Developing *Jemparingan* Tradition-Based and Android-Assisted Learning Media for Improving the Graphic and Vector Representation Ability

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Abstract—This study aimed to (1) Develop jemparingan tradition (JEMASIK)-based and android-assisted learning media and (2) reveal the effect of JEMASIK-based media to improve the graphic and vector representation ability on the sub-chapter of parabolic motion vector.

The subjects of the field test trial were 61 students, consisting of 29 students in the control class and 31 students in the experimental class. The research results showed that there were differences between the experimental classes taught using JEMASIK-based media and the control class taught using Power Point media. The difference was proved by the multivariate test score of 0.000 less than 0.05. The effectiveness of JEMASIK-based media was shown by the gain score in the pretest and posttest. The gain score of the control class was 0.54 in graphical representation and 0.49 in vector representation, while that of the experimental class was 0.75 in graphical representation and 0.60 in vector representation. The study concludes that the developed learning media The developed learning media based on traditional culture, JEMASIK, fulfils the feasibility criteria. There is a significant difference between the teaching of physics using JEMASIK media and that using Power Point media. And also, JEMASIK teaching media has a positive impact on the improvement of the graphic and vector representation ability.

Keywords—Android, JEMASIK, graphic representation, vector representation

1 Introduction

Problem solving skills are a complex part of physics learning [1]. Students are stated as having a problem solving skill when they have a good ability/skill of verbal, mathematical, vector describing, diagram and graphical representation abilities [2][3][4]. Graphical and vector representations are part of the problem solving skill. Students are required to represent graphs and vectors to solve the physical matters. However, many high school and university students have difficulties in representing graphs and vectors in physics subject [5][6] [7] [8]. Their graphic representation ability in the form of ability to read, draw and interpret, is in the low category [9][10] [11]. In vector representation, they use more mathematical concepts than physics

concepts [12] [13]. Errors in representing the vectors are caused by their inability to understand vectors and anti-vectors, mathematical operation, outlining vectors, and angles in vectors [14].

Physical materials especially in parabolic motion require the graphic and vectors representation ability. The students who are unable to represent graphics and vectors on parabolic motion will have difficulty in learning parabolic motion. Their difficulties may lead them to failure in achieving the learning goal in the sub-chapter of parabolic motion vector. Prescott and Mitchelmore [15] observe students' errors in giving reasons for the location and magnitude of variable X and Y of ball's motion on the parabolic track. The students still fail to understand the basic concepts of parabolic motion [16] [17] [18] [19] [20].

Parabolic motion is closely related to everyday life, such as *Jemparingan* tradition, which is a traditional archery art in Yogyakarta and Central Java. *Jemparingan* is different from the archery sport in general because the archers are required to sit in a cross-legged position and to wear traditional Javanese clothing. This tradition is the local culture of Indonesia. Local culture is a property that has an emotionally binding power [21]. However, the young generation in Indonesian today begin to ignore their local culture [22]. The efforts to preserve the nation's culture may be conducted through teaching associated with culture [23] [24] because culture is transmitted from generation to generation [25] .

Due to the difficulty in time, means, and infrastructures, introducing the local culture to the young generation becomes an obstacle, and it needs an innovation to cope with the problems. Learning must run well in the classroom [26]. The obstacle may be coped with by utilizing the learning media. Learning media become a solution to difficulties in learning [27][28]. In addition, the learning media should increase the students' desire to learn [29]. Nowadays, almost all high school students use the Android as a means of communication. The use of Android in learning may become a learning innovation [30][31]. Students are more interested in using M-Learning in the Android than e-learning [32]. Another benefit of the use of Android as learning material is learning can take place anywhere [33]. In learning, Android also assists the students to interact and do tasks [34][35].

Android as a medium of physics learning should contain the *Jemparingan* tradition as an introduction to the culture of Yogyakarta. Learning should also improve the representation of graphics and vectors. JEMASIK (*Jemparingan* Applied Physics) is a medium of physics learning. JEMASIK tries to improve the representation ability of graphics and vectors in the sub-chapter of parabolic motion vector. JEMASIK also introduces *Jemparingan* as Indonesian culture. This research develops a JEMASIK valid learning media and explains its effectiveness.

2 Research Method

2.1 General background of research

This research is research and development which aims to develop the *Jemparingan* tradition-based and android-assisted learning media, and to assess the effectiveness of the developed media. The research used the 4-D model (define, design, develop, and disseminate) [36].

2.2 Sample of research

The sample of the study was divided into four stages. The first stage (validation) involved two expert lecturers, three physics teachers, and five peers. The second stage was an individual test to know the validity and reliability of the tasks, which involved a total sample of 246 students of two schools, consisting of 126 students of SMA N 2 Bantul, and 120 students of SMA N 3 Bantul. The third stage was the limited trial which involved nine students of three high schools, consisting of three students of SMA N 1 Sewon, three students of MAN 2 Yogyakarta, and three students of SMA N 1 Imogiri. The schools' sampling was qualified; MAN 2 Yogyakarta is located in the urban area, SMA N 1 Imogiri is located in the rural area, and SMA N 1 Sewon is on the outskirts of city. In addition, nine students were chosen because of their interest in learning media. They were asked to fill out a questionnaire about the quality of JEMASIK learning media. The fourth stage was field trials involving 61 grade X students of SMA N 1 Bantul, consisting of 29 students in the experimental class and 32 students in the control class. The class sampling was through the student analysis, including the analysis of their academic achievement, cognitive ability, problem solving skill, and socializing skill.

2.3 Instrument and procedures

The research instruments are a question list for observation, questionnaire, and tests. The questionnaire was used to determine the feasibility of the product which consisted of lesson plans, JEMASIK learning media in Android, and tasks about the representation of graphics and vectors. The questionnaire used the five-point Likert scale according to the rubric. Prior to spreading, the questionnaire was validated by an expert.

The graphic and vector representation test consists of a pretest and posttest. It is a multiple choice question test. Its scoring used the politomous scale, in which the score of 4 is given if the answer is correct and the reason is right, score of 3 if the answer is wrong but the reason is right, score of 2 if the answer is correct but the reason is wrong, and score of 1 if the answer is wrong and the reason is wrong. The tasks are developed in accordance with the core competence, basic competence, and indicators of physics learning. And, the directions of the graphical representation test is presented in Table 1 below, and the directions of the vector representation test is presented in

Table 2. Both types of tasks were validated by material experts, and then individual trials were done.

Table 1. Directions of Graphical Representation Test.

No.	Sub-Chapter	Cognitive Aspects				Total number of Tasks
		C_3	C_4	C_5	C_6	
1.	Analyzing the height of particle	1	2			2
2.	Understanding the high changes due to certain factors	3	4,5			3
3.	Matching and understanding the narrative information in graphs		6		7, 8, 9 ,10	5
4.	Determining the size of a variable if other variables are known	11	12	13		3
5.	Determining the velocity score	14		15		2
6.	Understanding the factors that cause an object to be motionless	16	17	18, 19, 20		5
Total		5	6	5	4	20

Table 2. Directions of Vector Representation Test

No.	Sub-Chapter	Cognitive Aspects				Total of Task
		C_3	C_4	C_5	C_6	
1.	Point and frame of particles motion	1				1
2.	Movements and position changes in a particle		2,3	4,5	6,7	6
3.	Analysis of velocity	8		9		2
4.	Factors causing a velocity	10	11			2
5.	The particles location in all directions		12	13	14	3
6.	Position function influenced by time	15	16	17	18	4
7.	Variables affecting the movement of the location of particles			19	20	2
Total		4	5	6	5	20

2.4 Data analysis

The analysis of the results of the validation by experts, physics teachers and peers of the learning devices was conducted using Aiken's V [37]. And the results of the limited trials was also analyzed by using Aiken's V. The feasibility analysis of the graphic and vector representation instruments from individual tests conducted validity and reliability tests. The calculation of the empirical validation test with Quest program with criteria of item or task declared as fit with IFIT MNSQ limit model from 0.77 to 1.30. Meanwhile, the empirical reliability was measured using Cronbach's Alpa. And lastly, the effectiveness of JEMASIK learning media in improving the graphical and vector representation ability was viewed from gain score [38].

The increase of the significance of graphical and vector representation after the teaching implementation in the experimental and control classes was viewed from the statistical test using the multivariate analysis. However, before conducting the multivariate analysis, the researcher found it necessary to assess the normality and homo-

geneity tests. The normality test was done by using Mahalanobis analysis. In contrast, the homogeneity test was done by using the statistic test of Bos'x M. After the normality and homogeneity tests were fit, and the multivariate test followed.

3 Results and Discussion

3.1 Results of research

The define stage of the study was conducted at SMA N 1 Bantul through interviews and observation. It continued to the design stage by collecting materials in accordance with the Jemparingan tradition. The material was shown in Table 3. It was organized and loaded in Android. After the learning media was loaded in Android Jemparingan Tradition-based, the next stage was the develop stage. Advice from experts and peer was used as an input to improve the media. The revised media was tested through a limited test, and then continued to field trials. In field trials, the learning materials were limited only to parabolic motion. It was in accordance with the suitability of research time duration. The JEMASIK media was applied in the experimental class. In contrast, the control class used Power Point media. The power point media contained only parabolic motion explanations, and did not emphasize on graphical and vector representations. The power point also did not explain about the Jemparingan tradition.

Table 3. Development Directions

Indicators	**Material**				
	Kinematics Motion by Vector analysis	***Energy***			***Momentum and Implus***
	Vector analysis of Parabolic motion	***Kinetic Energy***	***Potential Energy (Elevation factor)***	***Potential Energy (Elasticity factor)***	***Momentum***
Analyze the particle height	Calculate and analyze the high magnitude through graph		Calculate the potential energy by high particle analysis through graph		
Understand the high changes due to certain factors	Problem solving related to high magnitude due to certain factors through graphs		Determine the high magnitude through energy equations with the help of graphs		
Match and understand the narrative information with graphs	Choose a suitable graph appropriate to the parabolic motion issues	Choose a suitable graph appropriate to kinetic energy issues	Choose a suitable graph appropriate to potential energy issues	Choose a suitable graph appropriate to potential energy issues	Choose a suitable graph appropriate to the issue of momentum
Determine the magnitude of variables if other	Calculate, analyze and predict the angle, height	Calculate the magnitude of the kinetic energy if	Analyze the graph, then determine the	Analyze the graph, then determine the	Analyze the graph of particle velocity and

Indicators	**Material**				
	Kinematics Motion by Vector analysis	***Energy***			***Momentum and Implus***
	Vector analysis of Parabolic motion	***Kinetic Energy***	***Potential Energy (Elevation factor)***	***Potential Energy (Elasticity factor)***	***Momentum***
variables are known	and range of the particle if other variables are known through the graph of parabolic track	the velocity and mass of the particle are known through the graph	magnitude of potential energy if the height and mass of the particle are known	magnitude of potential energy if the elasticity constant and change of particle length are known	determine the momentum at the velocity
Determine the velocity	Determine and interpret the magnitude of the initial velocity and the velocity at each position through the graph	Determine the velocity if the kinetic energy and particle mass are known through graph			Determine the final velocity of the object through the quantity and graph
Understand the factors that cause an objects are not motionless	Determine the position of the object and the factor make the object is in that position through graph	Understand the velocity and energy of motion as a result of objects are not motionless	Understand the magnitude of height and energy of motion as a result of not motionless objects	Understand the amount of potential energy as the factors that cause an objects to be not motionless	
Point and framework of particle	Determine the initial velocity magnitude by observing the direction		Determine the potential energy by observing the height of particles		Determine the amount of initial velocity before the collision occurs
Move and change of positions on particles	Understand the coordinate point, the magnitude of the velocity in terms of the axis of x and y	Understand the amount of energy that changes due to position change			Understand the movement of objects before and after the collision
Analyze the velocity	Analyze the minimum velocity and velocity at each position in terms of the axis of x and y	Analyze the velocity moment to determine the amount of energy			Analyze the velocity before and after the collision by observing the direction
Factors of Velocity making	Analyze and complete the image to determine the velocity at a certain time by observing the horizontal and vertical direc-				Determine the factor causing velocity changes by observing the direction of the collision

Indicators	**Material**				
	Kinematics Motion by Vector analysis	***Energy***			***Momentum and Implus***
	Vector analysis of Parabolic motion	***Kinetic Energy***	***Potential Energy (Elevation factor)***	***Potential Energy (Elasticity factor)***	***Momentum***
	tions				
The location of the particles against all directions	Analyze the particle positions both the x and y axes		Determine the high (the location of the particles against the y-axis)		
The position and velocity equations affected by time	Determine the coordinate and velocity points with the help of time that particle travels on the point				
Variables affecting the position shift of the particle	Complete a form of position equation when the initial velocity, angle and time are known	Determine the amount of energy by the known velocity as the shifting factor	Determine the amount of potential energy as a result of particle shift	Determine the amount of potential energy as a result of particle shift	Determine the amount of momentum as a result of object shift

(a) (b)

Fig. 1. (a). Position of *Jemparingan* Athlete, and Figure 1 (b). Equipment In *Jemparingan* Tradition

Fig. 2. The Relevance of *Jemparingan* Tradition with Physical Learning of Parabolic Motion Vector Analysis

Figures 1 and 2 are parts of the parabolic motion materials arranged in the Jemasik media. Figure 1 describes the parabolic trajectory of the arrow which is depicted in graphics. While Figure 2 explains the arrow modeling of the arrows analyzed in each point using vectors.

The emphasis of parabolic motion materials on graphical and parabolic representations is presented in Fig. 3.

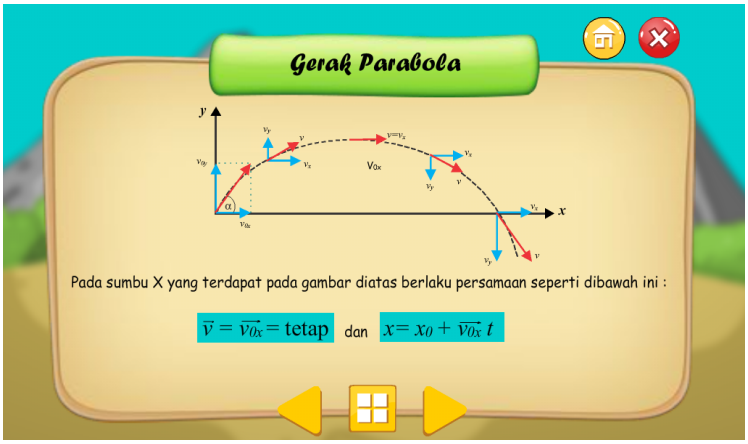

Fig. 3. Parabolic Motion Materials by displaying the graphics and velocity vectors to the X and Y axes

The validation result of learning device and instructional media is presented in Table 4, where the entire result is very good, and thus the learning device and media may be applied to physics teaching.

Table 4. Validation Result by Aiken's V

No.	Learning Device	Score of Aiken's V	Description
1.	Lesson Plan	0.97	Very Good
2.	Learning Media	0.93	Very Good
3.	Task of Graphic Representation	0.88	Very Good
4.	Task of Vector Representation	0.89	Very Good

The validity test result in the individual test shows that Item19 on the task of the graphical representation and Item 20 on the task of vector representation were deleted because they did not meet the fit item requirement. The reliability of the graphical and vector representation task is presented in Table 5 where both represenatiton results show the high task reliability, which means that the task meets the criteria of reliability.

Table 5. Reliability of Graphic and Vector Representation Test

No.	Task	Score of Reliability	Description
1.	Graphical Representation	0.81	Very high
2.	Vector Representation	0.80	Very high

After the learning media were found in a very good category and the tests were valid and reliable, the teaching in the experimental and control classes was conducted. In the control class, the teacher used the power point media, while in the experimental class the teacher used the JEMASIK media. At the beginning and the end of the teaching, a pretest and posttest were administered. The results of the pretest and posttest are presented in Table 6 below.

Table 6. Pretest and Posttest Results of Experimental and Control Classes

No.	Representation	Criteria	Experimental Class		Control Class	
			Pretest	***Posttest***	***Pretest***	***Posttest***
1.	Graphics	Average	25.99	83.19	27.70	67.81
		Standard deviation	13.10	9.56	15.34	6.14
		Highest Score	48.75	100.00	51.25	85.00
		Lowest Score	0.00	63.75	0.00	57.50
2.	Vectors	Average	25.99	71.08	21.41	60.51
		Standard deviation	10.90	6.71	12.74	7.11
		Highest Score	35.00	82.50	35.00	75.00
		Lowest Score	0.00	60.00	0.00	42.50

The multivariate analysis was used to reveal the effectiveness of using the JEMASIK media. However, before conducting the multivariate analysis, the researcher found it necessary to assess its normality and homogeneity. The normality test was done by using Mahalanobis analysis, while the homogeneity test was done by using the statistic test of Bos'x M. The result of the analysis of the normality and homogeneity tests is presented in Figure 4. After the normality and homogeneity tests were found fit, the multivariate test followed, and the result is presented in Table 7.

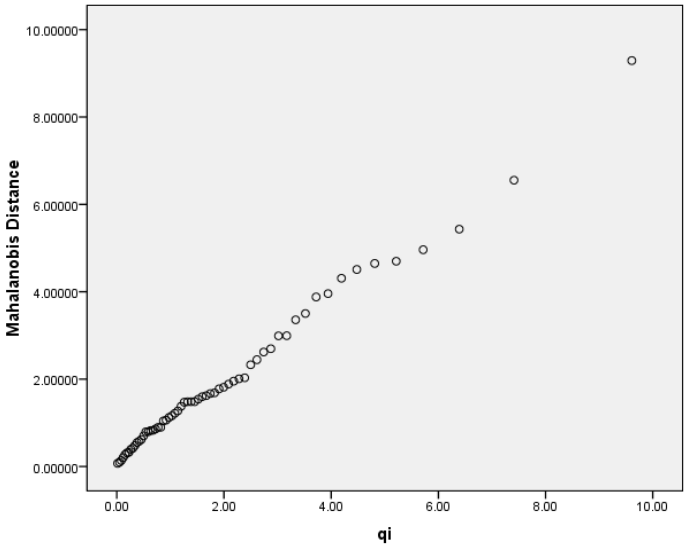

Fig. 4. *Scatter-plot* on Normality Test

Table 7. Box's Test of Equality of Covariance Matrices[a]

Box's M	2.502
F	.803
df1	3
df2	9.289E5
Sig.	.492

Figure 4 shows that the scattered data are normal and are shown by scatter-plots. The scatter-plot tends to make a straight line and more than 50% of the scores of the Mahalanobis distance are less than or equal to the qi score. Table 7 is the result of Bos's M test to determine the homogeneity test. The test results show that the graphic and vector representation ability shows a significance score of 0.492, which is greater than 0.05. Therefore, the result of normality test and reliability test is stated as fulfilling the requirement.

The completion of the prerequisite test is continued with the multivariate test. Table 8 shows that the hypothesis saying that there is a significant difference between the teaching using JEMASIK media and thatusing the Power Point media is accepted. It is shown by the significance score of Hotelling'S T2 of 0.000 which is less than 0.05.

Table 8. Multivariate Tests

Effect		**Score**	**F**	**Hypothesis df**	**Error df**	**Sig.**
Intercept	Hotelling's Trace	35.916	1.042E3[a]	2.000	58.000	.000
Grup	Hotelling's Trace	.737	21.373[a]	2.000	58.000	.000

Gain score is used to know the improvement of the graphic and vector representation ability in each class. Figures 5 and 6 show the gain score of each class. It shows that the experimental class has a higher ability improvement than the control class. In sum, the use of the JEMASIK media has a positive impact.

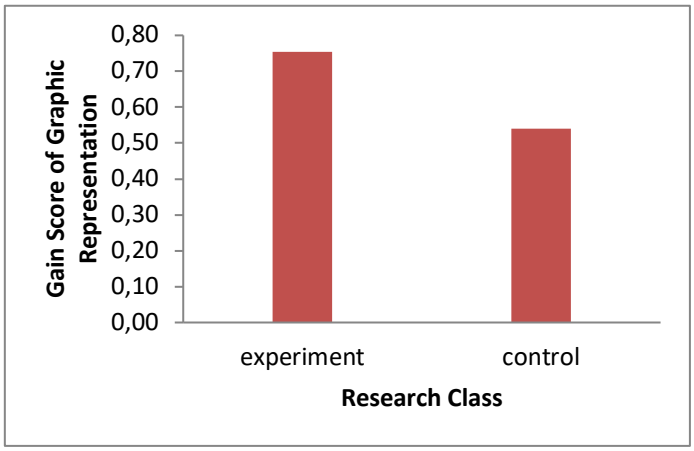

Fig. 5. Gain Score of Graphic Representation

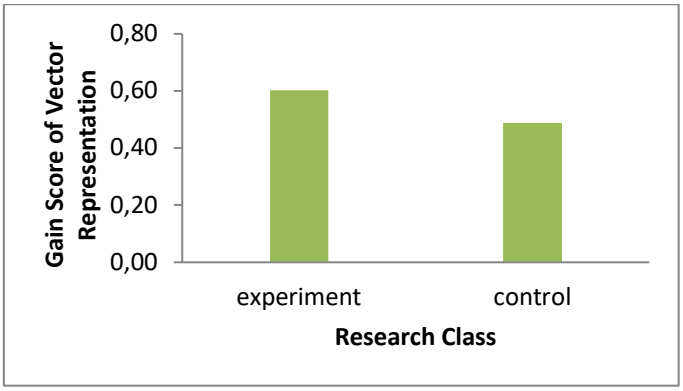

Fig. 6. Gain Score of Vector Representation

3.2 Discussion

In the first interviews with the teachers in the school, they stated that there were students' difficulties in problem solving. The problem solving ability primarily refers to graphic and vector representation ability. The students of State Senior High School (*Sekolah Menengah Atas Negeri* = SMAN) 1 Bantul actually have high cognitive ability. The finding is similar to the research by Allacaci, Lewis, O'Brien & Jiang [39] and Bahtiyar & Can [40], which found that students tend to have high cognitive ability but they find it difficult to do a task about graphic or vector representation.

Moreover, after the interview, we found that the teachers only use the power point in teaching. The schools actually support the use of Android teaching media. This situation is supported by research of [41], which reported that there is a difference between the use of m-learning and e-learning. The Android-based media has advantage in teaching because Android can be used anytime and anywhere.

Another problem in the school is the lack of local cultural related to the teaching of physics. Teachers associate their teaching only to everyday events without involving local culture. Agustina & Wahyudi's [42] research found that elementary school students are very interested in learning of culture through Android media. It is supported by Pamungka, Subali & Lunuwih [43] who state that there are satisfactory results in an effort to improve student creativity through the local wisdom-based teaching. But, the research is applied to the science class and not in the physics class, and also, the teaching in the research is conducted directly without using Android media. It supports the use of instructional media involving local culture. Local culture-based teaching is able to grow the sense of love of the country.

From the findings, this research was designed to find out the effect of JEMASIK media use on the improvement of the graphic and vector representation ability on the sub-chapter of parabolic motion. There are two classes used in this research: the control and experiment classes. The most distinctive difference between these two classes is the use of JEMASIK media in the experimental class, whereas the control class does not use it. At the first meeting, a pretestwas administered to both classes. And, at the end of the meeting, a posttest was administered to both classes. The result of the analysis of the pretest and posttest results show that there is a difference between the experimental class and the control class. It is viewed from the significance of Hotelling's Trace score of 0.000 which is less than 0.05, which means that there is a difference between the control class and the experimental class.

In terms of the gain score, the experimental class has a higher improvement than the control class for each representation. The class gain score on the graphic representation is 0.75 in the experimental class whereas in the control class the gain score is 0.54. For the gain score in the vector representation of the experimental class is 0.60 whereas in the control class is the score is 0.49. This means that there is a positive effect of the use of JEMASIK media on the improvement of the graphical and vector representation ability.

The results of this study are supported by the research by Ismail, Azizan & Azman [44], which reported that after the use of m-learning, the learning outcome increased. With the various potentials and advantages it has, Mobile Learning is expected to be an alternative learning resource that can improve the efficiency and effectiveness of teaching processes and learners' learning outcomes. However, the application of m-learning must be balanced with adequate facilities and infrastructure. The existence of smartphones and Internet network is the main capital of the use of m-learning.

The research by Barniol, Zavala [8], Alkan, Erdem [45] and Kilic, Sezen, Sari [46], reported that students had difficulties learning the graphic and vector represenation in the sub-chapter of parabolic motion vector analysis. The finding of the research by Bunawan, Setiawan, Rusli & Nahadi [11], which used a diagnostic test of optical material graph representation, showed that university students had difficulties analy-

zing graphs, and their ability was dependent on the type of graphs and levels or types of questions. These difficulties may be minimized by the use of JEMASIK media. The integration of multiple representations may help students study physics [47]. The research by Sirait, Hamdani & Oktavianty [48] reported the importance of the ability to represent vectors. In sum, learning physics requires not only a mathematical representation but also other representations such as graphic and vector representation.

The implementation of local culture should be strived to build students' love of the nation's culture. The research result by Suastra [24] showed that one of the suitable learning resources to support local culture-based science learning activities includes audio visual. In conclusion, the use of JEMASIK is very suitable for the teaching of physics on the sub-chapter of parabolic motion vector analysis

4 Conclusion

The developed learning media based on traditional culture, JEMASIK, fulfils the feasibility criteria. There is a significant difference between the teaching of physics using JEMASIK media and that using Power Point media. And also, JEMASIK teaching media has a positive impact on the improvement of the graphic and vector representation ability.

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