

Development of a Gamification-Based LKPD for the Human Movement System in Grade XI SMA N 1 Medan

Pengembangan LKPD Berbasis Gamifikasi untuk Materi Sistem Gerak Manusia di Kelas XI SMA Negeri 1 Medan

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Abstract. Biology learning on the Human Movement System still relies on conventional media that are less interactive, causing low student motivation and suboptimal learning outcomes. This study aimed to develop a gamification-based Student Worksheet on the Human Movement System material that is feasible, practical, and effective in improving learning motivation and outcomes of Grade XI students at SMA Negeri 1 Medan. This study used the Research and Development method with the 4D model comprising the Define, Design, Develop, and Disseminate stages. Data were collected through validation questionnaires, teacher and student response questionnaires, motivation questionnaires based on the ARCS model, and pretest-posttest instruments. Feasibility and practicality were analyzed using descriptive percentage analysis, while improvement was analyzed using the Normalized Gain formula. The Student Worksheet obtained material expert validation of 94.64% and design expert validation of 85%, both categorized as highly feasible. Teacher response practicality reached 96.67%, categorized as very practical. The N-Gain scores were 0.79 for learning motivation and 0.81 for learning outcomes, both categorized as high. These results conclude that the gamification-based Student Worksheet is feasible, practical, and effective. This study contributes to innovative Biology instructional media development by demonstrating that gamification elements promote active and student-centered learning in secondary education.

Keywords: *gamification; human_movement_system; learning_motivation; learning_outcomes; student_worksheet*

Abstrak. Pembelajaran Biologi pada materi Sistem Gerak Manusia masih bergantung pada media konvensional yang kurang interaktif, sehingga menyebabkan rendahnya motivasi dan hasil belajar siswa. Penelitian ini bertujuan mengembangkan Lembar Kerja Peserta Didik berbasis gamifikasi pada materi Sistem Gerak Manusia yang layak, praktis, dan efektif dalam meningkatkan motivasi dan hasil belajar siswa kelas XI SMA Negeri 1 Medan. Penelitian ini menggunakan metode Penelitian dan Pengembangan dengan model 4D yang terdiri dari tahap Define, Design, Develop, dan Disseminate. Data dikumpulkan melalui angket validasi, angket respons guru dan siswa, angket motivasi berbasis model ARCS, serta instrumen pretest dan posttest. Kelayakan dan kepraktisan dianalisis menggunakan analisis persentase deskriptif, sedangkan peningkatan motivasi dan hasil belajar dianalisis menggunakan rumus Normalized Gain. Lembar Kerja Peserta Didik memperoleh skor validasi ahli materi sebesar 94,64% dan validasi ahli desain sebesar 85%, keduanya dikategorikan sangat layak. Kepraktisan dari respons guru mencapai 96,67%, dikategorikan sangat praktis. Skor N-Gain sebesar 0,79 untuk motivasi belajar dan 0,81 untuk hasil belajar, keduanya dikategorikan tinggi. Hasil ini menyimpulkan bahwa Lembar Kerja Peserta Didik berbasis gamifikasi layak, praktis, dan efektif. Penelitian ini berkontribusi pada pengembangan media pembelajaran Biologi yang inovatif dengan menunjukkan bahwa elemen gamifikasi mendorong pembelajaran aktif dan berpusat pada siswa di jenjang pendidikan menengah.

1. Introduction

Education plays an important role in improving the quality of human resources through learning activities that encourage students to think critically, creatively, and actively. In Biology learning, students are expected not only to memorize concepts but also to understand scientific processes and their application in daily life. Therefore, Biology learning requires instructional media and teaching materials that can support students' understanding and engagement during the learning process (1)

One of the Biology topics considered difficult by students is the human Movement system. The human Movement system in *Homo sapiens* consists of bones, joints, and muscles that work together to support body movement and maintain posture. This material contains abstract and complex concepts, requiring students to understand the relationship between structures and physiological mechanisms involved in movement. Based on observations and interviews conducted at SMA Negeri 1 Medan, learning on the Movement system still relies mainly on conventional media such as printed modules and PowerPoint presentations. In addition, the LKPD used in learning generally only contains summaries and exercises without interactive activities, causing students to become less active and less motivated during learning. As a result, students' understanding and learning outcomes are still not optimal.

Learning motivation is one of the important factors affecting students' achievement. Students with high motivation tend to participate actively, complete tasks seriously, and achieve better learning outcomes. Therefore, teachers need to apply innovative learning strategies that can increase students' motivation and engagement. Innovative learning media are needed to create

student-centered learning and encourage active participation during the learning process (2). One of the learning media that can support active learning is the Student Worksheet (LKPD), which guides students through structured activities and exercises. However, conventional LKPDs are often less interactive and unable to attract students' interest effectively.

To overcome these problems, gamification can be integrated into LKPD. Gamification is the application of game elements such as points, levels, rewards, and challenges in non-game contexts, including education (3). The use of gamification is based on the assumption that game elements can increase students' motivation, participation, and learning engagement by creating a more enjoyable and meaningful learning environment. Through gamification, students are encouraged to participate actively and complete learning activities through challenging and structured stages (4).

Several previous studies have shown that gamification has a positive impact on Biology learning (5) found that a gamification-based digital module on the human reproductive system was valid and practical to use. Gamification strategies improved students' learning outcomes on excretory system material (6). The other also revealed that gamification-based learning applications increased students' motivation and conceptual understanding (7). Other studies also showed that interactive LKPD and learning media support active and student-centered learning processes (8) on digital modules and applications for other organ system materials. Research specifically developing a gamification-based LKPD on the human Movement system material to improve both learning motivation and learning outcomes is still limited. Therefore, this study provides novelty by developing a gamification-based

LKPD integrated with points, rewards, levels, and challenges specifically for the Movement system material.

This study uses the Research and Development (R&D) method with the 4D model developed by Thiagarajan, consisting of Define, Design, Develop, and Disseminate stages. The model is selected because it provides systematic stages for developing instructional products. The developed LKPD is expected to create

more engaging learning activities and improve students' motivation and learning outcomes (9).

Based on the explanation above, the purpose of this study is to develop a gamification-based Student Worksheet (LKPD) on the human Movement system material that is feasible, practical, and effective in improving students' learning motivation and learning outcomes in Grade XI SMA Negeri 1 Medan.

2. Methods

Place and Time of the Research

This research was conducted at SMA Negeri 1 Medan, located at Jalan Teuku Cik Ditiro No. 1, Madras Hulu Village, Medan Polonia District, Medan City, North Sumatra Province. The research activities were carried out from January to March 2026.

Type and Design of the Research

This study employed Research and Development (R&D) as the research method. Research and Development is a method used to develop and test the feasibility and effectiveness of an instructional product. The design applied in this research was the 4D development model developed by Thiagarajan, consisting of four stages: Define, Design, Develop, and Disseminate. This model was selected because it provides systematic and structured procedures for developing learning products.

The product developed in this study was a gamification-based Student Worksheet (LKPD) on the human Movement system material for Grade XI students. The research focused on evaluating the feasibility, practicality, and effectiveness of the developed LKPD in improving students' learning motivation and learning outcomes.

Research Subjects and Objects

The subjects of this research were material expert validators, design expert validators, a biology teacher, and students of class XI-2 SMA Negeri 1 Medan. The object of the research was the gamification-based Student Worksheet (LKPD) on the

human Movement system material developed by the researcher.

Research Instruments

The instruments used in this study consisted of:

1. Observation sheets
2. Teacher interview sheets
3. Validation questionnaires for material experts and design experts
4. Teacher response questionnaires
5. Student response questionnaires
6. Learning motivation questionnaires based on the ARCS model
7. Pretest and posttest questions

The materials used in this study included the biology curriculum for Grade XI, references related to the human Movement system, and supporting references regarding gamification-based learning. The tools used included laptops, Microsoft Word, Canva, printers, stationery, and smartphones for documentation.

Research Procedures

This research followed the stages of the 4D development model, which are described as follows:

1. Define Stage

At this stage, the researcher identified learning problems and analysed students' needs through observation, interviews, and questionnaires. Curriculum analysis and analysis of learning objectives were also conducted to determine the scope of the material and indicators of learning outcomes.

2. Design Stage

The researcher designed the initial draft of the gamification-based LKPD. Activities included selecting materials, determining the LKPD format, integrating gamification elements such as points, rewards, levels, and challenges, and preparing research instruments.

3. Develop Stage

The initial LKPD draft was validated by material experts and design experts. Revisions were carried out based on suggestions from validators. After revision, the LKPD was tested on students through limited trials and field testing to determine its practicality and effectiveness.

4. Disseminate Stage

At this stage, the finalized LKPD was implemented in classroom learning. Pretest and post-test were administered to measure students' learning outcomes, while motivation questionnaires were distributed to determine students' learning motivation after using the LKPD.

Data Collection Techniques

Data collection techniques used in this study included observation, interviews, questionnaires, and tests. Observation was conducted to identify classroom conditions and learning activities. Interviews with the Biology teacher were conducted to obtain information about learning problems and students' needs. Questionnaires were used to collect validation data, teacher responses, student responses, and learning motivation data. Tests in the form of pretest and post-test were used to measure students' cognitive learning outcomes before and after using the LKPD.

3. Result and Discussion

The gamification-based LKPD on the Human Movement System material was developed using the 4D model consisting of define, design, development, and disseminate stages. The feasibility of the LKPD was evaluated by material and design experts.

Data Analysis

The data obtained in this study consisted of quantitative and qualitative data. Quantitative data included validation scores, questionnaire results, and students' learning outcome scores, while qualitative data were obtained from suggestions and comments provided by validators, teachers, and students.

The feasibility and practicality data were analysed descriptively using a Likert scale with four categories. The percentage score was calculated using the following

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

Description:

P= Percentage Score

f = Total Score Obtained

N= Maximum Possible Score

The improvement in students' learning motivation and learning outcomes was analyzed using the N-gain formula:

$$N - gain = \frac{Posttest\ score - Pretest\ score}{Maximum\ score - Pretest\ score}$$

Description:

Post-test= Score after treatment

Pretest: Score before treatment

Maximum Score: Highest possible score

The results of the N-gain analysis were then classified into high, medium, and low categories to determine the effectiveness of the gamification-based LKPD in improving students' learning motivation and learning outcome

The material expert validation obtained a percentage score of 94.64%, categorized as very feasible, while the design expert validation obtained 85%, also categorized as very feasible (Table 1).

Table 1. Expert validation Results

Validator	Percentage (%)	Criteria
Material Expert	94. 64	Very Feasible
Design Expert	85	Very Feasible

The practicality of the LKPD was evaluated through teacher and student response questionnaires conducted in

individual, small-group, and large-group trials. The results are presented in Table 2.

Table 2. Practicality Test Results

Trial Stage	Percentage (%)	Criteria
Individual Trial	76. 13	Practical
Small Group Trial	78. 52	Practical
Large Group Trial	87. 43	Very Practical
Biology Teacher Response	96. 67	Very Practical

The effectiveness of the gamification-based LKPD in improving students' learning motivation was analyzed using the N-Gain formula. The results showed that

the N-Gain score of students' learning motivation was 0.79, categorized as effective (Table 3).

Table 3. Students' Learning Motivation Results

Variable	N-Gain Score	Criteria
Learning Motivation	0,79	Effective

Students' learning outcomes were measured through pretest and post-test activities after the implementation of the gamification-based LKPD. The results

showed that the N-Gain score of learning outcomes was 0.81, categorized as high (Table 4).

Table 4. Students' Learning Motivation Results

Variable	Score
Pretest Average	58. 90
Posttest Average	91. 20
N-Gain	0. 81

The high feasibility scores from the material and design experts indicate that the developed LKPD was appropriate for classroom learning. The LKPD content was arranged systematically and aligned with the learning outcomes, covering bones, joints, muscles, movement mechanisms, and disorders of the movement system. The use of communicative language and structured activities also supported students' understanding of the material. These findings are in line with previous studies stating that instructional materials should be aligned with learning objectives and students' (10) needs to support effective learning.

From the design aspect, the integration of gamification elements such as points, levels, challenges, and rewards successfully increased the attractiveness of the LKPD. The use of illustrations, layouts, and consistent colours also improved readability and student interest. Similar findings were reported by (11), who explained that gamification can increase student engagement and participation during learning activities.

The practicality results indicate that the LKPD was easy to use and understandable for both teachers and students. The learning instructions and gamification mechanisms were presented clearly,

allowing students to follow learning activities independently. In addition, the varied activities, including discussions, challenges, and exercises, prevented students from becoming bored during learning (8).

The high teacher response score also indicates that the LKPD was compatible with classroom learning conditions and facilitated teachers in guiding students during learning activities. This finding supports previous research stating that practical learning media should support both student participation and teacher facilitation during the learning process (12).

The implementation of the gamification-based LKPD significantly improved students' learning motivation. The increase in motivation occurred because the gamification elements created a more engaging learning atmosphere compared to conventional learning methods. Features such as points, levels, rewards, and challenges encouraged students to participate actively during learning activities.

This finding is consistent with the Self-Determination Theory proposed by (13), which explains that intrinsic motivation increases when students experience competence and meaningful learning experiences. The increase in motivation can also be explained through the ARCS model consisting of Attention, Relevance, Confidence, and Satisfaction (14). The attractive LKPD display captured students' attention, while the gradual challenges improved students' confidence and the reward system generated learning satisfaction (15).

4. Conclusion

The development of a gamification-based LKPD on the Human Movement System material for grade XI students at SMA Negeri 1 Medan, using the 4D model, resulted in a product categorized as very feasible (material expert: 94.64%; design expert: 85%) and effective in improving

The implementation of the gamification-based LKPD also improved students' learning outcomes significantly. The increase in pretest and post-test scores indicates that students experienced better conceptual understanding after using the LKPD (16).

Based on the discussion above, there is a tendency for a positive relationship between increased learning motivation and improved student learning outcomes. The N-Gain score for learning motivation of 0.79 (high category) aligns with the N-Gain score for learning outcomes of 0.81 (high category), indicating that both variables move in the same direction and reinforce one another. This can be explained through the cause-and-effect mechanisms that occur during the learning process. When students are motivated by the point, level, and reward systems in gamified worksheets, they tend to participate more actively in every learning activity, are more persistent in completing the challenges presented, and are more focused on understanding the material presented, which ultimately has a direct impact on improving their learning outcomes. This finding aligns with the view that learning motivation is an internal factor that plays a crucial role in determining the quality of students' learning processes and outcomes (17). Thus, the implementation of gamified worksheets has proven not only to enhance learning motivation but also to positively impact learning outcomes, thereby collaboratively supporting students' learning success.

students' learning motivation and cognitive learning outcomes, with N-Gain scores of 0.79 and 0.81, both in the high category. These findings confirm that gamification-based LKPD can serve as an innovative, validated medium to support more engaging and student-centered Biology learning, while enriching the literature on

gamification in science education. Further research is recommended to involve control classes and apply the LKPD to other

Biology topics or educational levels to examine its effectiveness more broadly.

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