3. Each group prepares the previously created cube net patterns as the framework for the Mini Projector. 4. Each group prepares the provided tools and materials and assembles them correctly according to the instructions in the Student Worksheet (LKPD). 5. Each group conducts an experiment to turn on the Mini Projector with the guidance of the teacher (trial). 6. Students observe what happens with the Mini Projector and record the results in the LKPD (observation).
Stage 5: Improving (Discussing possible improvements and repeating)
1. Students repeat the experiment to identify any shortcomings or errors in assembling the Mini Projector from the previous session (reasoning and trial). 2. Students answer questions in the Student Worksheet (LKPD) about their observations and experiments with the Mini Projector by discussing within their groups. 3. Each group summarizes the results of their experiment with the Mini Projector in the LKPD. 4. With the assistance of the teacher, students prepare their discussion results after completing the Student Worksheet (LKPD) for presentation in front of the class (presenting). 5. Each group takes turns presenting their discussion results to the class (communicating and confirming). 6. Each group submits the Student Worksheet (LKPD). 7. Students, along with the teacher, engage in a question-and-answer session about the steps they took in conducting the experiments and completing the Student Worksheet (LKPD) to evaluate the problem-solving strategies used by the students.

Before the instructional design is implemented in elementary schools, validation is conducted for the developed STEM instructional design product by an expert validator. Validation is crucial in maintaining the quality of outcomes in qualitative research (Afiyanti, 2008). The validation process is carried out to identify any deficiencies in the developed product. Based on the improvement suggestions provided by expert validators, the researcher then proceeds to the revision phase of the STEM instructional design product. The aim is to ensure that the STEM instructional design product meets the criteria of validity, practicality, and ease of understanding. After the completion of the STEM instructional design, and incorporating the recommended improvements from expert validators, the next step in this research is to conduct a direct trial of the STEM instructional design product at SDN 2 Pengadilan Kota Tasikmalaya. Based on the conducted trial, it can be concluded that the overall learning process has been successful, optimal, and aligned with expectations. The implemented learning followed the steps outlined in the Lesson Plan (RPP). Despite the identified shortcomings, such as the mismatch with the designed Lesson Plan (RPP) where some steps were not delivered in the correct sequence, it did not hinder the students' learning process. Instead, during the "creating" phase of the learning process, almost all students showed enthusiasm and excitement in making the Mini Projector media. Additionally, during the trial of the Mini Projector they created, all students actively participated. The STEM learning conducted in this research overall engaged student activities through creating or making products and planning through group discussions, which resulted in positive student responses towards the learning process. This aligns with (Peraturan Pemerintah RI, 2013) on National Education Standards, which states that "The learning process in educational institutions should be interactive, inspiring, enjoyable, challenging, motivating students to actively participate, and providing ample space for student initiative, creativity, physical and psychological independence

Evaluation and Reflection

Stage three is evaluation and reflection. In this stage, the evaluation and reflection of the STEM instructional design development are conducted through the implementation of a pilot test. The purpose is to obtain an overview of the learning process using the designed instructional design and assess the practicality of the product. The pilot test is accompanied by feedback and questionnaires filled out by teachers and students regarding the implemented instructional design. More specifically, the results of the first cycle, second cycle, are presented in tables 4 and table 5:

Table 4. The Implementation of Cycle 1 Pilot Test

STEM Learning Process	Student Activities
Asking The activity of observing and engaging in a question and answer' session about the video on the cube nets and properties of light is enthusiastically participated by all students. This is evident from the high level of enthusiasm and spirit displayed by students when answering the questions posed by the teacher.	
Imagining In this stage, the teacher demonstrates how to crate and operate the mini projector, which be made by each group.	
Planning In this stage, each group is instructed to prepare the tools and materials needed to create the mini projector.	
Creating In this stage, students start making the mini projector following the instructions provided in the students worksheer (LKPD). They begin by constructing the framework in the form of a rectangular prism, attaching black cardboard to the pattern, assembling the pattern using glue, and attaching the phone holder. They adjust the position of the magnifying glass until the image can be projected properly. In this stage, students also test the product they have made ubder the quidance of the teachers.	
Improving In this stage, students are asked to repeat the experiment to identify any shortcomings or errors from the previous trial. They work on improving the design or addressing any issues that arose during the initial testing. Additionally, in this stage, students present the results of their experiments in front of the class, sharing their findings and outcomes.	

After conducting the trial in cycle 1, it was found that the learning process went smoothly, although there are still some shortcomings that need to be addressed to enhance the learning experience for optimal results. As stated by Borg and Gall (in Hanafi, 2017) "Revising it to correct the deficiencies found in the field-testing stage." This means that revisions are made to improve the shortcomings and weaknesses found in the field-testing phase. Subsequently, at the conclusion of the teaching and learning activities, the researcher requested the classroom teacher, acting as an observer, to provide feedback by completing a questionnaire regarding the STEM lesson design in the form of a lesson plan (RPP) developed by the researcher. The teacher conveyed that overall, the learning steps carried out by the students were relevant to the delivered material. Throughout the STEM learning process, the students appeared enthusiastic and engaged in the lessons. The STEM lesson design can be used to develop the 4C skills in students, as they not only acquire knowledge but also fulfill performance skills. The researcher also sought feedback from the students regarding the learning they had undergone during the cycle 1 trial by having them complete a student response questionnaire. The aim was for the researcher to understand the benefits for students after participating in the implemented learning process. Based on the results of the cycle 1 trial, it can be concluded that the percentage of students who enjoyed the learning was 100%. 96% of students indicated that creating and testing the product was not difficult. Furthermore, 100% of students did not find it challenging to participate in the learning activities, thanks to the provided LKPD (Student Worksheet) as a guide, and 81% of students found it easy to work together in groups. Moreover, 81% of students comprehended the subject matter as a whole. Therefore, in the cycle 1 trial, the positive student response towards the conducted learning was 91.6%.

Table 5. The Implementation of Cycle 2 Pilot Test

STEM Learning Process	Student Activities
Asking In this stage, students observe a video about “jaring-jaring balok” and “sifat-sifat cahaya”. Afterwards, students and the teachers engage in a question and answer session based on the video.	
Imagining In this stage, the teacher demonstrates how to make and operate a mini projector. The teacher asks a few students to assist during the demonstration.	
Planning Students are directed to prepare the necessary equipment and materials to create the mini projector.	

STEM Learning Process	Student Activities
Creating In this stage, students begin constructing the mini projector according to the constructions provided in the learning and teaching materials (LKPD). Students also test their creates products with the guidance of the teacher.	
Improving Students repeat the experiment to identify any mistakes from the previous trial, allowing them to make improvements. During this stage, students are asked to present their trial results in front of the class.	

The implementation of the second cycle trial was conducted in Class V B. The results obtained showed that overall, the learning process was carried out optimally according to the STEM learning design, and the students were well-conditioned. Despite the optimal implementation, there are still some areas for improvement. One of the identified shortcomings is the omission of certain learning steps by the practitioners. The specific step that was missed is singing the national anthem. After the learning session ended, the practitioners requested feedback from the teacher acting as an observer regarding the implementation of the STEM learning activities. The teacher mentioned that the teaching and learning process was executed well and covered all the intended content. Next, the practitioners asked the students to fill out a questionnaire regarding the learning process they had participated in. Based on the results of the cycle 2 trial, it can be concluded that the percentage of students who did not feel bored during the learning activities was 100%. Furthermore, 100% of the students indicated that making and testing the products was not difficult, 96% of the students did not find the learning activities challenging because they had the Learning and Teaching Materials (LKPD) provided by the teacher as a guide. Additionally, 100% of the students did not have difficulty working together in their groups, and 88% of the students understood the subject matter as a whole. Thus, the average percentage in cycle 2 was 96.8%, indicating that the students responded positively to the STEM learning activities. Therefore, the student response to the planned STEM learning, as evaluated in the research, is considered good.

After conducting the trial, it was found that the STEM learning design with the Mini Projector media is suitable for use in the current curriculum, namely the Merdeka Curriculum. The STEM Learning Design has met the standards of validity based on expert validators and practicality, making it applicable in elementary schools. The resulting STEM learning design is in the form of STEM Lesson Plans (RPP) consisting of several stages of learning, namely: 1) asking, 2) imagining, 3) planning, 4)

CONCLUSION

Based on the research findings on the development of STEM learning design using a mini projector in Grade V of elementary school, the following conclusions can be drawn:

1. Learning activities in elementary schools in Tasikmalaya generally do not involve engineering activities or the creation of products that utilize technology.
2. The learning process has not fully developed the 4C skills (problem-solving, critical thinking, collaboration, and creativity) in students.
3. The overall learning process in this study has been effective and aligned with the designed learning plan.
4. Teachers have responded positively to the designed learning plan.
5. Students' responses to the learning activities in the first cycle of testing showed a positive average response rate of 91.6%, while in the second cycle, students also responded positively with a percentage of 96.8%.
6. Therefore, the STEM learning design developed by the researcher is suitable for use in Grade V of elementary school.

These research findings indicate that the STEM learning design with a mini projector has the potential to enhance the quality of learning in elementary schools and develop 21st-century skills in students. The recommendation is to implement this learning design more widely to expand its positive impact and conduct further research to deepen the understanding of using STEM learning design in an educational context.

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