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Preface

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The 2nd International Conference on Physics and Mathematics for Biological Science 2020

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We would humbly thank all participants who have embraced the time to partake in “The 2nd International Conference on Physics and Mathematics for Biological Science 2020 (ICOPAMBS 2020)”. This even was conducted by the Department of Mathematics and Basic Science, Faculty of Teacher Training and Education in the University of Jember August 8 - 9 2020. The conference was undertaken in dual modes, namely virtual and face-to-face basis, either for the plenary and parallel session. We invited four plenary speakers in the plenary session. They are from Australia, India, Philippines, and Indonesia. In detail, Prof. Adil Bagirov, Ph.D is from Australia, Dr. Ramesh Nachimuthu is from India, Associate Prof. Joanne V. Serrano, Ph.D is from Philippine, and Prof. Dafik, M.Sc, Ph.D and Dr. Dwi Wahyuni, M.Kes are both from Indonesia. Due to the travel restriction in the Covid19 outbreak, the speakers from abroad delivered their slide presentation virtually as well as the participants who stay far from Jember town joined the conference virtually by using ZOOM cloud meeting. The platform employed to manage and organize all data and manuscript submission used Easychair system. The participants who stay nearby Jember town, they joined the conference in face-to-face basis. We had 50 participants joining in person. They were placed in two classrooms respected to the medical protocol for Covid19. Thus, each room of $88m^2$ area consisted of 25 participants. The time spent for each speaker was 60 minutes, and Q/A session after plenary session was run within 30 minutes. The total number of participants was 175 people, and the number of submission received by ICOPAMBS 2020 committee was 125 participants. The number of paper sent to reviewer was 110 papers, and the number of accepted submission papers is 74 papers. Thus the acceptance rate is 59.2%.

The main purpose of the conference is to welcome scientists, lecturers, students, and researchers from diverse parts of the globe to showcase their massive interests and insights germane to Physical Science, Biomedicine, Biotechnology, and Applied Mathematics. The conference is projected to be the yearly international forum where civil society organizations and representatives, university students, academics and researchers, scholars, scientist, teachers and practitioners from all around the globe to share and exchange ideas germane to theoretical and practical knowledge about Physics, Mathematics, Biological Science, and their applications. The conference takes the initiative to present and discuss the cutting-edge trends for disseminating novel theoretical, methodological and empirical insights as well as more fine-tuned understanding concerned with Physics, Mathematics, Biological Science, and science education. The conference focuses on the following themes: (1) Physical Mathematics, Computational Physics, and applications, (2) Mathematical modelling for Material Physics, semiconductor materials, and Applications, (3) Bioinformatics and Computational for Biomaterials, (4) Graph Theory, Combinatorics, and Applications, (5) Applied Statistics, (6) Polymer, Biomaterials and applications, (7) Mathematical modelling for Biological Sciences, (8) Environmental science, Biotechnology, and applications (9) Geophysics and Earth Sciences, (10) Development of Software engineering for Physics, Mathematics and Biological Sciences

On behalf of the organizing committee, we gratefully acknowledge the support from The Faculty of teacher Training and Education-University of Jember of this conference. We would also like to extend our gratitude to all lovely participants who have taken part in this unforgettable and valuable event.

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Multiple representation based physics learning to improve students learning outcomes at SMAN 3 Jember on projectile motion materials

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Multiple representation based physics learning to improve students learning outcomes at SMAN 3 Jember on projectile motion materials

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Abstract. This research informs about multiple representation based physics learning. Multiple representation is an alternative learning strategy that is very important in physics. The delivery of material in various representations in the form of verbal, mathematical, picture and graphic will provide variations in the learning process so that it can make it easier for students to capture learning material. This is the advantage of multiple representation based learning. This study aims to analyze physics learning based on multiple representation of the learning outcomes of SMAN 3 Jember students, especially on Projectile Motion material. The type of research is quantitative descriptive with respondents consisting of 52 students of class XII MIPA SMAN 3 Jember. Respondents were given a pretest and posttest which consisted of 10 multiple choice questions including verbal, graphic, picture, vector and graphic representations. The research data obtained were analyzed by looking for the N-gain value to determine the category of increasing multiple representation based physics learning on student learning outcomes. The N- gain value obtained at 0.47 indicating that there was an increase student learning outcomes with the medium category.

1. Introduction

Physics as a science subject is a very important. Besides being able to explain natural phenomena, physics is also the forefront of developments in the field of technology. This is in line with the expected competency demands for students after studying physics at the SMA/MA level, those are understanding natural phenomena and understanding the impact of physics development on technological development [1].

Given the importance of physics, there must be innovation and creativity of teachers in carrying out physics learning. The prospect, the goal of learning physics can be achieved. In the development of the field of education, many innovative approaches, strategies, models, methods and techniques are found in conducting learning, especially learning physics. One of them, is multiple representation based physics learning. Multiple representation is the representation of the same material in different forms of delivery [2] can be in the form of verbal, mathematical, picture and graphic [3,4]. Unfortunately, so far the physics learning process has not emphasized important representations in the delivery of material. Whereas in physics learning delivery with multiple representation will greatly help students' understanding in capturing material [5].

The multiple representation functions include: 1) complementary function, some representations will provide information or learning in a different way so that students are expected to benefit from the multiple presentations presented, 2) the constraining function, the information through the given representation makes the material easier for students to understand so that it can constrain other interpretations, 3) constructing functions, with some representations displayed can build and broaden students' understanding of the material presented [6].

Learning using multiple representation has several advantages, among others: providing opportunities for students who have different intelligence backgrounds (multiple intelligence), can visualize something that is abstract so that it helps students in understanding concepts or materials, and can help in solving physics problems that require reasoning, illustrations and mathematical equations [7,8].

Mathematics has an important role in learning physics. Like a 'twin brother' physics and mathematics cannot be separated in learning. Therefore, physics learning requires a specific strategy in its delivery. Moreover, mathematics is often being an obstacle for students in receiving physics lessons. Physics learning should not only express mathematical symbols, but also display picture and graphic in addition to verbal language that can help students understand the physical phenomena of these mathematical equations [9].

Several studies have shown the influence and effectiveness of multiple representations in explaining physics materials, including: the effect of multiple representations on understanding material and scientific consistency in physics learning [5], multiple representation-based physics learning can improve student skills in problem solving [10] and teaching materials based on multiple representation can improve the mastery of concepts [11]. Besides being able to provide variations in the delivery of material in the form of verbal, mathematical, picture and graphic, multiple representation also makes it easy for students to capture learning material because the material is delivered in various representations [12]. This shows that multiple representation is an appropriate alternative strategy in learning physics.

From the observations made, most students have difficulty in learning projectile motion. Some of the reasons put forward include: too many formulas, learning is not interesting and does not understand the concept. Projectile motion is one of the high school physics materials that must be mastered by students. The basic competence which is expected to be mastered by students is to analyze the projectile motion using vectors, the following physical meaning and its application in daily life [1]. Of course to achieve these basic competencies, teachers must have a strategy in learning after determining the indicators of competency achievement. One of learning strategies that can be used is multiple represention based learning.

Multiple representation based learning can be implemented by using several learning media, among others: flash media as a means of animated visualization that can make students motivated, active and easier to master concepts [13] and as well as multiple representation based physics modules can improve students' critical thinking skills [14]. This shows that the right multiple representation learning media also contributes to improving student abilities and has an impact on student learning outcomes that are increasing.

2. Method

The type of research used in this research is quantitative descriptive with respondents consisting of 52 students of class XII MIPA SMAN 3 Jember. Respondents given a pretest at the beginning of learning and posttest after finishing learning the material of projectile motion. The Pretest and posttest consist of 10 multiple choice questions including verbal, mathematical, picture, vector and graphic of two question respectively. Considering that the research was conducted during the COVID 19 pandemic, both the pretest, posttest and learning were carried out online. The Pretest and posttest were carried out using the google form application while learning through the zoom application. For students who had network difficulties,The researchers provide a link of explanation material via youtube. The research data obtained were analyzed by looking for the N-gain value to determine the category of improving physics learning based on multiple representations of student learning outcomes.

3. Result

In this study students were given questions consisting of 10 multiple choice questions with distribution: questions number 1 and 6 were questions to test students' ability on verbal representations, questions numbers 2 and 7 were questions to test students' abilities in mathematical representations, questions number 3 and 8 is a question to test the ability of students in picture representation, questions number 4 and 9 are questions to test the ability of students in vector representation, while questions number 5 and 10 are questions to test student ability in graphical representation.

The research data obtained in the form of students' correct answers to each item as well as the pretest and posttest scores. The ability of students in each representation is shown by the percentage of the number of students who answered correctly on each question according to the shape of the representation in the problem. Furthermore, it is made in graphical form and explained descriptively. While the pretest and posttest values are used to find the N-gain value.

The student's ability to answer questions in verbal form, namely questions number 1 and 6 can be seen in the following graph:

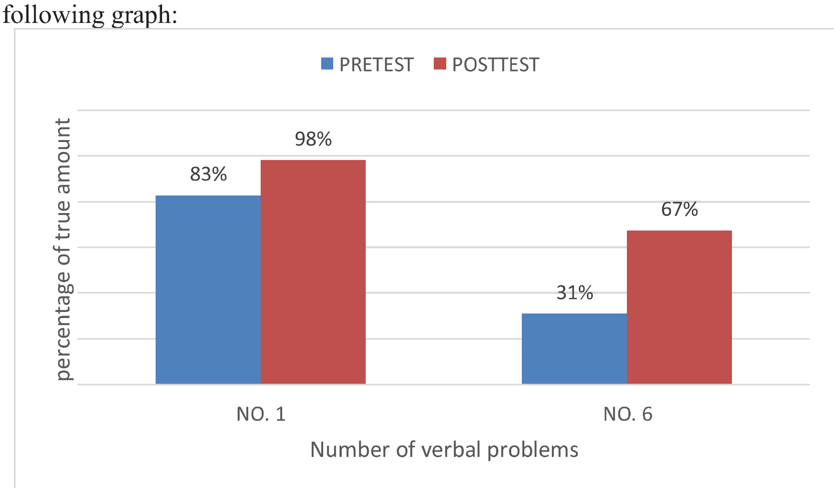


Figure 1. Graph of percentage of students answering correctly about verbal form

In figure 1, you can see the graph on question number 6 during the pretest, only 31% of students can answer correctly. As an illustration, we can see the form of question number 6 as follows:

6. An object is thrown upward with an elevation angle α. Speed at each point on the track can be broken down into two components, namely vertical and horizontal. Among the following statements which are true are ....
a. Vertical components are successively smaller
b. Vertical components are successively larger
c. Vertical components are successively constant
d. The horizontal components are successively constant
e. The horizontal components are successively smaller, then larger.

Figure 2. Questions in verbal form

There are still students who have difficulty in verbal delivery of a mathematical form or mathematical meaning in a verbal form. Therefore we need the help of mathematical representation in the process of verbal explanation. However, seen in graph 1 there is an increase in the number of students who answer correctly between pretest and posttest.

The student's ability to answer questions in mathematical form, namely in questions number 2 and 7 can be seen in the following graph:

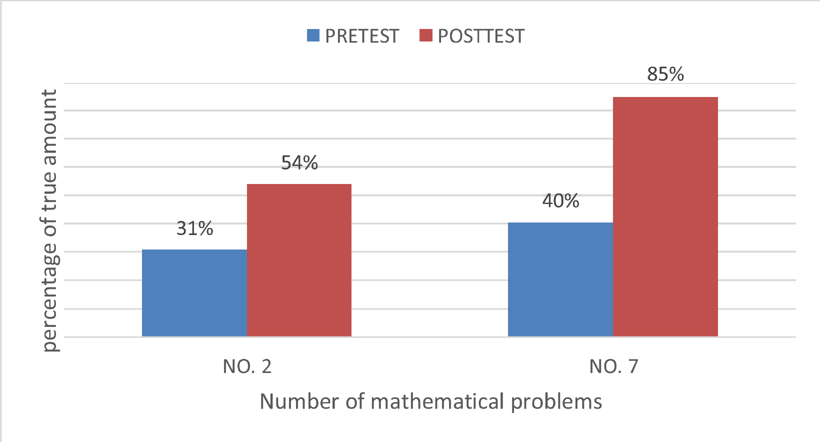


Figure 3. Graph of percentage of students answering correctly about mathematical form

Figure 3 shows the number of students who could correctly answer question number 2 at the pretest was only 31%, as well as 54% in the posttest meant that there were still about half the number of students having difficulty solving mathematical form questions. Whereas for question number 7 there was a very large increase for students who answered right at posttest. As an illustration, we see the form of question number 2 as follows:

2. Objects are thrown upwards with initial velocity v_0 and elevation angle α. The speed of the object at the highest point is ....
a. $v_0 \sin \alpha$
b. $v_0 \cos \alpha$
c. $v_0 \sin \alpha - gt$
d. $v_0 \cos \alpha - gt$
e. $v_0 \sin \alpha .\ t$

Figure 4. Questions in mathematical form

Students still have difficulty in writing the mathematical equations of the speed of the projectile motion when the object is at its highest point. This shows that students still do not understand the mathematical equation of object velocity at its highest point. The teacher needs to emphasize the explanation of mathematical equations at key points especially at the highest and farthest points of the object in the projectile motion trajectory.

The ability of students to answer questions in the form of images that are in questions number 3 and 8 can be seen in the following graph:

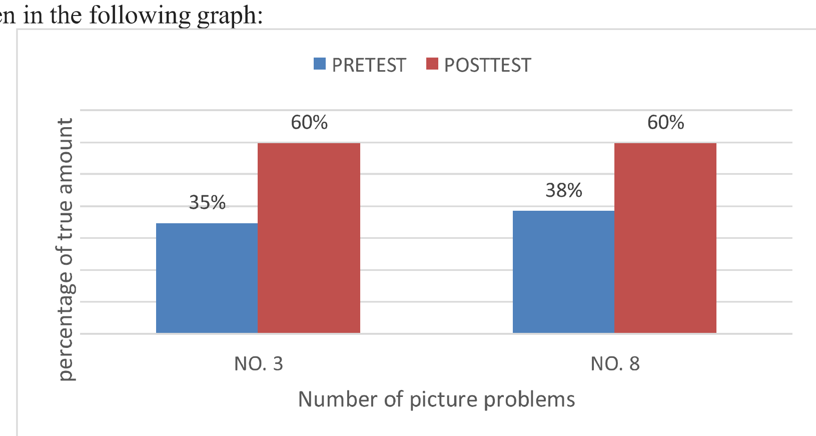
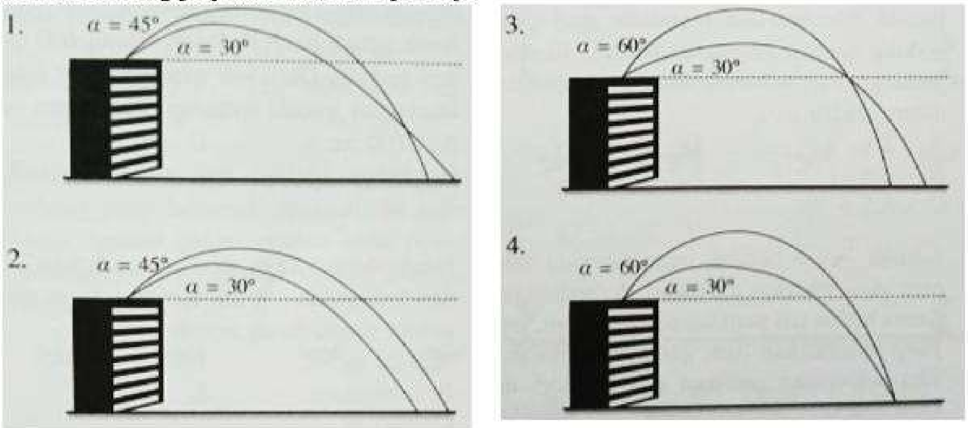


Figure 5. Graph of percentage of students answering correctly about picture form

In Figure 5, it can be seen that there is an increase in the number of students who answered correctly between pretest and posttest both in question number 3 and number 8. Although the increase that occurred was not optimal. One example problem in the form of a picture as follows:

3. Consider the following projectile motion trajectory :



If air resistance is ignored, then the correct picture is ....

a. 1 and 3
b. 2 and 4
c. 1 and 4
d. 2 and 3
e. 4 only

Figure 6. Questions in the picture form

Students still have difficulty in understanding the maximum distance of objects with different elevation angles. Need mathematical knowledge and understanding of images to answer questions in the form of the picture above. Therefore there is a need for learning in the form of animation that can show the difference in mileage at each different elevation angle.

The student's ability to answer questions in vectors form, namely questions number 4 and 9 can be seen in the following graph:

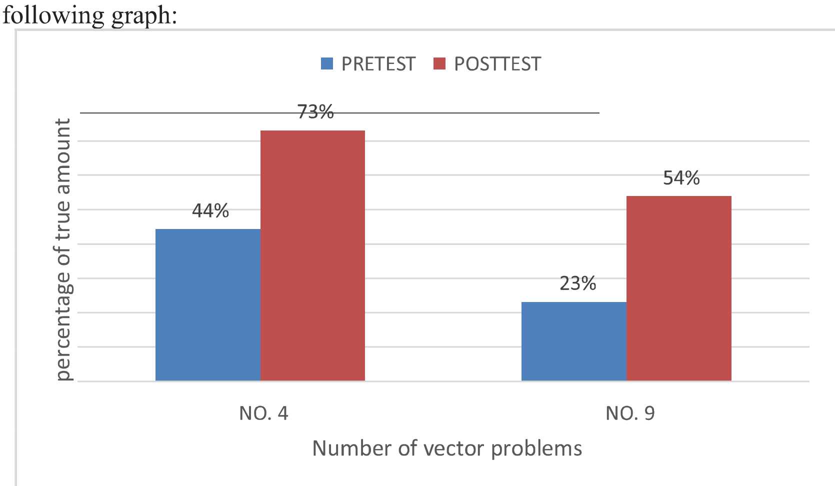
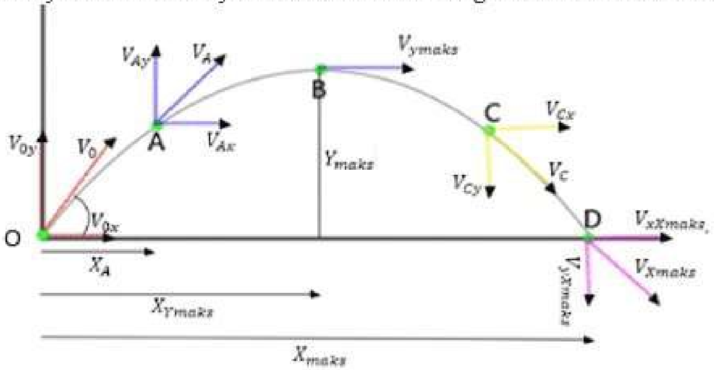


Figure 7. Graph of percentage of students answering correctly about vector form

It can be seen in the figure 7 that the number of students who answered correctly the questions in vector form on question number 9 was only 23% at the pretest and 54% at the posttest. This shows the difficulty of students in working on question number 9. As the following illustration the form of question number 9 is displayed:

9. The velocity that occurs in the parabolic motion is the sum of the velocity vectors on the x-axis and the velocity vectors on the y-axis as shown in the figure then the sum of the velocity vectors is ....



a. $v_t = \sqrt{v_{tx}^2 + v_{ty}^2}$
b. $v_t = \sqrt{v_{tx} + v_{ty}}$
c. $v_t = v_{tx} + v_{ty}$
d. $v_t = v_0 \cos\alpha + v_0 \sin\alpha$
e. $v_t = v_{tx}^2 + v_{ty}^2$

Figure 8. Problem in vector form

The possibility is that there are still many students who do not know the writing of mathematical equations for the sum of two components of the velocity vector. The velocity vector component on the x-axis (horizontal) is always perpendicular to the vector component on the y-axis (vertical). Likewise with the direction of the object's speed is always changing at each projectile trajectory. The teacher needs to explain the equation of adding two vertices perpendicular to each other.

The student's ability to answer questions in graphical form, namely questions number 5 and 10 can be seen in the following graph:

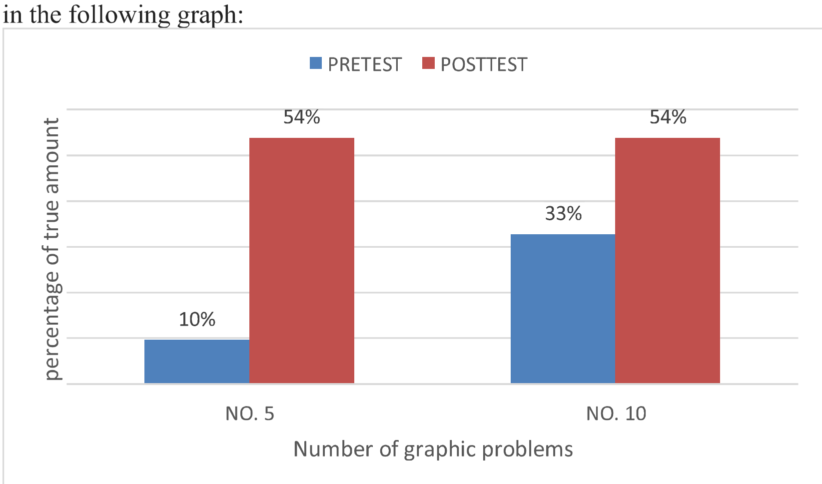


Figure 9. Graphic percentage of the number of students answering correctly about the the graphic form

Figure 9 shows that most students have difficulty in understanding the graph in question number 5 during the pretest. This can be seen from the data in graph 5 only 10% of students answered correctly.

Similarly, in number 10 almost half the number of students who have not been able to solve the problem correctly. As an illustration the form of question number 5 is as follows:

5. A foot ball on the grass of the Camp Nou stadium is kicked by Messi so that it forms α certain elevation angle. The relationship between the vertical velocity (v_y) of the ball and the time (t) according to the graph ….

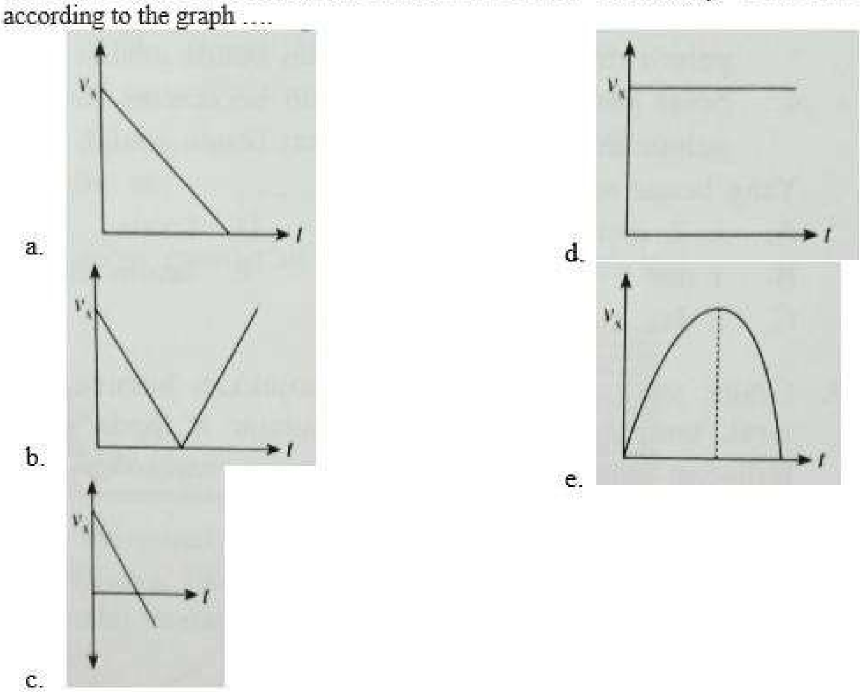


Figure 10. Questions in graphical form

The teacher needs to explain how the various graphic shapes in the projectile motion correspond to the requested variable. For example, the shape of the graph between the speed on the x-axis with time, the graph between the speed on the y-axis with time, distance traveled with time or height of objects with time. This can be done by making a table on each variable, then students are asked to draw a graph.

In this study, researchers used the Power Point media (PPT) to explore physics learning of projectile motion material based on multiple presentations to explain to students. PPT media that is used displays several representations in the learning process, namely: verbal, mathematical, images, vectors, graphs and even animations and videos to make students more interested and motivated and easy to understand in learning projectile motion. This complete representation is expected to improve students' understanding of projectile motion. The examples of the forms of representation used in PPT are as follows:

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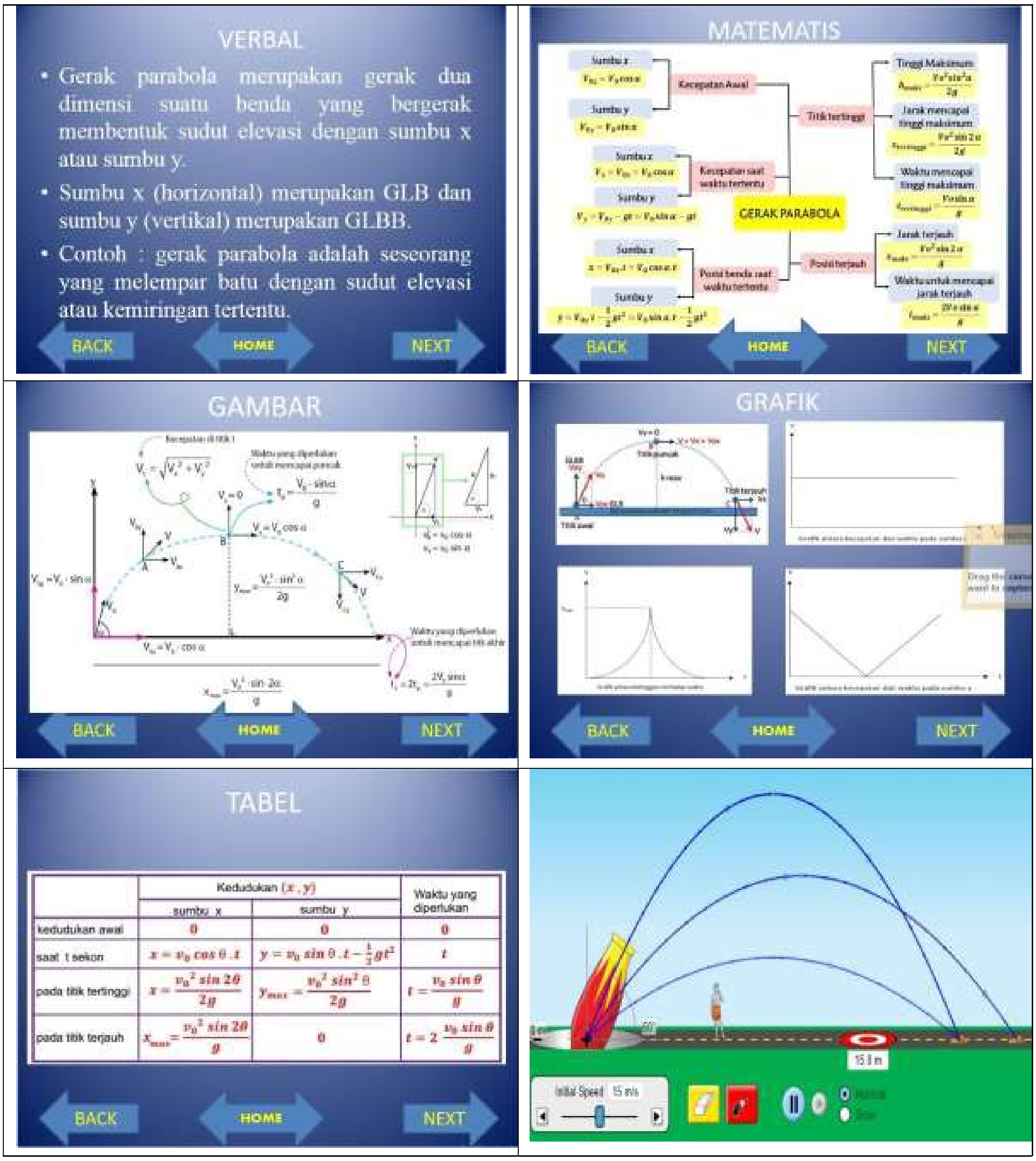

Figure 11. Picture of representation form in PPT

Figure 11 shows an example of learning delivered through PPT media. The hope is that students will more easily understand and solve projectile motion problems in various forms of representation.

The average percentage graph of the number of students answering correctly on the questions of each form of verbal, mathematical, images, vectors and graphs representation can be seen in the graphic below:

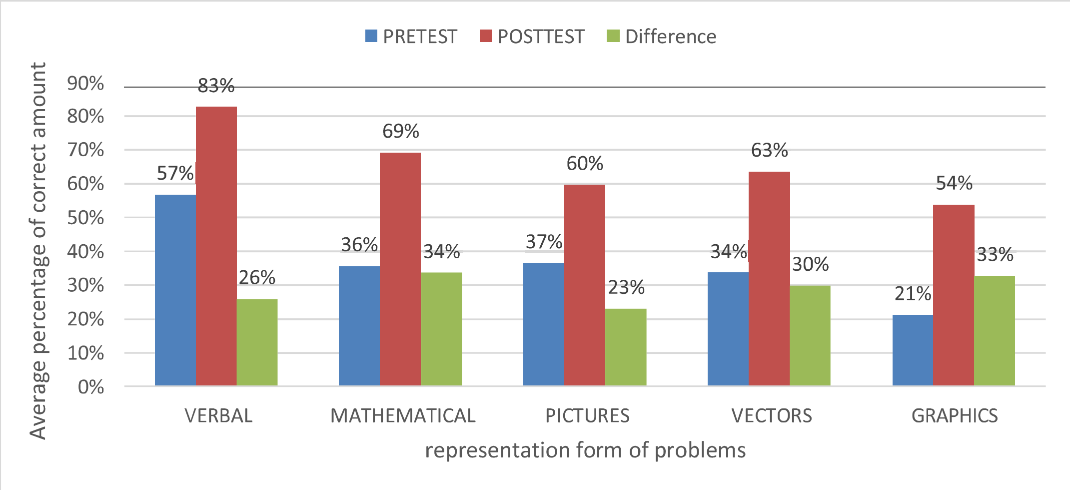

Figure 12. Graph of percentage of the average number of students answering correctly on various representation problems

In general, it can be seen in Figure 12 that there is an increase in the percentage of the number of students who answer correctly in each form of each question either verbal, mathematical, picture, vector and graphic between the pretest and posttest. The results of the average pretest and posttest values can be seen in the graphic image below:

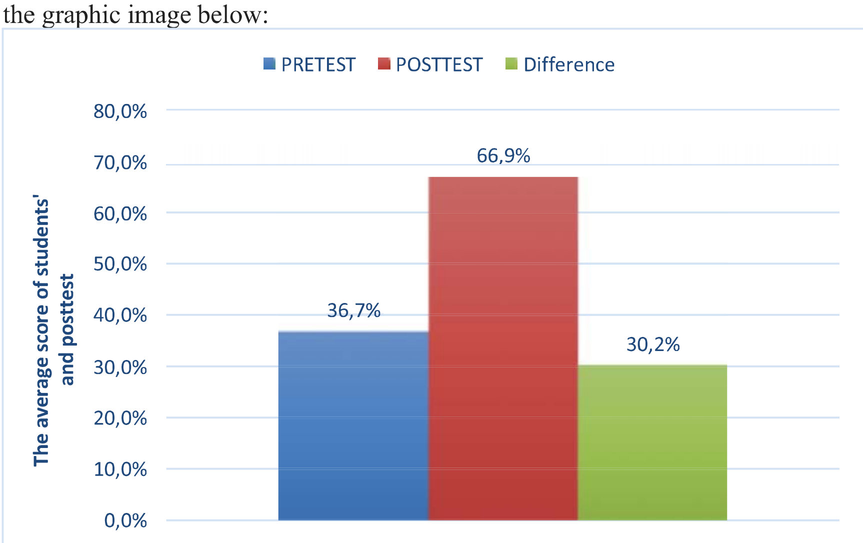

Figure 13. Graph mean values of pretest and posttest

It can be seen from Figure 13 that there is an increase of 30.2% in the average value of student learning outcomes from pretest to posttest.

Meanwhile, to find out the category of increasing student learning outcomes can see the value of N-gain. The normalized N-gain classification according to Richard R. Hake can be seen in the following table:

Table 1. N-gain classification chart

Gain (g)	Classification
g < 0,3	Low
0,3 ≤ g < 0,7	Medium
g ≥ 0,7	High

From the calculation, the N-gain value is shown in the table below:

Table 2. N-gain values

Number of student	Pretest average	Posttest average	N-gain	Classification
52	36,7	66,9	0,47	Medium

From table 2 it can be seen that the N-gain value of the study is 0.47, which shows an increase in student learning outcomes including the medium category.

4. Discussion

From the analysis of research data conducted by calculating the value of N-gain, it appears that there is an increase in student learning outcomes after getting multiple representation based physics learning. This is in line with other studies which state that the multiple representation learning approach can improve student learning outcomes [15].

Multirepresentation learning tries to display all important representations in learning in the form of verbal, mathematical, picture and graphic. It aims to form a complete understanding of students so that it can be used in solving problems [16,17]. Seen in the questions given often not only raises one representation, but also requires an understanding of other representations. Therefore, the delivery of multiple representation based physics learning is needed.

The possible reason for the results obtained was less than optimal was that the research was conducted during the CÖVID 19 pandemic. There are several things that cause obstacles in the learning process online, including: 1) The role of the teacher in providing explanations is not optimal because of limited expressions and explanations in delivering material, 2) The lack of optimal interaction process between teachers and students becomes an obstacle in understanding the material, because the limitations of students to ask questions directly about the material difficulties faced, 3) Teachers cannot directly monitor and control what students do. Do students really learn and understand the material that has been conveyed, 4) Frequent network and connection disruptions also cause disconnection of information conveyed by the teacher, 5) For students who do not have communication tools or quotas, finally the teacher's explanation is only replaced by viewing the learning video PPT delivered by the teacher.

However, in the midst of the existing limitations, it turns out that Multiple representation based physics learning still has an influence on improving student learning outcomes.

5. Conclusion

Based on the exposure to the results and data analysis, it can be concluded that physics learning based on multiple representation has an effect on improving student learning outcomes, especially projectile motion material in class XII MIPA SMAN 3 Jember with the medium category.

Multiple representations make it easier for students to understand physics material because the material is presented in various representations in the form of verbal, mathematical, picture and graphic [5]. Furthermore, it is necessary to carry out further research and development on the presentation of other physics material by using multiple representations and testing on a broader scale.

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