



Development of PUHA (Pop Up Horses Algebra) educational games for enhancing grade 7 students' algebraic learning

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Abstract: The PUHA (Pop Up Horses Algebra) game is developed for enhancing mathematics learning in Grade 7 algebra. This research aims to create interactive games that are not only engaging but also effective in facilitating students' comprehension of algebraic concepts in an enjoyable manner. Employing the ADDIE Model (Analysis, Design, Development, Implementation, Evaluation) as a developmental framework, this study endeavors to ensure the systematic and structured creation of PUHA. The findings underscore that the development of PUHA games significantly enhances students' grasp of algebraic principles at the Grade 7 level. Utilizing the ADDIE Model for PUHA game development ensures a methodical approach, guaranteeing the production of high-quality and impactful educational games. In conclusion, the development of the PUHA game utilizing the ADDIE Model showcases a promising approach to fostering students' algebraic understanding in Grade 7 through engaging and effective educational gaming experiences.

Keywords: Game development, Learning media, Mathematics learning, Pop Up Horses Algebra

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INTRODUCTION

Education is an effort to bring about changes in human beings through conscious and planned steps. The learning process carried out by students produces broad insights and knowledge, which are products of the educational process (McKenney & Reeves, 2018). In building and designing learning, teamwork is needed between teachers and students to achieve the desired learning objectives (Gentry, 2013).

One of the aids to the success of learning objectives is learning media (Surur, 2022; Mweene & Muzaza, 2020). Media, from an educational perspective, is a very strategic instrument in determining the success of the teaching and learning process (Umarova, 2020; Puspita et al., 2022). Because its existence can directly provide its own dynamics to students, Sadiman (2002) states that learning media are materials, tools, or techniques used in teaching and learning activities with the intention that the educational communication interaction process between teachers and students can take place in an appropriate and efficient manner. Learning media is a supporting factor in the success of the learning process in schools because it can help the process of conveying information from teachers to students or vice versa (Ahern & Wilkinson, 2012; Khairani, 2016). Through digital media and various types of educational technology, we can support students with various learning abilities, providing more educational opportunities (Molnar & Gair, 2013; Abdulrahman et al., 2020).



Learning media can be described as media that contain information or instructional messages and can be used in the learning process. Learning media are media that convey messages or information that contain the intent or purpose of learning. Learning media is support to help students acquire new concepts, skills, and competencies. In the digital era, educators must be able to use not only classic learning media but also modern learning media. Several research findings also show the positive impact of media used as an integral part of classroom learning or as the main method of direct learning (Dinar et al., 2020).

We often encounter in schools that when learning mathematics, there is still a tendency for teachers to rarely use media or visual aids. Teachers use sober or very simple media or props that are far from attracting students' attention because they do not pay attention to color composition, sizes are not proportional, and they are not packaged properly. Such conditions make learning mathematics unattractive and unpleasant, so it is not optimal for helping students acquire mathematical concepts.

One of the factors that influences students' motivation to learn mathematics is the use of learning media (Afgani et al., 2008; Djamarah & Zain, 2010; Putra & Sumbawati, 2015; Umar, 2017). The role of learning media in learning mathematics is one of the efforts to enhance the process of teacher-student interaction, student interaction, and the mathematics learning environment. The function of learning media is as a teaching aid, namely to support the use of teaching methods by teachers. Motivated students can use higher cognitive processes to study, learn, and master the material provided (Graham, 1991; McGuire et al., 2015).

Existing learning resources and media certainly cannot be used entirely by teachers. Teachers must be able to use or create learning media according to the material and conditions of the students. This is supported by Arsyad's opinion, which says that one of the criteria for media that is worth choosing is media that is aligned and in accordance with the needs of learning tasks (Arsyad, 2017).

PUHA (Pop Up Book Horses Algebra) is a pop-up book that is combined with Ludo games to become a learning medium that goes through a modification process to suit learning algebra material. Cooperative learning through PUHA learning media is easy to use because the media has elements of play and reinforcement that involve all students. Games using PUHA make the learning process more relaxed but still foster an attitude of responsibility, cooperation, and healthy competition among students so that they will be more enthusiastic about carrying out the learning process. The PUHA used in this study is basically similar to the Ludo game, but for the sake of learning, there are modifications. There are algebra materials: 40 tiles, 12 question cards, 12 answer cards, and 4 pieces, with each piece containing 2 players. The square in the middle will contain math questions with algebra material; each student who stops at that section is required to answer correctly before continuing to the next step.

PUHA is a game that is packaged in such a way that it can be used for learning. The priority is that students are more motivated to learn mathematics, especially algebra material (Kuwatno et al., 2022; Mahendrawan et al., 2021; Wijayanti, 2021). By participating in learning using this medium, students become involved and active because of the application of game rules that require them to move according to the procedure. PUHA is not used as material delivery but rather as material for reflection and evaluation to remember algebra material that has been presented before.

PUHA was chosen because this game can make students more interested in learning mathematics, be more active, not easily bored, and hone their thinking skills. The advantage of this ludo game is that it is easy and fun to play (Rosmiati et al., 2020), so that students can understand and recall the explanations that have been conveyed by the teacher, as well as test students' understanding of working on problems in the learning process in class (Tyas et al., 2018). The purpose of this paper is to develop interactive games that are interesting and effective in helping students understand algebraic concepts in a fun way.

METHOD

The development model used in this research is the ADDIE development model. The systems approach is used in designing instructional learning in the ADDIE model. The purpose of the systems approach is to break down the planning process into several steps, organize the steps into logical sequences, and then use the output of each step as input for the next steps (Januszewski & Molenda, 2008). The ADDIE model has five main stages based on its name (Cahyadi, 2019).

In the analysis stage, there are three activities. First, analyze the teacher, including the teacher's skills in managing the class and implementing learning strategies and methods. Second, conduct an analysis of students, including student characteristics, knowledge, and also the material to be studied. third, an analysis of the learning resources used in learning. Design. This stage is the preparation of frameworks and ideas for making media. Compilation of designs so that researchers have an idea of the appearance and content of the media to be made. The developed media aims to facilitate and increase student interest in the learning process, so that what is developed is a game. The game board is equipped with pop-ups containing material and also horse-shaped pawns (using horse pawns from chess games). Media development uses materials that are easy to find in stationery supply stores and are reasonably priced. After the media design has been completed, it is followed by the design of the rules for using the media. Then proceed with designing the required instrument. The instruments used were interview guides and questionnaires designed to evaluate the media that had been made. The preparation of the instrument was given to the material expert validator, media expert, and learning expert to test the feasibility of learning media, and a questionnaire was given to students to find out the practicality of learning media.

The development stage is the stage of realization of the plans that have been made in the previous stage. After the manufacturing stage is complete, the media is validated by media and material experts, as well as the mathematics teacher as a learning expert, for feasibility before being tested. Implementation. The implementation stage is the implementation of media trials twice: the first trial is a limited field trial, and the second trial is a large field trial to see the practicality and effectiveness of the media used. Evaluation. The evaluation stage is an improvement on the research results from the validator and student responses. All suggestions and improvements made to the developed media were properly revised.

The subjects in this study were class VII students, material validation experts, and media validation experts. Selection of class VII students, because these students in odd semesters have received the material, and the research was conducted in even grades. Meanwhile, the researcher did not select students from the upper grades because the material had been missed and also because of preparation for the school's final exams. The data analysis technique uses a Likert scale with score conditions that can be seen in Table 1.

Table 1. Likert scale

| Score | Category |
|-------|---------------|
| 5 | Very Good |
| 4 | Fine |
| 3 | Good Enough |
| 2 | Not Good |
| 1 | Very Not Good |

The instrument used who have conducted development research by making a medium that is also used in learning mathematics (Hada et al., 2021). The research instruments used were student responses, material expert validation, and media experts (Surur et al., 2023). To validate learning media, indicators are prepared based on media construction, media display design, and media components. In order to validate the learning materials, indicators are prepared based on the quality of the objectives, the quality of the content, and the quality of

the learning. Media and material validation was carried out by two mathematics study programs. The validation results are then adjusted to [Table 1](#).

RESULTS AND DISCUSSION

Results

Analysis Stage

In Instructional Objectives, the problem comes from the teacher. Algebraic material is material that is abstract for students, so the teacher must be careful when explaining this material to students. Students themselves have different understandings of material and require teachers to create learning methods or learning media that can be accepted by all students, not only those using the lecture method (like most teachers today).

With this PUHA learning medium, it can help teachers explain algebra material to students by attracting students' attention because it uses attractive colors by combining dark and light colors as a differentiator and giving a contrast impression, so that it can be used in various rooms. There is a real form of algebraic material in the form of materials and exercises related to everyday problems. In PUHA itself, there is a game (ludo) that can be played by all students, and there is also material in the game. The Ludo game is a fairly well-known game, and there is also an explanation of how to use it if there are students who have never played this game.

PUHA learning media, students are expected to be able to explore the material on their own. So that when students don't understand the material and don't dare to ask questions, they can explore and understand the material themselves with this PUHA media. In this PUHA media, it will contain algebraic material as an introduction, and on one of the pages there is a Ludo game that all students can use to explore and understand the algebraic material.

In terms of resources, problems originate elsewhere than with teachers and students. The media used in some schools is still very limited, so students will feel bored because learning is not interesting. The media used are usually in the form of textbooks, blackboards, and worksheets. These limitations result in the fact that the content produced also only comes from the material in the book; there are no other references. That is, the use of technology in the learning process is not good. However, the facilities will also be put to good use if the facilities in the school are adequate, such as having an LCD. In actual field conditions, there are still obstacles to learning mathematics algebra material in grade 7, which is common, namely the lack of interest and understanding of students towards abstract and complex algebraic concepts.

Inadequately qualified human resources can also be an obstacle in the teaching and learning process. The use of resources that are not optimal will also cause the process of developing talents and interests among students to not be optimal. With PUHA learning media, it is hoped that students will be interested in the learning process. The media used will be new to students. The content provided also does not have to be with students reading the contents of the entire book. PUHA can be said to be a good use of technology to support the learning process. With this PUHA, it can overcome students who feel bored or sleepy, so it will not hinder the learning process. Maximum use of resources like this will also provide maximum benefits for students and teachers in the learning process that occurs.

Design Stage

The PUHA game was developed as an interactive and fun learning medium. The PUHA used in this study is basically similar to the Ludo game, but for the sake of learning, there are modifications. There are algebra materials: 40 tiles, 12 question cards, 12 answer cards, and 4 pieces, with each piece containing 2 players. The square in the middle will contain math questions with algebra material; each student who stops at that section is required to answer correctly before continuing to the next step.

a. Steps to use the media or rules of the game

Four Horses is a board game played with dice and corners. In this game, players (horses) move their corners as many times as the number of dice they roll to try to beat other players and reach the finish line. Here are the Four Horses game rules adapted to mathematics: 1) Corners and Dice, each corner has a number from 1 to 4. While the dice that the corner will use have a number from 1 to 6; 2) Position, the player (Knight) must start from the starting position on the bottom right side of the board. Each player has four corners that must be moved to the finish line on the top left side of the board; 3) Displacement, players can move their corner according to the number of dice they get after throwing them. If the player's dice number matches their corner number, they can choose to start a new corner or move the corner that has already moved; 4) Dead End, if players cannot make a move with the number of dice they rolled, then they are considered finished in the game, and the next turn begins.

5) Assault, if a player's corner stops at a box that has been filled by another player's corner, then the other player's corner will be hit and must return to its starting position; 6) Mathematics, this Four Horses game has been adapted to mathematics. The horse used is a pawn in a chess game. Choose a horse because the track in a game of luda forms like a series of "L" letters, much like the way a horse walks in a game of chess. In addition, because this is a game, there is an element of speed in it, so it can be made a winner. This speed is also synonymous with horses. Therefore, players must answer math questions quickly before returning to their part; 7) Math Questions, mathematical questions will be provided in PUHA, which will later adjust the numbers on the four horse game board. The questions provided are about "Algebra" material in the form of essays and multiple choice. The player who answered correctly can proceed to move their corner according to the number of dice they rolled; 8) Win, the first player to successfully move all of his corners to the finish line on the top left side of the board will be the winner in this game of Four Horses.

b. Element design

The assessment in this game is in the form of questions to find out the ability of students to answer the questions they get. With learning objectives, students can understand algebraic concepts (coefficients, variables, and constants) well, and they can analyze and solve problems related to algebraic concepts (terms, coefficients, variables, and constants) appropriately.

Development Stage

As an illustration, a picture of the finished media has been shown, as in **Figure 1** and **Figure 2**. The media is ready to be used, then carry out a trial and learning process. Materials and tools: Cardboard, scissors, black manila paper; ruler, origami paper; stationery, paper glue; cutter, double tape; question paper.



Figure 1. Pop-up book media design

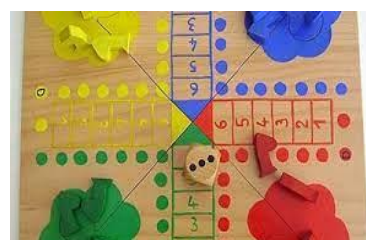


Figure 2. Four horses in media design

Making process: Cardboard is measured and cut according to a predetermined size (**Figure 3**). Cover the cardboard with black manila paper and tidy it up (**Figure 4**). Cover the cardboard with black manila paper and tidy it up (**Figure 4**). Make a game using origami paper attached to cardboard (**Figure 5**). Paste the questions in the game area (**Figure 6**). Paste the materials and

answer keys for the questions (Figure 7). Paste the game rules and description (Figure 8). Paste the title and decorate it (Figure 9).

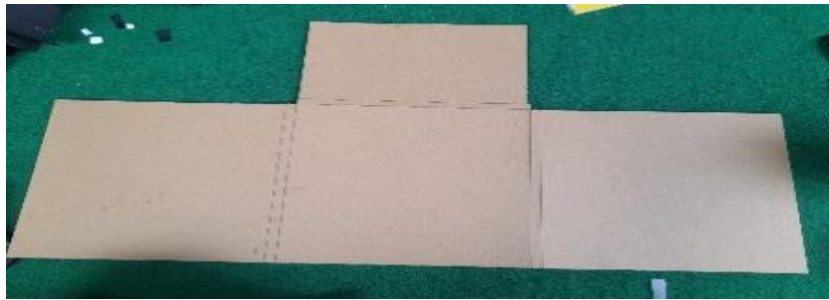


Figure 3. Cardboard

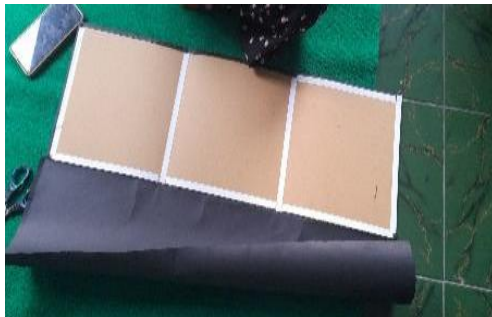


Figure 4. Give a Cover



Figure 5. Making a Game



Figure 6. Game Board

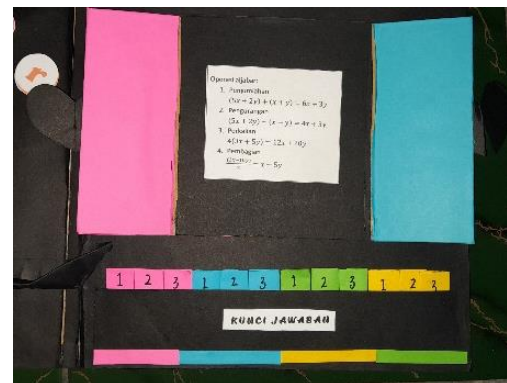


Figure 7. Answer Key

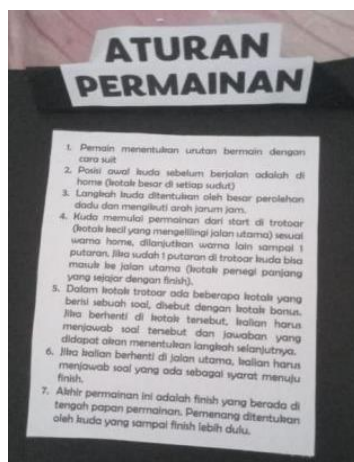


Figure 8. Rule of the Game



Figure 9. Title of Game

Describe the parts of the instrument used by explaining the parts (statements) in the instrument. The purpose of the instrument is to obtain valid media through media experts, effective material through material experts, and practicality through student responses. Validation was carried out with material experts, media experts, and student response sheets.

The results of this validation process are: The average score obtained is 70. Based on [Table 1](#), the validation results are included in the good enough category so that the media can be suitable for use with revision according to the notes provided by the validator. While the notes given by the validator concluded that the PUHA game media still has deficiencies, namely in the rules/use of media section, so that the media needs to be improved, namely, this game media is good enough, but it is still not very detailed in explaining the rules of the game. Furthermore, the author makes improvements by clarifying the rules and detailing certain parts, such as the rule that when in the same box as the opponent, there is no need to return to the original place; if a player gets a dice number 6, there is no need to repeat it again; multiply the questions in the media.

The steps for using the media are as follows: Players determine the order of play by suit, The initial position of the horse before walking is home (a big box in each corner), The horse's move is determined by the number of dice obtained and surrendered in a clockwise direction, The horse starts the game by starting on the sidewalk (the small square that surrounds the main road) according to the home color, followed by another color until one round; if it has been one round on the sidewalk, the horse can enter the main road (the rectangular box that is parallel to the finish), In the sidewalk box, there are several boxes that contain a question, called a bonus box. If you stop at that box, you have to answer the question, and the answers you get will determine your next step, If you stop on the main road, you have to answer the existing questions as a condition for the finish, To check whether the answer is correct or not, it can be seen in the answer key column, The end of the game is the finish line in the middle of the game board ([Figure 10](#)). The winner is determined by the horse that finishes first.



Figure 10. Final Media

This media implementation will be carried out on Sunday, May 21, 2023, at 13.00. Before carrying out the implementation, it was opened first with greetings and continued by explaining the material in the media, namely algebra. Next, give stimulation first regarding the outline of the algebraic material. After remembering the material, students are informed about the rules of the game and the existing information and continue playing until the game is over.

Communications-interactions activity process: Greetings to open the lesson, Tell students about the material used in the media, Explaining the outline of algebra material to students to stimulate them to recall algebra material, Students who ask questions related to the material will be immediately answered by the presenter, Read the steps in the game and also the information that must be known by students who play, Students start playing with suits and continue with the numbers obtained by throwing the dice, The student who stops at the bonus box must answer the question and be corrected by another student ([Figure 11](#)). If it is wrong, then the student has to guess the answer until it is correct, and if the answer is correct, then the student can continue his steps, Students who are already on the main road must also

answer the questions. To check whether the student's answer is correct or wrong, other students can check in the answer key column according to the color of the horse and the numbers provided, the student who reaches the finish line first wins the game, After students finish playing this game, they are given a student response questionnaire to gauge their interest in this game.



Figure 11. Interactions

Implementation Stage

This PUHA media contains several parts needed for learning, namely material, practice questions, games, and also new learning resources. The material in this medium is algebra material for class VII students who have already obtained this material. The game is implemented by carrying out game activities. In addition, there are algebraic questions that are used in the game while it is in progress. Students answer questions in groups so that, at the end, the cumulative value will be taken, which is used in the assessment. If you don't remember algebra material, then all you have to do is look at the summary in the media. In terms of working on questions, the teacher has prepared answer keys as a reference for seeing the results of student work.

The subjects used were class VII students who had received algebra material. By using this medium, it can be seen that students' mastery of algebra material, which students understand algebra material, and which students do not understand algebra material by using this medium, if there are students who understand algebra material, the students will contribute to checking the answers of their friends.

This learning medium has a placement function because it has a compact form, is easy to carry, and is flexible. So, when using this medium, students can use it wherever and whenever they want, as comfortable as they are. This medium has a diagnostic function; this can be seen in the questions in the medium fulfilling the basic competencies that students must have in learning algebra, such as composing mathematical sentences and operations on algebra (addition, subtraction, multiplication, and division), so that when students have difficulty in algebra material, it can be known and identified as related to students' problems or difficulties in learning algebra. Level selection is carried out at the summative evaluation stage to determine the results of student learning achievements. This medium conducts a level 2 summative evaluation, in which the learning serves to measure the acquisition of students' knowledge and skills.

Evaluation Stage

This media helps to determine students' abilities regarding algebraic material because, at each step of this media game, a question is given that requires students to use the solution method that has been presented in the algebraic material. That is, students who understand the material well will easily continue the game. While the instrument on the questionnaire or student response sheet is used to determine the effectiveness of using media in learning and also in accordance with the student's perspective, The better the response, the better the learning process, and the learning objectives will also be achieved.

Discussion

The purpose of the algebra material itself can be applied in students' daily lives, so this material is very important for students to understand themselves (Lestari et al., 2019). Meanwhile, in practice, it turns out that when linking algebra material with everyday problems, teachers are still lacking. Moreover, the problems given are only presented in front of the class, and students work according to the method that has been given by the teacher. As a result, students become passive learners (Surur et al., 2017). For that, we need media that can overcome these problems.

In terms of object characteristics, problems originate with students (Hiemstra & Brockett, 2012). Lack of confidence Often, students lack confidence when they want to ask questions of the teacher. When students don't understand the material and don't ask questions about things they don't understand to the teacher, they will feel bored and find the material difficult. Especially in algebraic material, which is still abstract in nature, students will have difficulty understanding the material. Media that has been made will then be given to the validator to carry out the assessment process (Surur, 2021). The assessment was carried out quantitatively and qualitatively. Quantitative data is obtained from the results of filling out the questionnaire, while qualitative data is obtained from suggestions or criticism from the validator.

At this stage, there are two activities carried out: first, the media has been revised and is ready for use; second, the test subjects have been conditioned according to the characters and material contained in the media. The place used in implementing this medium is the house. Students who implement this medium are class VII students who have received algebra material. This learning medium can be used anywhere because learning is flexible, so it can be used as comfortably as the students themselves (Nusir et al., 2013; Pahmi et al., 2023).

This learning medium has a placement function because it has a compact form, is easy to carry, and is flexible. So, when using this medium, students can use it wherever and whenever they want, as comfortable as they are. This medium has a diagnostic function; this can be seen in the questions in the medium fulfilling the basic competencies that students must have in learning algebra, such as composing mathematical sentences and operations on algebra (addition, subtraction, multiplication, and division), so that when students have difficulty in algebra material, it can be known and identified as related to students' problems or difficulties in learning algebra (Stephens et al., 2021).

CONCLUSION

The PUHA game was developed as an interactive and fun learning medium. For the evaluation results of the use of the PUHA game, it shows that there is an increase in students' interest in learning algebraic material. In addition, students also showed an increased understanding of the algebraic concepts taught through this game. Even though the evaluation results are positive, there are still a number of things that need to be improved in the development of the PUHA game. There are still some difficulties or obstacles faced by students in using this game, and there are still certain aspects that can be improved to increase its effectiveness as a learning tool. To improve the PUHA game, it is better to make adjustments based on the feedback of students and teachers who have used it. Because it is necessary to simplify some complicated aspects, add clearer instructions or game rules, and provide a wider variety of challenges and levels of difficulty according to students' abilities.

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DECLARATIONS

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