Multimedia Learning Modules (MLMs) Based on Local Wisdom in Physics Learning to Improve Student Diagram Representations in Realizing the Nature of Science

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Abstract—This research was conducted to determine the feasibility of the instrument diagram representation test and the effectiveness of Multimedia Learning Modules (MLMs) integrated local wisdom in physics learning activities. The study design used a pretest-posttest control group design. The research instrument consisted of tests and non-tests. The test instrument was in the form of five items arranged according to the diagram representation indicators, namely drawing diagrams and their components and performing mathematical calculations according to the diagram explanation. The non-test instrument is a questionnaire study of test instruments. The validation of the test instrument was carried out using Aiken's V. The data analysis techniques used the General Linear Model (GLM) with a significance level of 0.05 to test the effectiveness of integrated local wisdom MLMs in improving student diagram representation. The results showed that the overall item items were declared valid with Aiken's V score in the range of 0.88 to 0.92 and the integrated local wisdom MLMs were effectively used in physics learning activities to improve student diagram representation based on Mean Difference (MD) values of -54,449.

Keywords—Diagrams, test instruments, local wisdom, multimedia learning modules, representations

1 Introduction

Physics learning in 21st century is very closely related to technological development. Rapidly developing technology makes learning activities more dynamic. Learning activities that require representation ability can be integrated with technologies such as interactive multimedia. The application of interactive multimedia has a positive impact as a support for learning to improve students' understanding of concepts [1]. Agreeing with this, interactive multimedia can also be used to improve problem-solving abilities [2]. In addition, the involvement of multimedia in learning activities can also improve learning achievement, positive attitudes and student motivation compared to conventional learning [3][4]. This indicates that the development of learning is in harmony with the development of technology so that media is needed that can be used to facilitate the delivery of material concepts.

Multimedia Learning Modules (MLMs) are introductory media that aim to motivate students to actively participate and be able to prepare and have preliminary knowledge before learning activities begin [5][6][7]. MLMs are made in the form of multimedia presentations in the form of graphic, text, video, narrative, animation and audio features that are realized with various forms of representation [3][4][7][8][9]. Various forms of representation provided a positive impact in the form of wealth of information from the use of MLMs so as to make learning activities more effective, increase students' understanding and motivation and students can obtain meaningful information and levels of understanding increase if they can link existing representations [3][10][11][12]. MLMs are used as a learning tool to reduce the limitations of the use of less effective textbooks where students only read books without taking more important information [7][13][14][15].

Indonesian Minister of Education and Culture Regulation No. 22 of 2016 concerning the standard process states that learning at primary and secondary levels must be held interactively, inspiratively, fun and can motivate students to actively participate in learning according to their interests and talents. But in reality, the teacher does not understand these aspects so physics tends to be learning that is abstract, difficult to understand and does not motivate students [16]. Learning that is abstract and difficult to understand can lead to negative perceptions related to the learning material. Students' negative perceptions of physics learning come from several factors such as teachers, peers and family, the community environment, and several other internal and external factors [17]. These factors influence the formation of character, attitudes, thought patterns and behavior of students in the development of perception and knowledge into a form of learning experience. This statement agrees with the results of the research by [18] which shows a positive relationship between students' perceptions of physics learning activities. Therefore, physics learning can be carried out well if students have positive perceptions that are able to encourage interactive, inspirational and challenging learning so that it is easier to understand.

Good learning suggests linking the concept of learning with the phenomena of everyday life so that the process of knowledge transfer becomes more meaningful. Meaningful learning can be realized by integrating local wisdom in its implementation [19]. The application of local wisdom to learning activities can make learning conditions more enjoyable. This makes students able to feel their experiences in daily life closer to learning [20]. In addition, learning activities by applying local wisdom also have a positive influence on the character of students and are able to improve academic achievement [21].

Positive influences related to increasing student academic achievement in the abstract and difficult to understand physics learning process can be realized by implementing appropriate problem solving strategies. The process of finding a solution to a problem depends on the solution strategy applied [22]. One strategy that can be used in solving problems (problem solving) is to use representation [23]. Representation can be used to solve physics problems [24]. A similar sentiment was also conveyed by Kurnaz and Arslan who explained that the use of representations during physics learning activities can make the learning process more meaningful and enhance students' understanding of concepts [25].

Diagrams are a form of representation that is often used to solve physics problems. The use of diagrams is very important to explain and understand phenomena from various kinds of multidisciplinary science [26]. Physics is learning about natural phenomena which are divided into several parts including kinematics and dynamics [23]. Some physical concepts related to kinematics and dynamics include force, motion, momentum and energy [23]. These materials must be understood and mastered by students because they relate in everyday life. But in reality, students still have difficulty understanding material related to the concepts of kinematics and dynamics. This is because these materials use diagrams as a means of representation in their learning [27]. The results of research show that some students still have difficulty in drawing free diagrams [28][29].

Diagrams as a form of representation help students interpret, represent and implement problem solving strategies to solve problems (problem solving) they face [30]. The representation of diagrams known in physics learning includes free-body diagrams, field line diagrams, energy bar charts [31] and among others. The advantages of using diagrams as representations are:

1. Diagrams help to explain scientific phenomena that occur easily
2. Diagrams provide a means to analyze and understand scientific phenomena
3. The diagram can be used as a means to identify cognitive abilities [32]

In addition, several advantages of using diagrams as representations such as:

1. Diagrams showing scientific cases explicitly
2. Diagrams act as bridging representations between real (concrete) and abstract situations
3. Diagrams help to foster intuition [33]

This study aims to test the feasibility of the instrument test the ability to represent diagrams and the effectiveness of Multimedia Learning Modules (MLMs) integrated local wisdom in physics learning activities.

2 Research Methods

This research uses a quantitative approach with a pretest-posttest control group design. Field testing was conducted to draw conclusions related to the implementation of Multimedia Learning Modules (MLMs) in physics learning to improve student diagram representation. Field testing was carried out on three classes of Natural Sciences in SMA 2 Batang chosen randomly using the cluster random sampling technique. Table 1 shows the research design used.

Table 1. Research Design

Group	Pretest		Treatment	Postest	
	Y_1	***Y_2***		***Y_1***	***Y_2***
Experiment	T_1	T_1	X_1	T_2	T_2
Contrast 1	T_1	T_1	X_2	T_2	T_2
Contrast 2	T_1	T_1	X_3	T_2	T_2

Information

T_1 : *Pretest*

T_2 : *Postest*

Y_1 : Diagrammatic representation

Y_2 : Vector Representation

X_1 : Using Multimedia Learning Modules (MLMs) integrated local wisdom

X_2 : Using the integrated local wisdom print module

X_3 : Use common modules used by the teacher

The research instrument was in the form of a cognitive ability test consisting of five items arranged according to indicators. Table 2 shows the item grids based on the diagram representation indicators. The test instrument was validated using Aiken’s V based on the number of assessors (rater) and the rating scale used. The test instrument is declared valid if it has a coefficient value of Aiken's V of $V \geq 0.75$ with a number of rater 8 people and a rating scale ranging from 1 to 4 [34].

Table 2. Diagram Representation Capability Test Chart

Grid			
Indicator of Diagram Representation	Problem Indicator	Item Number	Bloom's Taxonomic Aspects
Draw a diagram with its components	Draw a free diagram of the forces acting on a traditional rowing boat that has zero momentum	1	C3
	Depicts the motion diagram of a traditional rowing boat	3	C3
	Draw a contact force diagram between water and rowing in a traditional rowing competition	2	C3
Perform mathematical calculations according to the diagram explanation	Determine the impulsive force based on the concept of the relationship of momentum and impulse	4	C3
	Determine the speed of the boat after the impact based on the law of conservation of momentum	5	C3

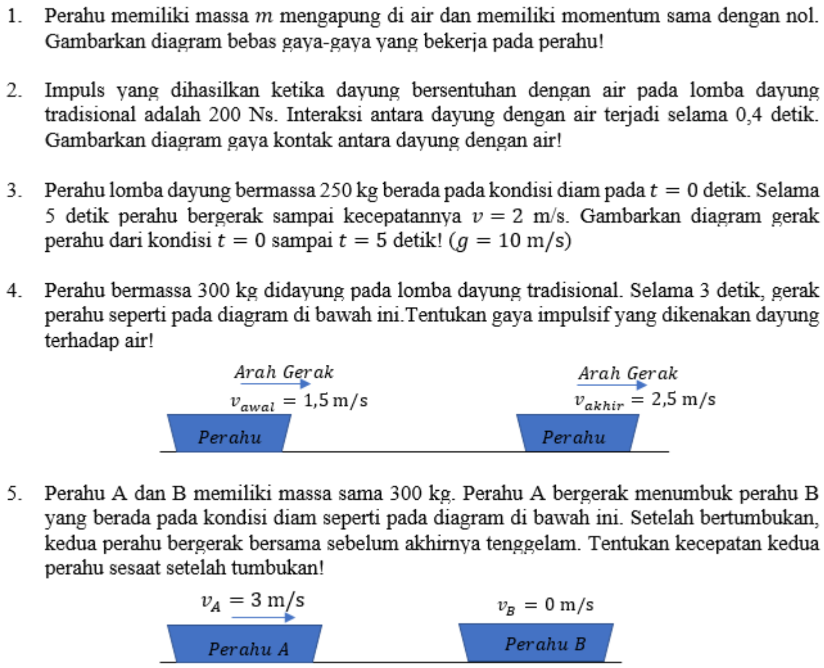
(Adapted from [35][36])

Data analysis techniques in the study used the General Linear Model (GLM) to infer an increase in students' diagram representation abilities. Improvement of students' diagram representation skills is seen based on the analysis of the pretest and posttest scores by comparing the value of the Mean Difference results of the output of the General Linear Model (GLM) mixed design [37].

3 Result and Discussion

3.1 Feasibility analysis instrument representation test diagram

The feasibility analysis of the diagram representation test instrument uses Aiken's V. The results of the Aiken V analysis show that the diagram representation test instrument is in the valid category. Table 3 shows the results of the analysis of the instrument assessment test representation diagram. Figure 1 shows the instrument of diagrammatic ability test used in this research.



1. Perahu memiliki massa m mengapung di air dan memiliki momentum sama dengan nol. Gambarkan diagram bebas gaya-gaya yang bekerja pada perahu!
2. Impuls yang dihasilkan ketika dayung bersentuhan dengan air pada lomba dayung tradisional adalah 200 Ns. Interaksi antara dayung dengan air terjadi selama 0,4 detik. Gambarkan diagram gaya kontak antara dayung dengan air!
3. Perahu lomba dayung bermassa 250 kg berada pada kondisi diam pada $t = 0$ detik. Selama 5 detik perahu bergerak sampai kecepatannya $v = 2$ m/s. Gambarkan diagram gerak perahu dari kondisi $t = 0$ sampai $t = 5$ detik! ($g = 10$ m/s)
4. Perahu bermassa 300 kg didayung pada lomba dayung tradisional. Selama 3 detik, gerak perahu seperti pada diagram di bawah ini.Tentukan gaya impulsif yang dikenakan dayung terhadap air!
5. Perahu A dan B memiliki massa sama 300 kg. Perahu A bergerak menumbuk perahu B yang berada pada kondisi diam seperti pada diagram di bawah ini. Setelah bertumbukan, kedua perahu bergerak bersama sebelum akhirnya tenggelam. Tentukan kecepatan kedua perahu sesaat setelah tumbukan!

Fig. 1. The Instrument of Diagrammatic Representation Ability used in Research

Table 3. Assessment Instrument Representation Test Diagram

Representation	Item Question	Aiken's V score	Criteria
Diagram	2,5	0,88	Valid
	1,3,4	0,92	Valid

The assessment of the instrument diagram representation test obtained Aiken's V score in the range of 0.88 to 0.92 which is in the valid criteria. This is in accordance with the validation criteria according to Aiken's V which states that for 8 validators and a rating scale ranging from 1 to 4, items are declared valid if obtaining an Aiken's V score $\geq$ 0.75 [34].

3.2 Analysis of improvement of student diagram representation

Data analysis to test the increase in student diagram representation is to use the General Linear Model (GLM). The analysis was carried out based on the students' pretest and posttest scores in doing diagram representation tests by interpreting Mean Difference (MD) and significance (Sig.) outputs on pairwise comparisons output. The results of the analysis are presented in Table 4.

Table 4. Pairwise Comparisons of Diagrammatic Representation

Group	**Time (I)**	**Time (J)**	**Mean Difference (I-J)**	**Sig.**
MLMs integrated local wisdom	Pretes	Postes	-54.449	.000
Integrated local wisdom print module	Pretes	Postes	-15.221	.000
General modules used by the teacher	Pretes	Postes	-13.110	.000

Table 4 shows the GLM output associated with increasing student diagram representation. Conclusions are based on significance (Sig.). Ho is rejected and Ha is accepted if the Sig value < 0.05. Table 4 in the significance column (Sig.) obtained a value of .000 which proves that Ho was rejected and Ha was accepted, meaning that there was a significant increase in the representation of student diagrams in the MLMs class integrated with local wisdom compared to the printed class module in local wisdom and the general modules used by the teacher. Significant improvement is evidenced from the Mean Difference value of -54,449 for the integrated local wisdom class MLMs, -15,221 for the integrated local wisdom module print class and -13,110 for the general module class used by the teacher. The Mean Difference value is used to show how much an increase in the student diagram representation. Mean difference (MD) is obtained from the reduction of the mean pretest score against the posttest score. The increasingly negative MD scores in Table 4 prove that there is a significant increase in the representation of student diagrams based on pretest and posttest scores. The pairwise comparisons output results in Table 4 prove that the MLMs class integrated with local wisdom gives a better score improvement than the printed class integrated local wisdom module and the general module used by the teacher to obtain an MD of -54,449 [37]. MD which has negative value proves that there is an increase in score from pretest to posttest [38].

Improvement of students' diagram representation ability is determined based on the analysis of the pretest and posttest scores displayed by the Estimated Marginal Means plot graph. The plot of increasing student diagram representation is presented in Figure 2. Figure 2 shows that the use of integrated local wisdom MLMs is able to increase student diagram representation. This is in agreement with the research which states that learning by applying MLMs can improve the ability of representation better than traditional learning [6]. In addition, meaningful learning can be realized by integrating local wisdom so that it can improve student academic achievement [19][20][21]. The intersection of lines between MLMs integrated local wisdom classes with print classes integrated local wisdom modules and the general modules used by the teacher in Figure 2 shows the interaction between MLMs integrated local wisdom classes, print modules integrated with local wisdom, and general modules used by teachers. This shows the influence generated between classes. The causes of the interaction include a number of students in the printed module integrated with local wisdom or the general module used by the teacher asking the experimental class students about the learning material. The effectiveness of MLMs in this study is in accordance with the results of other research which state that MLMs are a solution in overcoming the use of print media that are less effective [7][38].

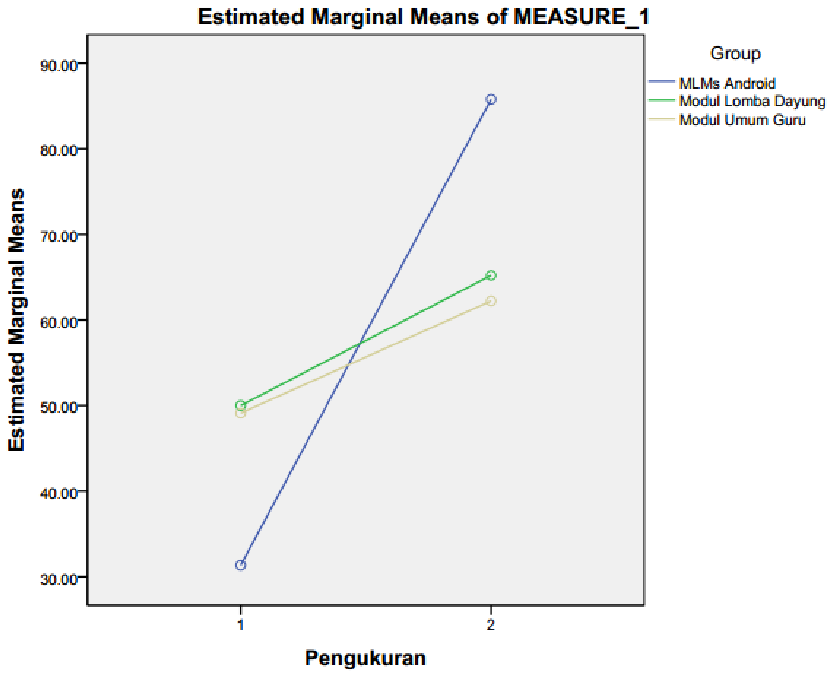


Fig. 2. Estimation Chart for Increased Student Diagram Representation

4 Conclusion and Future Work

In this study, the implementation of the influence of Multimedia Learning Modules (MLMs) integrated local wisdom on physics learning has been carried out to improve the representation ability of student diagrams. The results showed that Multimedia Learning Modules (MLMs) integrated with local wisdom can improve students' diagram representation abilities. Improved student diagram representation ability is obtained based on the analysis of pretest and posttest scores after using Multimedia Learning Modules (MLMs) in physics learning with General Linear Model (GLM) techniques. Analysis technique using GLM proves that the MLMs class integrated with local wisdom gives improved scores better than the paddle race module class and the general teacher module by obtaining a Mean Difference (MD) score of -54,449. This value proves a significant increase related to student diagram representation.

Suggestions for further research can be to develop multimedia learning modules based on local wisdom of other regions in Indonesia to improve the ability of physics representation and high-level thinking of students. In addition, it can be integrated with evaluation questions to measure students' high-level representation and thinking skills.

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