CHAPTER III
RESEARCH METHODS

3.1 Research Design

This study examines the creative thinking skills of junior high school, senior high school, and vocational high school students in stem-based robotics activities. Data was collected through questionnaires, assessment of student worksheets, and observation sheets, then processed using a quantitative approach. The survey method through a questionnaire is used to collect information about how students respond to STEM learning. The questionnaire data collection process was conducted after the activity through Google Forms. Student worksheets were assessed to find out and assess the results of design ideas from products developed by students during group activities. The observation sheet was used to assess students' creative thinking performance individually. The data were analyzed using descriptive statistical methods, which is a method whose presentation is made based on the need to provide an overview of the data that has been collected (Martias, 2021). Then the research results were explained using a quantitative descriptive approach to interpret the statistical data that had been processed (Rahi, 2017).

3.2 Research Participants

The participants in this study were students from 6 schools, including two junior high schools, two high schools, and two vocational schools spread across Bandung City, Bandung Regency, and Sumedang Regency. This research started from 06 December 2022 to 24 February 2023. An overview of the profiles of research participants, which provide information about gender and distribution of students at each level, can be seen in Table 3.1.

Table 3. 1 Description of Respondent Profiles

Participant	n	%
Gender		
Male	57	63.3
Female	33	36.7
Class		
7	20	22.3
8	10	11.1
10	30	33.3
11	30	33.3
Major		
Senior High School		
Natural Sciences	30	33.3
Vocational High School		
Industrial Electronics	30	33.3

From Table 3.1, which is a description of the profile of participants, the research sample in this study amounted to 90 respondents, with more male participants than females. Senior high school students who became participants came from Natural Sciences majors, and vocational high school students came from Industrial Electronics majors. The data on the distribution of respondents in each school can be seen in Table 3.2.

Table 3. 2 Data of School Origin

Participant	n	%
Junior High School (JHS)		
JHS A	15	16.6
JHS B	15	16.6
Senior High School (SHS)		
SHS A	15	16.6
SHS B	15	16.6
Vocational High School (VHS)		
VHS A	15	16.6
VHS B	15	16.6

Table 3.2 shows the data on the distribution of participants based on school origin. It can be seen that the number of students who participated was the same for each school.

3.3 Research Instruments

The research instruments used in this study were adapted from previous studies. The first instrument regarding students' views of STEM learning was adapted from (Kaniawati et al., 2021), the IEEE Lecturer Research Team had previously developed the next instrument regarding the creative thinking assessment through student worksheets, and the last instrument regarding the assessment of student's creative thinking performances had previously been carried out by (Chasanah et al., 2017).

The research instruments used in this study are as follows:

1) Questionnaire

Questionnaires are used to measure students' opinions, attitudes, and perceptions of STEM learning. The measuring tool in this study contains 12 questions related to STEM learning as described in Table 3.3.

Table 3. 3 Questionnaire Research Instruments

Statement
A. I found STEM activities very interested.
B. I studied harder when did STEM activities.
C. I felt burdened when given a STEM project assignment.
D. I believe this STEM activity can be useful for me.
E. Many things related to my life when did STEM activities.
F. I tried to have done well on STEM projects.
G. I found STEM activities bored.
H. This STEM activity made me lazy to studied.
I. I think this STEM activity can help me achieve my goals.
J. I found STEM activities quite enjoyable.
K. In my opinion, this STEM activity was an important activity.
L. This STEM activity makes me more enthusiastic about learning.

In this instrument, the scale used is the Likert scale. This scale is then interpreted in a quantitative form by assigning scores to the answers to the questions answered by the respondents (Emerson, 2017). The scoring on responses to STEM learning is explained in Table 3.4.

Table 3. 4 Rating Scores for Responses to STEM Learning

Statement	**Rating**			
	Strongly Agree (SS)	**Agree (S)**	**Disagree (TS)**	**Strongly Disagree (STS)**
Positive	4	3	2	1
Negative	1	2	3	4

2) Student Worksheets

Another instrument used in this research is student worksheets to measure students' creative thinking skills. Student Worksheets consist of 2 pages which are done in groups. On the first page, students are asked to write down problems related to the phenomena introduced and ideas for solutions to these problems. On the second page, students are asked to design a product from the results of the solution ideas made. Furthermore, Student Worksheets can be seen in the Appendix.

In this instrument, the assessment scores for student worksheets are explained in the Creative Thinking Ability Rubric, which can be seen in Table 3.5.

Table 3. 5 Creative Thinking Assessment Rubric

Aspect	**Rating**			
	Basic (1)	**Developing (2)**	**Proficient (3)**	**Advanced (4)**
Generate diverse ideas	Able to produce a rigid product design.	Able to produce a solution design idea by considering other factors in	Able to produce several designs by considering other factors in making design solution ideas /thinking	Generating many design diagrams takes into account many factors in making the design/thinki

		making a solution design ideas / thinking smoothly.	fluently and flexible.	ng fluid and flexible.
Generate creative ideas	The design of the resulting solution idea is general or has been proposed by someone else previously.	The resulting design solution idea slightly modifies existing ideas.	The design of the resulting solution idea is not common. But there is another group that has the same idea.	The solution ideas are not general, unique, and different from other groups.
Evaluate and improve ideas	Not doing trials and improvements to the designs that have been made.	Conduct trials, but do not improve the design that has been made.	Make improvements to the design without conducting trials.	Conduct trials and the results of design changes for the better.

3) Observation sheet

Another instrument used in this study is the individual observation sheet. This observation sheet is used to assess students' creative thinking performances individually based on criteria for creative thinking skills, which are further elaborated in the stages of the engineering design process. The aspects assessed on this observation sheet can be seen further in Table 3.6.

Table 3. 6 Assessment of Student Creative Thinking Performances

Creative Thinking Criteria	Stages of the Engineering Design Process	Rated aspect
Flexibility	Identify Problem	Students look for problems related to the phenomenon introduced

	Discuss with group friends	Students seek and develop various ideas
	Revealing Solution	Students provide ideas, answers, and problem-solving
Originality	Design	Students try to draw product designs according to the solutions given
Fluency	Construct	Students are trained and fast in making products
Elaboration	Discussion	Students can develop and enrich their product ideas
	Test and Evaluation	Students can test products and find deficiencies
	Redesign	Students improve the products they make and add details to correct deficiencies

3.4 Research Procedures

In this research, several stages of research procedures were carried out as shown in Figure 3.1.

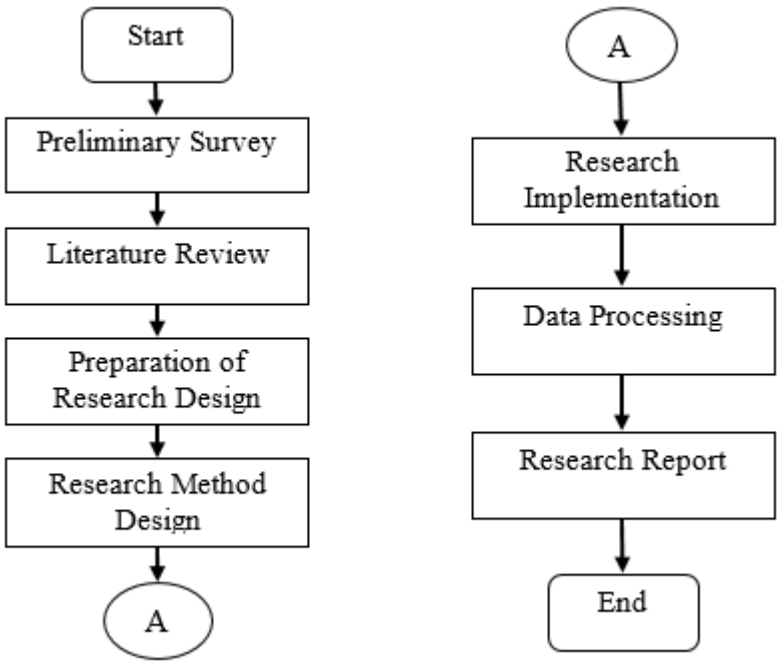

Figure 3. 1 Research Procedures

Following the chart shown in Figure 3.1, the first step begins with conducting a preliminary survey to find a research problem, followed by a literature study to deepen and find related information as the second step. The third step is to develop a research design, starting with formulating the problem and determining the research objectives and benefits. The fourth step is selecting the research method to be applied, then reviewing the research instruments. The fifth step is the research stage, followed by searching research data for respondents. As for the activities carried out during the research implementation stage, students were given material regarding introducing STEM learning, Electronics, and Mechatronics components. Then students are directed to find problems around them to be used as a reference in making product designs. Furthermore, the necessary data was collected and processed in the sixth step. Then the last step is to make a research report.

More about the stages of research implementation can be seen in the Figure 3.2.

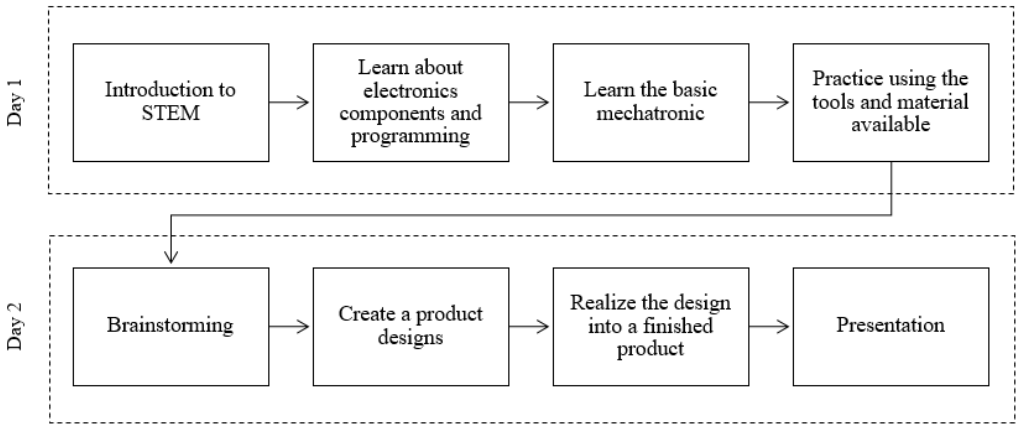

Figure 3. 2 STEM-based Robotics Activities Stages

Based on what is shown in Figure 3.2, this robotics activity was carried out for two days with details, on the first-day students were given learning about related material. Students are given material about the meaning of STEM and how the STEM approach is integrated into learning. After that, students learn the necessary electronic components, accompanied by an introduction to programming. Besides that, students learn the basics of

mechatronics and the tools needed and do exercises using tools and materials that have been studied so that students can better understand learning through practicum activities. On the second day, students are directed to look for problems around them and find solutions to problems with the help of researchers. Students are directed to embody problem-solving ideas into a product design to be developed. After that, students make product designs and create product frameworks with the tools and materials provided. At this stage, students are given the freedom to explore their creativity. Finally, students presented the products they had made.

3.5 Research Process

3.5.1 Data collection technique

The data collection technique used in this study was using questionnaires, student worksheets, and observation sheets. Questionnaires were used to find out students' responses to STEM-based learning, Student Worksheets were used to find out and assess design ideas from solutions developed by students, and Observation Sheets were used to measuring students' skills in creative thinking performances.

3.5.2 Data analysis technique

- **Student Questionnaire Grades**

The processing of questionnaire values regarding student responses to STEM learning is as follows.

$$STEM\ Score = \frac{\sum Sum\ of\ scores}{0.48}$$

From the results of student response scores to STEM then interpreted into several categories and score intervals as shown in Table 3.7.

Table 3. 7 Categories of Responses to STEM Learning

STEM Response Score (X)	Category
0% - 24.99%	Apathetic
25% - 49.99%	Uninterested
50% - 74.99%	Interested
75 – 100%	Enthusiastic

- **Grades of Student Worksheets**

In processing assessments from student worksheets regarding creative thinking skills, guided by the Creative Thinking Assessment Rubric as described in Table 3.6. The score for the ability to think creatively is described as follows.

$$Creative\ Thinking\ Rubric\ Score = \frac{\sum Sum\ of\ scores}{3}$$

From the results of the score for creative thinking ability, it is then interpreted into several categories as shown in Table 3.8.

Table 3. 8 Categories of Creative Thinking Skills

Creative Thinking Rubric Score (X)	Category
1 – 1.75	Basic
1.75 – 2.5	Developing
2.5 – 3.25	Proficient
3.25 - 4	Advanced

- **Observation Sheet Value**

In processing data from the observation sheet, scores are used to measure students' ability in the creative thinking process. The score for assessing students' creative thinking performance is explained as follows.

$$Creative\ Thinking\ Performance\ Score = \frac{\sum Sum\ of\ scores}{0.4}$$

From the results of the observation sheet assessment scores are then interpreted into several categories as shown in Table 3.9.

Table 3. 9 Categories of Creative Thinking Performances

Creative Thinking Performances Score (X)	Category
$X \geq 80$	Excellent
$X \geq 60$	Good
$X \geq 40$	Sufficient
$X \geq 20$	Bad
$X < 20$	Very bad

- **Descriptive Analysis**

  Data analysis used in this research is descriptive analysis with a quantitative approach. This analysis is an analysis that is used to interpret or provide an overview of the findings through the data that has been obtained (Martias, 2021; Rahi, 2017). Descriptive analysis is used to explain the acquisition of scores regarding STEM learning responses and the level of student's creative thinking skills.