

CHAPTER III

RESEARCH METHODS

3.1 Place and Time of Research

3.1.1 Research Location

This research conducted at SMA Kartika I-2 Medan, which is located at Jalan Brigjend H.A Manaf Lubis, Central Helvetia, Medan Helvetia District, Medan City, North Sumatra.

3.1.2 Research Time

The research will be conducted from October 2024 - October 2025.

3.2 Type of Research

This type of research is development research, which is research to develop teaching materials in the form of Student Worksheets (LKPD), so this research used is a type of research and development (Research and Development).

3.3 Subjects and Objects of Research

The subjects of this research were material expert lecturers, media expert lecturers, learning expert lecturers, class XI-2 SMA Kartika I-2 Medan, and one biology teacher of class XI SMA Kartika I-2 Medan. The object of this research is the feasibility of teaching materials in the form of Student Worksheets (LKPD) based on learning cycle 5e movement system material.

3.4 Operational Definition

To avoid misinterpretation of the definitions used, the definition of variables is limited:

1. The development carried out is to produce certain products and test the effectiveness of the products.
2. The developed LKPD will contain tasks, instructions, and learning evaluations that must be done by students to assist students in understanding learning.
3. The Learning Cycle 5E learning model is used in a student-centered teaching and learning process. Knowledge and meaning are built from students' experiences.

4. Movement System material is one of the biology learning topics that students will learn about bones, joints, muscles, and disorders that occur in the motion system.

3.5 Research Design

This research is a development research to develop teaching materials in the form of Learner Worksheets (LKPD). This research is also known as Research and Development (R&D) research. The development model used in this research is the 4-D model developed by S. Thiagrajan, Dorothy S. Semmel, and Melvyn I. Semmel. This model consists of 4 main stages, namely Define, Design, Develop, and Disseminate.

3.6 Data Collection Technique

3.6.1 Interview

Interviews were conducted to collect information by means of questions and answers between researchers and research subjects. Interviews in this study were conducted at SMA Kartika I-2 Medan by conducting interviews with biology teachers as resource persons. The interview data is the basis for identifying problems related to methods, learning media sources, and learning models.

3.6.2 Questionnaire

The questionnaire in this study was shown to product validators, namely 3 expert teachers consisting of material experts, learning experts, media experts, and 1 biology teacher.

3.6.3 Test

The test method in this study is to conduct a pretest and posttest on students of class XI-2 at SMA Kartika I-2 Medan. The questions given to students are in the form of multiple choices which are used to measure the improvement of student learning outcomes on the material of the motion system after testing using the LKPD based Learning Cycle 5E.

3.7 Research Instrument

The research instrument is a device used to find data for a study. The data collection instruments used in this study include interviews, questionnaires used

to test the validity and find out the responses of students and teachers to the LKPD, as well as test instruments aimed at the effectiveness of LKPD.

3.7.1 Material Expert Validation Sheet

This validation sheet aims to determine the assessment by the material expert on the LKPD product developed, containing 3 aspects of assessment, namely content feasibility, presentation feasibility, and language feasibility on LKPD which will be validated by 1 material expert lecturer. The lattice of instrument validation sheets by material experts can be seen in Table 3.1.

Table 3.1 Lattice of Questionnaire Validation Sheet by Material Experts

No	Aspect	Indicator	No. Item
1	Content Feasibility	Suitability of material with KD	1
		Material Quality	2,3,4,5
		Encourage Curiosity	6,7
2	Presentation Feasibility	Presentation Technique	8
		Coherence & Compactness of Thought Flow	9
		Learning Presentation	10
3	Language Feasibility	Direct	11,12
		Dialogical and Interactive	13
		Appropriateness to Student Development	14
		Conformity with Language Rules	15

Adapted and modified from (Almira et al., 2017)

3.7.2 Validation Sheet by Learning Experts

This validation sheet aims to determine the assessment by media experts on the LKPD products developed, containing aspects of presentation feasibility and content feasibility on LKPD which will be validated by 1 media expert. The lattice of instrument validation sheets by media experts can be seen in Table 3.2.

Table 3.2 Lattice of Questionnaire Validation Sheet by Learning Experts

No	Aspect	Indicator	No. Item
1	Content Feasibility	The pouring out of ideas or thoughts	1
		Content presentation design	2
		Preparation of LKPD	3
		Space for students to write down their ideas.	4
		The recency of the problem in the LKPD	5
		Suitability of LKPD in Motion System material	6
2	Learning Components	Orienting the problem	7
		Organizing students to learn	8
		Conducting independent and group investigations	9
		Developing the work of investigation	10
		Presenting and exhibiting the results of the investigation	11
		Analyzing the problem	12
		Evaluating the problem solving process	13

Adapted and modified from (Almira et al., 2017)

3.7.3 Media Expert Validation Sheet

This validation sheet aims to determine the assessment by media experts on the LKPD products developed, containing aspects of grammatical feasibility and language use on LKPD which will be validated by 1 media expert. The lattice - lattice instrument validation sheet by media experts can be seen in Table 3.3.

Table 3.3 Grid of Questionnaires for Validation Sheet by Design Experts

No	Aspect	Indicator	No. Item
1	Software	Compatible (learning multimedia can be accessed or run on various existing hardware or software)	1
		Usable (easy to use and simple to operate)	2,3
		Reusable (reuse either part or all of the learning multimedia)	4
		Operational learning multimedia	5
2	Visual Communication	Use of letters	6,7
		Use of color	8,9
		Layout of elements	10,11
		Illustration Content	12,13,14
3	Media Characteristics	LKPD Characteristics	15

Addapted and modified from (Almira et al., 2017)

3.7.4 Teacher Response Questionnaire

The instrument used in measuring teacher response is using a teacher response questionnaire sheet. The use of teacher responses to LKPD aims to see the teacher's response to the product developed. The questionnaire lattice of teacher responses to the LKPD can be seen in Table 3.4.

Table 3.4 Teacher Response Questionnaire Grid

No	Aspect	Indicator	No. Item
1	Learning Design	Accuracy of LKPD title with material	1
		The suitability of the material presented in the LKPD with Basic Competencies	2
		Coverage of material contained in LKPD	3,4

		Suitability of exercise questions in LKPD with the material presented	5
		Students' learning motivation during learning by using LKPD	6
		The accuracy of LKPD development with Motion System material	7
2	Operational	Availability and clarity of instructions for using LKPD	8
		Ease of using LKPD	9
3	Visual Communication	The suitability of the type of font in LKPD	10
		Language used in LKPD	11,12
		Image display of LKPD	13,14,15

3.7.5 Student Response Questionnaire

The tool used to measure student responses was a student response questionnaire via a G-Form link. The use of student responses to the LKPD was intended to observe student responses to the developed product. The pattern of teacher response questionnaires to the LKPD can be seen in Table 3.5.

Table 3.5 Student Response Questionnaire Grid

No	Aspect	Indicator	Number item
1	Material	Presentation of Material	1, 2
		Attractiveness and Clarity	3,4,5,6,7,8,9,10
2	Display	Content Design	11, 12, 13, 14, 15
		Support Capacity	16, 17, 18

3.7.6 Test Instrument

The instrument used is a test instrument in the form of pretest and posttest as many as 40 multiple choice questions with 5 choices (a, b, c, d, e). The items were designed to cover 3 (three) indicators of cognitive ability levels in learning, namely C4 (Analyzing), C5 (Evaluating), C6 (Creating). The

questions given to students are in the form of multiple choices which are used to measure the improvement of student learning outcomes on the material of the motion system after testing using the LKPD based Learning Cycle 5e. Test analysis was conducted by expert validators.

Table 3.6 Lattice of Test Questions on Motion System Material

No	Indicator	Question levels and their distribution			Total
		C4	C5	C6	
1	Explain the structure and function of the skeleton as a constituent of the human movement system	5, 12	13, 16, 27, 35	6, 9, 17, 40	10
2	Explain the relationship between bones that form various joints	1, 32	29, 30	25, 39	6
3	Explain the structure and function of muscles as constituents of the human movement system	3, 15, 26, 28, 33	8, 10, 18, 23	7, 14, 34, 36, 38	14
4	Identify various diseases or disorders that occur in the human movement system	19, 20, 24	2, 4, 21, 22, 31, 37	11	10
Total		12	16	12	40

3.8 Research Procedure

The procedure used by researchers in developing products follows the 4-D development model. The following is a chart of the development stages of the 4-D model.

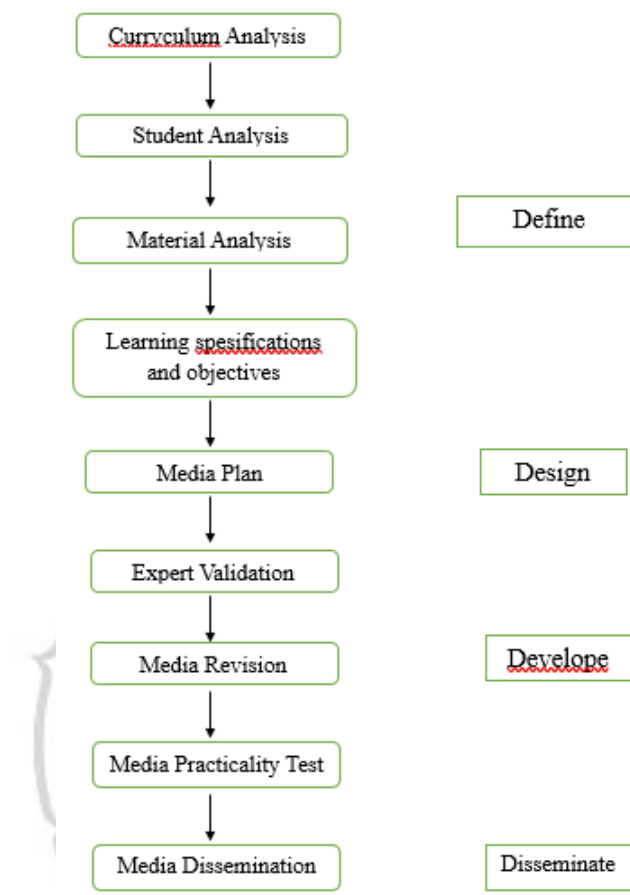


Figure 3.1 Schematic of the 4D Development Research Model (Riani Johan et al., 2023)

The procedure carried out by researchers in creating a learning cycle 5e-based biology learning LKPD on the material of the Motion System for class XI SMA Kartika I-2 Medan is in accordance with the 4-D development model belonging to Sivasailam Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel. Semmel. The stages of the development model include, among others, the defining stage (define), the design stage (design), the development stage (development), and the dissemination stage (disseminate).

3.8.1 Define Stage

At this stage, the initial stage is carried out to fill in the list of learning requirements to see and find problems that exist at SMA Kartika I-2 Medan. Steps at this stage, namely :

1. Curriculum analysis, intended to identify the curriculum used in schools, identify learning methods used by teachers, and identify fundamental problems faced in learning biology.
2. Student analysis, intended to assess the needs and types of students in class XI IPA 2 SMA Kartika I-2 Medan as a learning plan based on the LKPD problem to be developed.
3. Material Analysis, intended to determine the content in the LKPD using the Learning Cycle 5e model of biology learning material on the Motion System that will be created. This analysis includes content presentation, procedures, information, and objectives.

3.8.2 Design Stage

This activity includes the preparation of Learning Cycle 5e-based LKPD on the material of the Motion System in class XI SMA Kartika I-2 Medan. The purpose of this LKPD design is to ensure that the LKPD is designed with the abilities and needs of students in accordance with the Merdeka curriculum. The steps of designing LKPD include collecting material, selecting formats, preparing test instruments.

3.8.3 Development Stage

The development phase is the phase where researchers design the developed product. The elements implemented in the development phase are :

1. Expert Validation
Products that have been made will be validated by material expert validators and media experts who will produce suggestions, comments, and input as a reference for making revisions. After the product is revised, the revised results will then be used in the product trial or implementation stage.
2. Media Revision
After approval (validation process completed) of this product by all experts, the researcher refined and implemented it according to the auditor's review and evaluation, so that the product became even better.
3. Media Practicality Test

LKPD that have been corrected and revised are then given or sent to teachers and students to find out whether the product is suitable for use or not.

3.8.4 Disseminate Stage

After completing the development stage, the next stage is the dissemination stage. At this stage, the LKPD that has been revised during the development stage will be produced for wider use in other schools to test the effectiveness of teaching materials by actual users over a long period of time. In this study, only limited dissemination was carried out, namely by distributing the final product of the LKPD based on Learning Cycle 5E to biology teachers of grade XI and students of grade XI-2 at Kartika I-2 High School in Medan.

3.9 Data Analysis

This research uses descriptive data analysis and the data analysis method is divided into two parts, namely data analysis of validation survey results conducted by experts, teachers, and students and data analysis of product effectiveness using normalized N-gain.

3.9.1 Expert Team Assessment Data Analysis

The data obtained from the answers to the questionnaire given were analyzed with a Likert scale. The steps are as follows:

1. Data was obtained in the form of a check list summarized in the form of a Likert scale that has been scored as in Table 3.6

Tabel 3.6 Criteria for Answering Instrument Item Validation with Likert Scale

No	Answer	Score
1	Very Feasible	5
2	Feasible	4
3	Fairly Feasible	3
4	Less Feasible	2
5	Not Feasible	1

2. Calculate the feasibility level with the following formula:

$$P = \frac{f}{N} \times 100\%$$

(Widoyoko, 2016 : 142)

Description:

P = Category Presentation

f = Number of category scores selected

N = Total ideal score

From the results of the calculation using the formula above, a number in the form of percentages is produced which is interpreted qualitatively.

Table 3.7 Presentation of Assessment and Feasibility of Validation Questionnaire Instruments

Score Range	Interval Presentation (%)	Criteria	Qualification
$32,5 \leq x \leq 40$	$81,25 \leq x \leq 100$	Very Feasible	The questionnaire instrument is ready to be utilized in the field for research / no revisions
$25 \leq x \leq 32,5$	$64,28 \leq x \leq 81,25$	Feasible	The questionnaire instrument is ready to be used in the field for research / no minor revisions
$17,5 \leq x \leq 25$	$44,64 \leq x \leq 62,5$	Less Feasible	The questionnaire instrument can be continued by adding something missing, making certain considerations, the additions made are not too large.

$10 \leq x \leq 17,5$	$25 \leq x \leq 43,8$	Not Feasible	Revise the questionnaire instrument by re-examining carefully and looking for weaknesses in the product to be refined.
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Table 3.8 Presentation of Assessment and Feasibility of LKPD for Expert Questionnaire Instruments

Scor Range	Interval Presentation (%)	Criteria	Qualification
$47 \leq x \leq 56$	$83,92 \leq x \leq 100$	Very Feasible	LKPD products can be used in the field for learning activities but there are minor revisions / no revisions
$36 \leq x \leq 46$	$64,28 \leq x \leq 82,14$	Feasible	LKPD products can be used in the field for learning activities but there are minor revisions
$25 \leq x \leq 35$	$44,64 \leq x \leq 62,5$	Less Feasible	LKPD products can be continued by adding something that is lacking, making certain considerations, the additions made are not too large.
$14 \leq x \leq 24$	$25 \leq x \leq 42,85$	Not Feasible	Revise the LKPD by re-examining carefully and looking for weaknesses

			in the product to be refined.
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3.9.2 Data Analysis of Teacher & Students Practicality Test Questionnaire Results

The instrument assessment was arranged according to a rating scale calculation scale which was tested on 1 biology teacher at SMA Kartika I-2 Medan.

The steps are as follows:

1. Data obtained in the form of a check list summarized in the form of a Likert scale that has been given a score in table 3.9
2. Calculating the LKPD practicality test by the teacher with the following formula:

$$P = \frac{f}{N} \times 100\%$$

(Widoyoko, 2016 : 142)

Description:

P = Category Presentation

f = Number of selected scores

N = Total total score

3. From the calculation results, the results will be obtained in the form of percentages, then interpreted in qualitative sentences. The presentation of the LKPD practicality test by the teacher can be seen in table 3.9

Table 3.9 Criteria for Practicality Test Results by Teachers & Students

No	Interval	Criteria
1	76% - 100%	Very Practical
2	51 % - 75%	Practical
3	26% - 50%	Less Practical
4	0 % - 25%	Not Practical

3.9.3 Validity Test

Test validity is used to determine how valid the items used as research instruments are. In the validity test, the product moment correlation technique is used, namely the definition r_{xy} will show the correlation index between variables X and Y using the help of SPSS.

$$r_{xy} = \frac{N \sum xy - (\sum x)(\sum y)}{\sqrt{(N \sum x^2 - (\sum x^2))(N \sum y^2 - (\sum y^2))}}$$

Description:

r_{xy} = Coefficient between X and Y

N = Number of test subjects

x = Score per item

y = Total score

$\sum xy$ = Multiplication of scores per item and total score

$\sum x$ = Multiplication of the score of each item and the total score

$\sum y$ = Multiplication of scores of each item and total score

To determine the level of validity from the beginning, the validity of the questions was tested using SPSS. For multiple choice learning outcome tests on the validation test results can be seen in the following table.

Table 3.10 Criteria for Question Validity

Range	Classification
0,810-1000	Very High Validity
0,610-0,800	High Validity
0,410-0,600	Fair Validity
0,210-0,400	Low Validity
0,000-0,200	Very Low Validity

3.9.4 Reliability Test

The reliability test is used to state the consistent level of a test question. The reliability test uses the following formula

$$r_{11} = \left(\frac{k}{k-1} \right) \left(\frac{x^2 - \Sigma pq}{S^2} \right)$$

Description :

r_{11} = Overall test reliability

k = Number of items

p = Proportion of subjects who answered the item correctly

q = Proportion of subjects who answered the item incorrectly

Σpq = The sum of the product of p and q

S^2 = Score variance

With the interpretation of the reliability value as follows

Table 3.11 Interpretation of the Reliability Value

The value of r	Interpretation
0,00-0,20	Very Low
0,21-0,40	Low
0,41-0,60	Fair
0,61-0,80	High
0,81-1,00	Very High

3.9.5 Problem Difficulty Level

Level of difficulty is a number that indicates the difficulty and ease of a question. In this study, the test of the level of difficulty of the question used the following formula

$$P = \frac{B}{JS}$$

Description :

P = Difficulty Index

B = The number of students who answered the question correctly

JS = Number of students taking the test

With criteria as follows

Table 3.12 Test Score Question Difficulty

Question Difficulty Level	Question Category
0,00-0,29	Difficult
0,30-0,69	Medium
0,69-1,00	Easy

3.9.6 Differentiating Power

In determining the differentiating power of the question, the following formula can be used

$$D = \left(\frac{BA}{JA} \right) - \left(\frac{BB}{JB} \right)$$

Description :

D = Differentiating Power

BA = The number of upper group participants who answered correctly

JA = Number of upper group participants

BB = The number of lower group participants who answered correctly

JB = Number of lower group participants

With criteria as follows

Table 3.13 Criteria for Question Distinguishing Power

Criteria for Question Distinguishing Power	Interpretation
0,00-0,20	Bad
0,21-0,40	Fair
0,41-0,70	Good
0,71-1,00	Excellent

3.9.7 Data Analysis of Product Effectiveness Assessment

Development research in the field of education to see its impact can be done directly through product assessment after simulation. This assessment is carried out to obtain the feasibility or effectiveness of the product results. In addition, the N-Gain formula is used to measure the increase in individual and group understanding. The impact of the developed LKPD product is tested in the

learning process. The design used is a Pre-test Post-test Single Group Design. The research involved one class with a total of 36 students, in accordance with the research design listed in Table 3.14.

Table 3.14 One – Group Pretest – Posttest Design

Class	Pre-Test	Treatment	Post-Test
XI SMA Kartika I-2 Medan	A ₁	With LKPD	A ₂

Description:

O1 is the pretest value or the initial value before using the LKPD.

O2 is the posttest value using the Learning Cycle 5E LKPD.

The implementation of the test in the learning process in the classroom is:

- (1) Determining which class is used as the main group and determining which group is given treatment;
- (2) Giving an initial ability test (pre-test) on biological material in the class;
- (3) Giving treatment to the class that is used as a subject;
- (4) Giving the final ability test (post-test) which is the same as the pre-test question;
- (5) Data analysis using gain score.

$$\text{Gain score} = \frac{\text{skor posttest} - \text{skor pretest}}{\text{skor maksimum} - \text{skor pretest}}$$

With the gain index interpretation criteria shown in the following table:

Tabel 3.15 N-Gain Category

Nilai N – Gain	Category
N – Gain $\geq 0,70$	High
$0,30 < \text{N – Gain} \leq 0,70$	Medium
N – Gain $\leq 0,30$	Low