Wahana Pendidikan Fisika (2025) 10 (1): 99-112
https://doi.org/10.17509/wapfi.v10i1.79371
2406-9205 (Print) | 2477-4820 (Online)

ORIGINAL RESEARCH

# Implementation of game-based learning in vibration and wave puzzle to increase students' interest and motivation in physics learning

**Hari Agusasi Pramesti, Adhi Harmoko Saputro**

Received: 7 January 2025 · Accepted: 23 February 2025 · Published Online: 28 February 2025


## Abstract

The purpose of this study is to describe how the implementation of learning with the STEM-integrated problem-based learning model can increase student creativity. This study used a quantitative method with a pre-experimental design in the form of a one group pre-test post-test design which was carried out in one of the high schools in Sumedang Regency. The sample in this study were 43 students in class X MIPA at the school. The sampling technique used is purposive sampling. The data collection instrument used to measure student creativity is the CPAC test which consists of 8 statements related to act and flow aspects given during the pre-test and post-test, and student creativity observation sheets to observe the emergence of student creativity during learning. which includes aspects of flexibility, fluency, originality, elaboration, and clarification. In this study, learning was carried out using a problem-based learning model by integrating STEM elements in momentum and impulse topic. The results showed that the increase in students' creativity based on the results of the n-gain analysis of the pre-test and post-test scores was 0.433 which was in the moderate criteria in the act and flow aspects, and with good criteria in the aspects of flexibility, fluency, originality, elaboration, and clarification with a percentage of 77.56%. So based on the analysis of the findings in the research, the application of the STEM- integrated problem-based learning model can increase students' creativity.

**Keywords**: Game-based Learning · Learning Motivation · Puzzle · Vibration and Wave

## INTRODUCTION

Understanding physics concepts is the main goal in the learning process at school. Understanding physics concepts (such as mass, energy, time, and electric charge) that are abstract and tend not to be captured by human senses, is like understanding the nature of the universe. Some other factors that make it difficult for students to understand the physics concepts taught are a) physics is accompanied by formulas, b) teachers only deliver in theory, and the background of the students themselves who have difficulty in counting (Redhana dkk., 2021). Explaining in the proper understanding of the basic principles of physics and their applications is the goal of teaching and learning physics (Banda & Nzabahimana, 2021).The selection of appropriate learning model and media is needed to overcome these problems so that the concepts conveyed to students are more easily accepted and understood. (Fitriyana et al., 2020). To ensure that students develop conceptual understanding and mastery of learning, teachers are encouraged to use diverse methods in their teaching. This means that teachers should move to incorporate active learning methods in the classroom. Active learning methods can help students in a) thinking critically or creatively, b) speaking and discussing in groups, c)

✉ Hari Agus Pramesti
hari.agusasi@ui.ac.id

Adhi Harmoko Saputro
adhi@sci.ui.ac.id

Departmen of Physics, Universitas Indonesia, Jakarta, Indonesia.

**How to Cite**: Pramesti, H.A. & Saputro (2025). Implementation of game-based learning in vibration and wave puzzle to increase students' interest and motivation in physics learning. *Wahana Pendidikan Fisika, 10*(1), 99-112. https://doi.org/10.17509/wapfi.v10i1.79371

expressing ideas through writing, d) exploring attitudes, e) giving and receiving feedback, and f) reflecting on the learning process (Redhana et al., 2021; Ren et al., 2021). This will improve the achievement of students' conceptual knowledge competencies. Learning is said to be well achieved if the learning outcomes of students fulfill three aspects, namely, cognitive, affective, and psychomotor aspects, which means that students' understanding of the concept taught reaches a high value (Panggabean et al., 2021). One of the available resources that can and is being used to help students develop conceptual understanding in science, particularly physics, is in the form of simple games and demonstrations (Ariffin et al., 2022).

Learning media is a tool used in the educational process to deliver subject matter. The use of learning media has an important role in achieving learning objectives, which is very helpful for students to play an active role during the learning process and makes it easier to communicate messages and material content (Romanvican et al., 2020). Game-based learning media with the help of modules and simple experiments or demonstrations can help and facilitate them in understanding concepts and honing their knowledge to solve problems (Aji et al., 2019). Learning interest is an influence that is sought, with the selection of learning media that makes the learning atmosphere interactive and flexible (Azizah et al., 2021).

Game based learning (GBL) has attracted much attention in the world of education (Zeng et al., 2020). GBL is gaining increasing attention in formal education, as it can create realistic situations in games and incorporate game elements, such as competitiveness, challenge, motivation and fantasy into science learning (Cardinot et al., 2022a). Games are a powerful and challenging learning strategy that motivates students to take more responsibility for their own learning. Games can improve students' behavior and attitude towards learning through intrinsic motivation, increasing engagement and motivation in learning (Luarn et al., 2023). Students' difficulties in problem solving are also caused by a lack of conceptual understanding. The suitability of physics concepts and principles with problems is the key to getting the right solution to a problem (Mulyastuti et al., 2019). A study mentioned that if there are board games that learners can play, then they will be able to assimilate new concepts more intuitively, in addition to allowing pre-recorded information and organizing it in such a way as to facilitate learning (Malicoban et al., 2021).

Based on the results of the analysis found in school, most of the learning media used by students have not been able to make students active. Teaching materials assisted by players will help students become happier in learning (Oktaweri et al., 2019). The selection of appropriate learning methods will affect the pleasant learning atmosphere and allow students to develop their creativity. In addition to learning methods, another factor that can affect student learning outcomes and interest is the driving force that can arouse the spirit of learning. Interest is a strong source of motivation to learn and is the cause of students' participation and activeness in learning activities. Without interest in learning in students, it will result in less-than-optimal results in the learning process. Students who have a high interest in learning will always give their full attention in their efforts to achieve learning goals (Suratno et al., 2023).

GBL is a learning method that is starting to be widely used by educators to be applied to learning in the classroom. Games are one of the media that can help students in understanding physics concepts. It can motivate and provide opportunities for students to be independent in learning (Tinedi et al., 2018). However, educational game research is haunted by the following paradox: increasing learning will reduce fun, and increasing fun will reduce learning. One way

https://doi.org/10.17509/wapfi.v10i1.79371

to improve learning from educational games is to add learning supports that aim to support learners and help them transfer the knowledge and skills acquired in the game (Bainbridge et al., 2022). Physics board games are becoming a highly engaging resource to motivate and support the teaching of physics at all levels of education (Cardinot et al., 2022). The game board is primarily used for summative assessment, although it also includes some elements of formative evaluation. This entails reviewing with students to get feedback on their understanding of knowledge (Dziob, 2020). In completing the educational game, students are invited to learn with a creative learning method, which invites them to be active and think critically to solve a physics problem. Problems that encourage students' creativity are usually open-ended, giving learners the opportunity to find solutions to problems (Subanji et al., 2023).

The topic of this study is vibrations and waves. This module is often considered challenging because students must not only understand the concepts of vibration and waves but also integrate them into a comprehensive understanding. The learning in this study focus on key concepts related to vibrations and waves. Therefore, the study will cover various aspects of vibrations and waves, including the quantities involved, their common characteristics, and their applications in everyday phenomena.

Based on the background of the problem, the research questions for this study are formulated as follows. 1) How can vibration and wave concepts be taught in a fun and engaging way? 2) How can a puzzle board game be developed to support learning these concepts? 3) How can the methods and media used in this research be evaluated for their effectiveness in enhancing students' interest, motivation, and learning outcomes? The objective of this research is to develop a game-based learning method using a puzzle board game to increase students' interest and motivation, promote active and student-centered learning, and improve learning outcomes in a fun and engaging way. The research hypothesis is that applying a game-based puzzle learning method to vibration and wave concepts at the high school level can effectively enhance students' interest, motivation, and learning outcomes through active and enjoyable learning experiences.

## METHODS

The research that has been conducted is experimental research with pretest and posttest. The number of students was 70 people from five classes in the school. The sampling method used is total sampling, which involves using all available samples in the study. The research was conducted in the academic year 2023/2024 even semester. Researchers chose the time adjusted to the subject matter of Physics taught in class XI SMA, namely Vibration and Waves. The outcome of this study is a puzzle board game vibration and wave concepts. This research starts from conducting a literature review, observing students, conducting discussions with experts, designing learning devices, teaching materials, learning media, and research instruments, observing and collecting data on students, analyzing data, and writing scientific research results.

The research method used in this study is the experimental research method, which focuses on testing theories or hypotheses to determine the relationship between specific variables. In this study, the focus is on the effect of learning outcomes on students' interest and motivation to learn. The research process begins with identifying the problem or hypothesis to be tested. The researcher then selects the relevant variables, specifically the effect of learning outcomes on increasing students' interest and motivation to learn. After determining the variables, the

https://doi.org/10.17509/wapfi.v10i1.79371

researcher designs the experiment and experimental procedures. The experiment is conducted according to the established procedures, using random sampling of the entire sample. The next step is data collection, followed by data analysis. The data obtained through observation is analyzed qualitatively, while validation data is analyzed both qualitatively and quantitatively. Based on the data analysis results, the researcher can draw conclusions and compile a report on the findings.

## RESULT AND DISCUSSION

This chapter contains the results and discussion of the research that has been conducted. This research begins with conducting a literature review and observing students to get the problems that will be raised in the research, then the researcher conducts discussions with experts to design research needs, such as learning devices, teaching materials, learning media, and research instruments. The following is a discussion related to the design of research needs.

### Procedures for designing learning tools, teaching materials, and learning media

The learning tools used are lesson plans (RPP), with teaching materials in the form of modules and PowerPoint of vibrations and waves, and the learning media used are vibration and wave puzzle game boards. The vibration and wave modules and PowerPoint are made in accordance with the lesson plans that have been prepared, and the modules are also designed in such a way as learning materials and instructions for students in completing the vibration and wave puzzles. Researchers chose vibration and wave material as the learning material to be given in the research class. Furthermore, the material is poured into a concept map, so that researchers are directed in providing material in class and making it easier for researchers to make the puzzle.

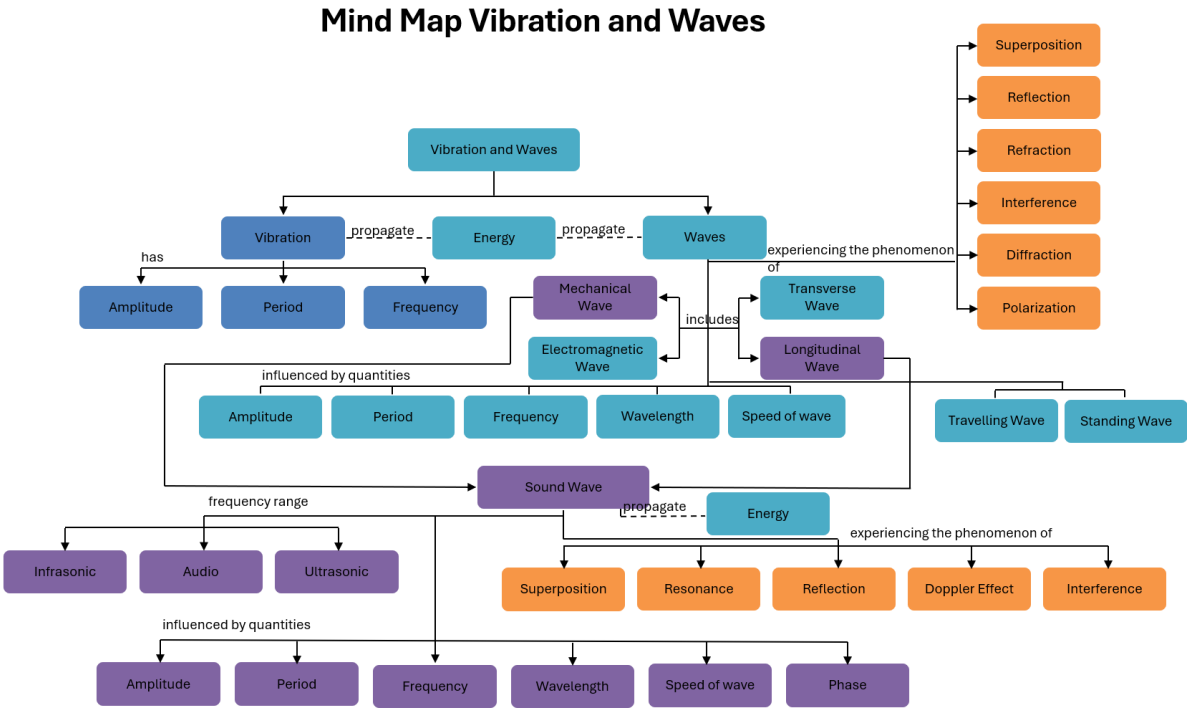


**Figure 1.** Mind Map of Vibration and Waves

https://doi.org/10.17509/wapfi.v10i1.79371

The concept map in Figure 1. is made to facilitate researchers in developing wave vibration material into questions that will be used as vibration and wave puzzles. The material to be discussed is grouped with sub-chapters of vibration and waves. The delivery of vibration and wave material either delivered in front of the class using *PowerPoint* with material in the module, or the material in the puzzle pieces is the material on the concept map.

After researchers have a concept map that is used as a reference in delivering the material, the next step is to create a material table. The material table contains materials that will be studied by students in the classroom. The material poured into the table is in the form of questions that have answers (a pair). The questions made by the researcher were considered slices. There are some questions that are the same but have different answers. This was deliberately made by the researcher to trick students in arranging the puzzle pieces. With the existence of these same pieces of questions, it is hoped that students can think critically in the preparation of the puzzle, based on the materials and concepts they learn and understand, either when paying attention to the teacher's explanation, or with the learning module they have. The following is a table of vibration and wave material that will be used in the puzzle.

**Table 1.** Vibration and Wave Materials in Puzzle

| Question | | Answer | | Description |
|---|---|---|---|---|
| 1 | Vibrations and Waves | | | |
| 2 | Vibrations | A | reciprocating motion through an equilibrium point | Concept |
| 3 | Waves | B | propagating vibration | Concept |
| 4 | Frequency | C | number of vibrations/waves per second | Concept |
| 5 | Period | D | time taken to form 1 vibration/wave | Concept |
| 6 | Vibrations and Waves | E | propagating energy | Concept |
| 7 | Amplitude | F | farthest deviation | Concept |
| 8 | Wavelength | G | length for one wave | Concept |
| 9 | Wave Speed | H | $\lambda f$ or $\frac{\lambda}{T}$ | Concept |
| 10 | Traveling Wave | I | fixed amplitude | Concept |
| 11 | Standing/Stationary Waves | J | changing amplitude | Concept |
| 12 | Electromagnetic Wave | K | waves that do not require an intermediate medium | Concept |
| 13 | Mechanical Wave | L | waves that require an intermediary medium | Concept |
| 14 | Transverse Wave | M | direction of vibration perpendicular to the direction of propagation | Concept |
| 15 | Longitudinal Wave | N | direction of vibration parallel to the direction of propagation | Concept |
| 16 | Phase Angle | O | angle traveled by the vibrating object | Concept |
| 17 | Phase Angle Difference | P | $\Delta\theta$ | Concept |
| 18 | Velocity Angle | Q | $\omega$ | Concept |
| 19 | Phase | R | wave quantities related to the deviation and direction of propagation of waves | Concept |
| 20 | Phase Difference | S | wave phase difference or wave stages | Concept |
| … | | | | |

Based on Table 1, there are 20 questions displayed by researchers out of 73 questions and 72 answers that researchers managed to create. Both questions and answers researchers provide codes. The code on the question is in the form of numbers and the answer is in the form of letters. This code is made to facilitate researchers in placing questions and answers on puzzle

https://doi.org/10.17509/wapfi.v10i1.79371

pieces. Because before making the puzzle in the desired size, the researcher first designs it on a sheet with a smaller size, therefore the code makes it easier for researchers to arrange questions and answers in a limited space. The final part that is of concern in the table is the description column, where researchers know that the description of the questions made is a physics concept or an example in everyday life of physics phenomena regarding vibrations and waves.

The next step, the research makes a puzzle design. Puzzle design is the shape of the puzzle that the researcher wants and will make. The material in the puzzle refers to the concept map that has been poured into the table. A total of 73 questions and 72 answers owned by researchers are based on the desired puzzle size. The researcher wants to make a puzzle with an A3+ size so that it is easy to carry (portable), the size is considered not too big and not too small. Based on this consideration, with the size of A3+, the researcher designed a hexagon-shaped puzzle, with each piece made in the shape of a triangle. The puzzle pieces are made with a triangular shape so that not too many sides are used, because later each piece will be related. This will make it difficult for researchers in making puzzle arrangements, because it requires a lot of material in the form of questions, or material that intersects and is related. The more sides used, the more possibilities there will be, which will make it more difficult for students to arrange the puzzle into a whole.

With the size of the hexagon puzzle and the size of the triangular puzzle pieces desired by the researcher, 54 puzzle pieces are needed, with three sides on each piece, except for the puzzle pieces on the outside. The outer side of the puzzle is not given a statement, question, or answer. The chapter title on the piece was placed in the upper left corner, so that the other two sides could be used as a benchmark to start assembling the pieces. The piece containing the title does not have to be in the top left corner. It is the critical and creative thinking of the learners that makes this puzzle arranged in one piece but not in the same direction in its arrangement. The colors given to the puzzle were initially blocked on the sub-chapters they learned in class, but this will make it easier for students to arrange the puzzle because they arrange it based on color. This made expert input for researchers to consider color selection. Therefore, researchers made the colors on the hexagon puzzle into graded colors.

After the hexagon puzzle shape was completed, then the researcher made a puzzle with another shape, namely the tetris shape. Researchers made a tetris puzzle model on input from experts, with the hope that this different puzzle shape could provide other variations to students. This tetris puzzle was made with a size combining 3 sheets of A3 + size paper. This size is used so that the writing of the questions and answers placed on the puzzle pieces is not too small. The same questions and answers as in the hexagon puzzle are used in this tertris puzzle. Making this tetris model puzzle starts from making a model for each piece by giving the same color to each piece. The following are images of the hexagon puzzle model (Figure 2.) and the tetris puzzle model (Figure 3.).

https://doi.org/10.17509/wapfi.v10i1.79371


**Figure 2.** Hexogon Puzzle

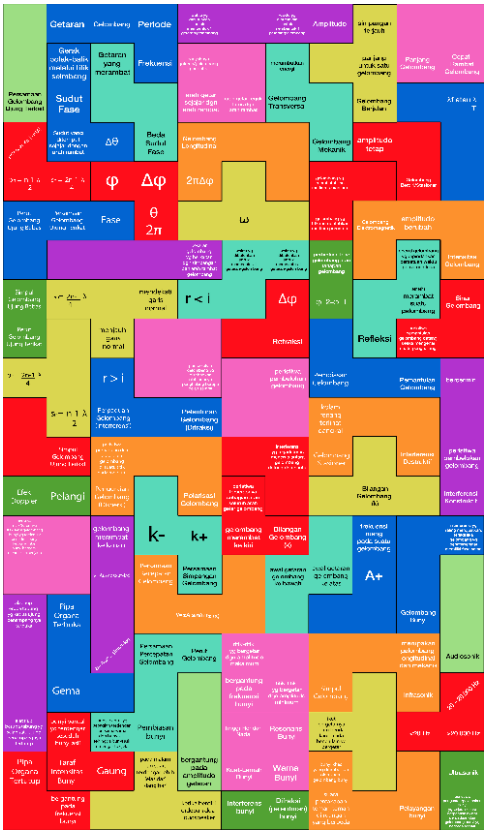

**Figure 3.** Tetris Puzzle

## Research Instrument Design Procedure

The research instruments used to collect data were learning outcome tests (pretest and posttest) and questionnaires. This test was developed by the researcher. Meanwhile, the questionnaire used to collect data related to students' responses to the learning methods applied, to see how much the influence of interest and learning motivation on learning outcomes. This questionnaire is in the form of closed questions with four answer options, namely strongly agree, agree, disagree, and strongly disagree. This instrument has been validated by experts and classified as valid.

After the questions and answers from the material are fulfilled, the puzzle design has been formed, then the researcher maps the questions and answers into the puzzle pieces. This mapping is based on the flow of material presented periodically in classroom learning. A total of 73 questions with 72 answers owned by researchers were arranged in accordance with the order of the material presented in the classroom. The placement of questions and answers was made to follow the flow of material delivery in the classroom. Not only that, but the researcher also considered the placement of questions that were the same but had different answers. After a question and answer is arranged on each piece of the puzzle, the puzzle is ready to be printed for further testing. After being tested and validated, the puzzle is ready to be used in the classroom.

## Data Collection Procedure

Before the learning began, the five classes were given a test (pretest) to determine the initial understanding of the students about vibrations and waves, before they were given learning in

https://doi.org/10.17509/wapfi.v10i1.79371

the classroom. The pretest time was 40 minutes with 9 essay questions. Overall, there are four stages in learning by using this method. The implementation of this learning method lasted for four weeks (1 month), and each meeting lasted for 60 minutes.

The learning stages are as follows. First, the teacher conveys the learning objectives and the scope of material to be learned. The teacher divides a few learners into small groups (3 students) in one group in each class, then the teacher provides an explanation in front of the class with the help of PowerPoint and simple demonstrations that can be directly seen, noticed, and done by each small group in each class. After the material delivery stage is completed and students have received the material, then they are given a learning module and a set of learning media in the form of a puzzle game board (with 2 different types of puzzles). With the material they have received in class, learners can arrange the puzzle pieces with the help of the learning module. Learners must get the material first before arranging the puzzle pieces, therefore the puzzle cannot be completed at one time. The puzzle will be arranged if students have obtained all the material about vibrations and waves, because each piece of the puzzle is part of the relationship between vibration and wave material. Another factor in arranging the puzzle is not the learning material they have obtained, but students are also required to think critically so that the puzzle pieces are arranged intact and correct. The last stage in this learning is that students do practice questions (Competency Test) as teacher evaluation material.

The way teachers deliver each sub-matter is different, besides using *PowerPoint*, teachers are also assisted by other learning media in delivering material in class. Learners can do simple experiments directly, or see demonstrations exemplified by the teacher in front of the class, or just by giving simple examples, with the aim that students easily understand what material is conveyed by the teacher. At the end of the meeting after all the material is given to students and they succeed in arranging the puzzle into a unified whole, the teacher corrects whether the puzzle pieces are correct and in accordance with the concepts that have been taught. After the learning stages until the students finish arranging the puzzle into a complete puzzle, the students' learning outcomes are measured by a test (posttest). The test used after this treatment is the same as the test used before treatment, with a duration of 40 minutes and 9 essay questions students do. After being given a posttest, as an evaluation material, the teacher provides a questionnaire related to the learning that has taken place.

### Analisis Data

The data in this study will be analyzed descriptively and quantitatively. Analysis of research data that has been obtained is analyzed using the SPSS 25 application. As for analyzing it can be done in the following way.

#### *Analysis of Pretest dan Posttest Data*

Before analyzing the pretest and posttest results from students, it is necessary to carry out a prerequisite test, namely the normality test, which aims to determine whether the data is normally distributed or not. The decision-making rule in this normality test is if the p-value (Sig.) in the Tests of Normality table > 0.005 then the data is normally distributed.

After ensuring that the data is normally distributed, the next step is to conduct a paired sample t-test to determine whether there is an average difference between two samples that are paired with each other or not. In this paired sample t-test test, it can be seen whether the Mean

https://doi.org/10.17509/wapfi.v10i1.79371

value before treatment with after treatment there is a difference in Mean value, where the value before treatment < after treatment, it can be concluded that the treatment has a difference in learning outcomes. The next part is to look at the Sig. (2-tailed), if the p-value < 0.005 then there is an effect of the treatment given in a learning method applied.

*Paired sample T-test*

Based on the paired sample t-test, there is a difference in the average of two samples (two groups) that are paired or related to each other as provide in Table 2.

**Table2.** Average Value of Learning Outcomes based on Pre-test and Post-test

| Pair 1 | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| NA_Pretest | 3.8519 | 70 | 1.45168 | 0.17351 |
| NA_Posttest | 8.0475 | 70 | 1.14627 | 0.13701 |

Based on Table 2. above, for the pretest and posttest scores, the average learning outcomes or Mean is obtained, with a Mean value of 3.8519 in the pretest and 8.0475 in the posttest.

**Table 3.** Effect of the Use of Learning Methods

| Pair 1 | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|
| | | | | Lower | Upper | | | |
| NA_Pretest - NA_Posttest | -4.1956 | 1.59288 | 0.19039 | -4.57541 | 3.81579 | -22.037 | 69 | 0.000 |

The most important output is shown in Table 3., in this section you can find out whether there is an effect of using learning methods by knowing the formulation of research hypotheses and decision-making guidelines. Based on Table 3. obtained Sig value. (2-tailed) of 0.000 where the value is smaller than 0.005, the hypothesis can be accepted, so it can be concluded that there is an average difference between the pretest and posttest learning outcomes, which means that there is an effect of using puzzle game-based learning media in increasing students' motivation and interest in learning vibration and wave material at the high school level (Leo & Sardanelli, 2020).

*Analysis of Questionnaire Data*

The questionnaire sheets that have been filled in by students are analyzed in the following way. Changing the value in qualitative form using a Likert scale. The rules for weighting the score on each statement item are carried out through the provisions as shown in Table 4 (Joshi, 2015).

**Table 4.** Weighting Score for Each Item

| Rating | Skor |
|---|---|
| Strongly Agree | 4 |
| Agree | 3 |
| Disagree | 2 |
| Strongly Disagree | 1 |

*Formulating the research hypothesis.*

The formulation of the research hypothesis is as follows.

https://doi.org/10.17509/wapfi.v10i1.79371

H0 : There is no effect of using puzzle game-based learning media in increasing student motivation and interest in learning vibration and wave material at the high school level.
H1 : There is an effect of using puzzle-game-based learning media in increasing students' motivation and interest in learning vibration and wave material at the high school level.

*Conducting validity test*

The validity test aims to test whether the value of the question items reflects the total value of the variable. Based on the decision-making rules if the significance value Sig. (2-tailed) < 0.005 then there is a correlation between the variables that are connected and can be declared valid.

**Figure 5.** Questionnaire Validity Value

| | | Motivasi | Minat | Prestasi |
|---|---|---|---|---|
| Motivasi | Pearson Correlation | 1 | 0.519** | 0.615** |
| | Sig. (2-tailed) | | 0.000 | 0.000 |
| | N | 70 | 70 | 70 |
| Minat | Pearson Correlation | 0.519** | 1 | 0.557** |
| | Sig. (2-tailed) | 0.000 | | 0 |
| | N | 70 | 70 | 70 |
| Prestasi | Pearson Correlation | 0.615** | 0.557** | 1 |
| | Sig. (2-tailed) | 0.000 | 0.000 | |
| | N | 70 | 70 | 70 |

**Correlation is significant at the 0.01 level (2-tailed)

Based on Table 5. obtained a Significance value Sig. (2-tailed) of 0.000 < 0.005, so there is a correlation between the variables of interest and motivation on achievement (learning outcomes) which can be declared valid.

*Conducting reliability test*

The reliability test aims to see if the questionnaire has consistency if measurements are repeated. The decision-making rule if the Cronbach's Alpha value > 0.6 is said to be a reliable questionnaire.

**Table 6.** Cronbach's Alpha value

| Cronbach's Alpha | N of Items |
|---|---|
| 0.778 | 12 |

Based on decision making can be seen in Table 6. the Cronbach's Alpha value is 0.778 where the value is greater than 0.6 and it can be said that the questionnaire is reliable.

*Performing multiple regression analysis*

Regression analysis aims to determine whether there is an independent influence on the dependent variable. There are several parts in interpreting the research results. First, interpret the results of the Adjusted R Square value to see what percentage of the contribution of the influence of the independent variable (interest and motivation of students to learn) on the dependent variable (student learning outcomes) simultaneously (together). Furthermore, looking at the ANOVA table if the significance value Sig. < 0.05, it can be concluded that the

https://doi.org/10.17509/wapfi.v10i1.79371

independent variables (interest and motivation of students to learn) have a significant effect simultaneously (together) on the dependent variable (student learning outcomes). The last part of multiple regression analysis is to look at the Coefficients in Table 7 where we can analyze the T-Test or Hypothesis Test on the research questionnaire (Morgan et al., 2019). The criteria for testing the T-test (Hypothesis Test is if the significance value Sig. < 0.05 concludes that there is a significant influence. Then the Regression Equation is obtained from the regression analysis that has been carried out using the SPSS 25 application.

**Table 7.** Adjusted R Squre Value

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | 0.675[a] | 0.456 | -.439 | 1.958 |

In Table 7, it is known that the Adjusted R Square value is 0.456, it concludes that the contribution of the influence of interest variables and learning motivation to the achievement variable or student learning outcomes simultaneously (together) is 45.6%. Please refers to Table 8.

**Table 8.** ANOVA Regression Analysis

| Mode | | Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 215.103 | 2 | 107.551 | 28.050 | 0.000[b] |
| | Residual | 256.897 | 67 | 3.834 | | |
| | Total | 472.000 | 69 | | | |

a. Dependent Variables: Prestasi
b. Predictors: (Constant), Minat, Motivasi

The regression model is declared FIT if the Sig. < 0.05. It is known that the Sig. value of 0.000 < 0.05, it concludes that the independent variables have a significant effect simultaneously (together) on the dependent variable as seen in Table 9.

**Table 9**. T-Test (Hypothesis Test)

| Mode | | Unstandarized Coefficients | | Standarized Coefficients Beta | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | | | |
| 1 | (Constant) | 6.201 | 1.735 | | 3.575 | 0.001 |
| | Motivasi | 0.747 | 0.177 | 0.445 | 4.225 | 0.000 |
| | Minat | 0.550 | 0.178 | 0.326 | 3.095 | 0.003 |

*T-Test Analysis (Hypothesis Test)*

Sig value. motivation variable of 0.000 < 0.05, it concludes that the motivation variable has a significant effect on the achievement variable. Sig. value of the Interest variable is 0.003 < 0.05, it concludes that the Interest variable has a significant effect on the Achievement variable. The Regression formula is shown in Equation 1.

$$6.201 + 0.747\ (\text{motivation}) + 0.550\ (\text{interest}) \quad (1)$$

The constant value obtained is 6.201, it means that if the independent variable is 0 (constant), the dependent variable is 6.201. Coef value. The regression value of the Motivation variable is positive (+), it means that if Motivation increases, Achievement also increases, and vice versa. The coef. regression value of the Interest variable is positive (+), it means that if Interest

https://doi.org/10.17509/wapfi.v10i1.79371

increases, Achievement also increases, and vice versa (Arkes, 2023; Salam & Adji, 2021). The histogram as provide in Figure 4.

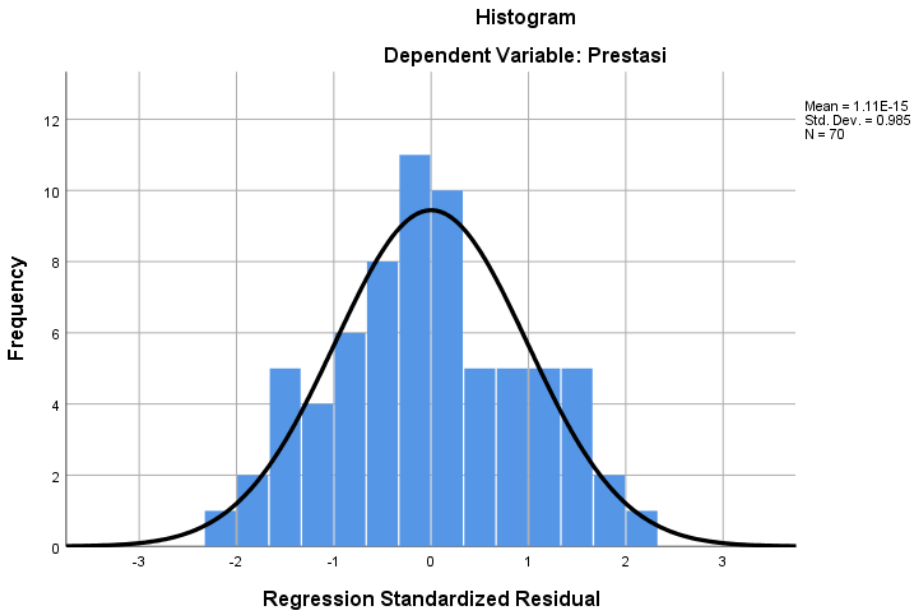


**Figure 4.** Histogram of Dependent Variable: Achievement

## CONNCLUSION

Based on the results of the data analysis that has been carried out, it can be concluded that the learning method developed affects interest and motivation to learn the learning outcomes of students. This can be seen from the Mean value in the pretest of 3.8519 and posttest of 8.0475. Furthermore, in the paired sample t-test test, the Sig. (2-tailed) of 0.000 < 0.005, where the application of learning methods has an influence in increasing students' interest and motivation in learning vibration and wave material. Based on the adjust R square value of multiple regression analysis, the effect of learning methods is 0.456, that the contribution of the influence of the independent variable (interest and motivation) to the dependent variable (learning outcomes) simultaneously is 45.6%.

## REFERENCES

Aji, S. D., Aprianto, R. D., Abdullah, A. G., & Hudha, M. N. (2019). Physics Education (PhyEdu): Mechanical wave media for physics learning. *Journal of Physics: Conference Series*, *1402*(6).

Ariffin, N. H., Azmi, M. S. M., & Rahman, N. A. (2022). The development of “Monolektrik Kit” for the topic on Series and Parallel Circuits for secondary school Science and its’ usability among Physics trainee’s teachers. *Journal of Physics: Conference Series*, *2309*(1).

Arkes, J. (2023). *Regression analysis: a practical introduction*. Routledge.

Azizah, N., Nengsih, E. W., Wati, L., Rahimah, & Nastiti, L. R. (2021). The perspective on monopoly as media in physics learning by using teams games tournament. *Journal of Physics: Conference Series*, *1760*(1), 012015.

Bainbridge, K., Shute, V., Rahimi, S., Liu, Z., Slater, S., Baker, R. S., & D’Mello, S. K. (2022). Does embedding learning supports enhance transfer during game-based learning? *Learning and Instruction*, *77*.

https://doi.org/10.17509/wapfi.v10i1.79371

Banda, H. J., & Nzabahimana, J. (2021). Effect of integrating physics education technology simulations on students' conceptual understanding in physics: A review of literature. *Physical Review Physics Education Research*, *17*(2), 023108.

Cardinot, A., McCauley, V., & A Fairfield, J. (2022). Designing physics board games: A practical guide for educators. *Physics Education*, *57*(3).

Dziob, D. (2020). Board Game in Physics Classes—a Proposal for a New Method of Student Assessment. *Research in Science Education*, *50*(3), 845–862.

Fitriyana, N., Wiyarsi, A., Ikhsan, J., & Sugiyarto, K. H. (2020). Android-based-game and blended learning in chemistry: Effect on students' self-efficacy and achievement. *Cakrawala Pendidikan*, *39*(3), 507–521.

Joshi, A., Kale, S., Chandel, S., & Pal, D. K. (2015). Likert scale: Explored and explained. *British journal of applied science & technology*, *7*(4), 396.

Di Leo, G., & Sardanelli, F. (2020). Statistical significance: p value, 0.05 threshold, and applications to radiomics—reasons for a conservative approach. *European radiology experimental*, *4*, 1-8.

Luarn, P., Chen, C. C., & Chiu, Y. P. (2023). The Influence of Gamification Elements in Educational Environments. *International Journal of Game-Based Learning*, *13*(1).

Malicoban, E. V., Bulado, J. F., Soriano, D. A. A., Monte, A. B. L., & Mordeno, I. C. V. (2021). Development of a STEM board game electriciladders for grade 8 students. *Journal of Physics: Conference Series*, *1835*(1), p. 012030

Mulyastuti, H., Sutopo, & Taufiq, A. (2019). Identification of high school students' problem-solving skills on rotational dynamics. *Journal of Physics: Conference Series*, *1171*(1), p. 012028.

Morgan, G. A., Barrett, K. C., Leech, N. L., & Gloeckner, G. W. (2019). *IBM SPSS for introductory statistics: Use and interpretation*. Routledge.

Oktaweri, S., Festiyed, & Djamas, D. (2019). Curriculum analysis in developing interactive multimedia teaching materials scientific model assisted games for physics learning. *Journal of Physics: Conference Series*, *1185*(1), p. 012118.

Panggabean, J. H., Siregar, M. S. D., & Rajagukguk, J. (2021). The effect of teams games tournament (TGT) method on outcomes learning and conceptual knowledge in physics science. *Journal of Physics: Conference Series 1819*(1), p. 012047.

Redhana, I. W., Widiastari, K., Samsudin, A., & Irwanto. (2021). Which is more effective, a mind map or a concept map learning strategy? *Cakrawala Pendidikan*, *40*(2), 520–531.

Ren, P., Xiao, Y., Chang, X., Huang, P. Y., Li, Z., Gupta, B. B., ... & Wang, X. (2021). A survey of deep active learning. *ACM computing surveys (CSUR)*, *54*(9), 1-40.

Romanvican, M. G., Mundilarto, Supahar, & Istiyono, E. (2020). Development learning media based traditional games engklek for achievements mastery of the material and tolerance attitude. *Journal of Physics: Conference Series*, *1440*(1), 012044.

Rosyid, F. A., Arjo, S., Suminten, N., Sandjaja, D. P., & Makdiani, N. (2020, March). The development of android-based physical learning media brain quiz game assisted on momentum and impulse materials. *Journal of Physics: Conference Series1491*(1), p. 012027

Salam, R., & Adji, A. (2021). Application of Logistic Regression Modeling for Complex Survey Data on Education Continuity of Poor Households Children. In *Proceedings of The International Conference on Data Science and Official Statistics* (Vol. 2021, No. 1, pp. 659-665).

Subanji, Nusantara, T., Sukoriyanto, & Atmaja, S. A. A. (2023). Student's creative model in solving mathematics controversial problems. *Cakrawala Pendidikan*, *42*(2), 310–326.

Suratno, Muazza, Murboyono, R., & Guspita, D. (2023). What is the effect of learning models and interests on study results? *Cakrawala Pendidikan*, *42*(3), 804–814.

Tinedi, V., Yohandri, Y., & Djamas, D. (2018). How Games are Designed to Increase Students' Motivation in Learning Physics? A Literature Review. *IOP Conference Series: Materials Science and Engineering*, *335*(1).

https://doi.org/10.17509/wapfi.v10i1.79371

Zeng, H., Zhou, S. N., Hong, G. R., Li, Q. Y., & Xu, S. Q. (2020). Evaluation of interactive game-based learning in physics domain. *Journal of Baltic Science Education*, *19*(3), 484–498.

https://doi.org/10.17509/wapfi.v10i1.79371