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Inclusive Design of Teaching Aids for Social Science Learning Process for Elementary and Middle School Students based on Creative Mini PC Raspberry Technology

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Abstract. The purpose of this activity is to educate students and teachers with the inclusive board game invention as a learning tool for memorizing subjects for elementary to high school students. This product answers the problem for the difficulty of students remembering and understanding social science teaching materials. There are two approaches to the Learning Board Game teaching method, the first is visualization of social science teaching materials through interactive videos integrated with images according to subjects and screens and the second is gamification through the elements of challenge and fantasy by answering questions to get rewards cards or marking as a marker gets points. This product was developed with the New Product Development (NPD) Process and uses the Stage-Gate Model. In this model, product design goes through various stages starting from discovery / idea generation to launch with each stage that functions as a quality-gate of product design.

1. Introduction^a

Student's low-interest in the social science subjects of the archipelago is due to the absence of synergy between educational institutions with methods that support interactive and fun. In addition, until now there are still many instructors who deliver social science material with classical or textual methods [1], whereas instructors only deliver subject matter with the lecture method. Issues regarding social science subjects, especially history have been carried out in Dyah's (2014) research which explains that most social science subjects for students who study these subjects need good memorization lessons.

In the activities discussion, the process of teaching and learning about lessons in the classroom is important to the process of communication between teachers and students, especially in the process of delivering teaching material. However, the communication process may not be effective, not monotonous and not delivered so that the message delivered by the teacher to students can be well received. In this regard, to support the teaching and learning process in the classroom which is more innovative in subjects, which can reduce boredom, a more interactive learning media is needed to facilitate communication between teachers and their students [2].

This research tries to provide solutions for creating products that contain teaching for social science subjects by using New Product Development (NPD). In this study, NPD made a tool to produce attractive teaching aids that did not spend for teachers and students. These teaching aids can be used as



interactive learning media to make students happy learning social science.

The stages of implementation generally consist of 7 stages, discussed, namely new product strategies (linking NPD processes with institutional concepts), idea making (looking for product ideas), screening, business analysis, development (developing ideas into tangible forms), testing and commercialization (marketing product) [3]. The final result of the NPD stage is an existence that is able to answer the needs of consumers [4,5]. New product development and new solutions to consumer problems will be called new product development, new product modification, new product development through the company's internal research and development processes (Armstrong and Kotler, 2005). Through this NPD stage, it is expected that the teaching aids on social science lessons that are produced can solve problems for the learning and teaching process in the environment of junior and senior high schools. In addition to NPD, the morphological matrix is used to determine alternative product solutions that we will design and brainstorm using AHP to select products that we will develop.

2. Methodology

2.1 Discovery Stage

In this research, we use the idea generation method to find the right product ideas to solve problems from customers and are feasible to be produced [6].

2.1.1 Idea Generation

2.1.1.1 Fault tree analysis. Our group's fault tree analysis creativity technique is used to determine the factors that make a problem possible. We see that it is difficult for students to understand social science lessons because two different things are boring learning material content, the teacher as the facilitator conveys the material not optimal, and the media delivery of monotonous material. The boring content factors of social science material are due to two factors including:

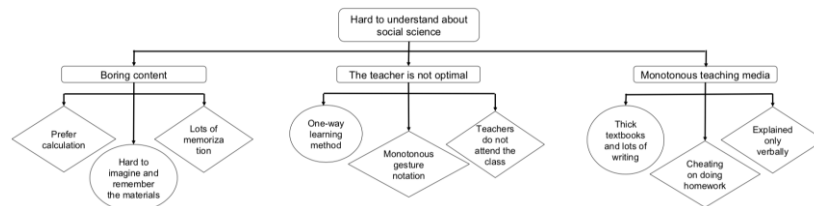
- 1) The large amount of material students must memorize makes it difficult for them to understand and be interested in learning social science.
- 2) Some students have a tendency to prefer physical rather than social subjects such as social science.

Teachers who do not deliver material optimally can be caused by several factors including:

- 1) One-way teaching methods do not attract students' attention to understand the content of the material delivered by the teacher.
- 2) The teacher's intonation, gestures, and teaching style are monotonous so students get bored listening to the material for several hours.
- 3) The teacher leaves class several times and is only given a substitute assignment so that face-to-face meetings between teacher and students are rare.

Factors and media delivery of monotonous material in our opinion is caused by several factors including:

- 1) Textbooks as the main medium of learning do not attract students' attention to learn in a thick form and contain long unraveled writing so that it does not make it easy for students to read and understand the material to be conveyed [7].
- 2) Social science teacher only conveys social science teaching material verbally or is illustrated with a presentation without any physical appearance that can attract students' attention
- 3) Homework assignments or tasks as a way for the teachers to ensure students repeat the material that has been learned in class has not run optimally because the student's absorption of material delivered to the class is not optimal so students cheat on assignments from other friends.

**Figure 1.** Fault Tree Analysis

2.1.1.2 Morphological matrix. As shown in Figure 1, we have determined that the product that will be designed will work to solve the boring one-way learning media factors so students find it difficult to understand the lesson. To get an idea for a product that will be designed, we use a morphological matrix that can produce several different ideas from the combinations of choices available in Table 1.

Table 1. Morphological Matrix

Activity	Playing	Watching	Discussion	Reading
Inclusive	Color difference	Object surface contour	Sign language	Braille letter
Advantages	Portable	Advanced technology	Unique form	Easy to use

2.1.1.3 Brainstorming. During the brainstorming process, we gathered and each group member gives innovative ideas based on the combination obtained in the previous morphological matrix so we can select the innovative ideas that we get. We select ideas by using rating and weighted tables. Some innovative ideas generated from brainstorming include the following:

- Product 1: Three-dimensional book
- Product 2: Interactive cartoon Indonesian social science
- Product 3: Hologram with characters from an area
- Product 4: Board Game in the form of a map of Indonesia

Our group conducted a product selection process using the AHP method by first rating each of the specified criteria and then calculating according to the product scores available to determine which product was better. The scale used is 1 (very bad) to 5 (very good). The criteria we use in this assessment are:

- a. Creativity Aspect: Product uniqueness, whether the innovations made can improve the product image and there is novelty in teaching aids.
- b. Technology: Applying appropriate technology to the products that we will design
- c. Solve problems: the product solves the root causes of students' difficulties in learning social science appropriately effectively

The following table weights from each criterion:

After weighting each criteria subjectively as shown in Table 2, followed by checking the consistency ratio that is owned, then do a rating calculation for each product. The following table weighs the results of each product evaluation after using the AHP method.

Rating of each product

Table 2. Criteria Weight

Criteria	Weight
Creativity	0,21467689
Technology	0,18729463
Problem Solving	0,69802848

Table 3. Weighted Score Product

Aspect	Creativity	Technology	Problem Solving	TOTAL
Weight	0,21	0,19	0,6	
Three dimension book	0,09	0,16	0,16	0,145499
Interactive cartoon	0,16	0,09	0,09	0,108599
Hologram	0,28	0,47	0,28	0,313429
Map board game	0,47	0,28	0,47	0,432473

As shown in Table 3, the Board Game product in the form of an Indonesian map gets the highest score with a total value of 0.432473.

2.2 FMEA

We use FMEA to identify the risks of developing this board game product as shown in the table below:

Table 4. FMEA

No	Potential failure mode	Potential causes for failure	Potential effects of failure	Current control	Severity	Likelihood	Detection	RPN	Recommendation	Severity	Likelihood	Detection	RPN
1	Product does not sell	The price is too expensive	The product fails because it is not profitable	Doing a market research and market testing	5	3	4	60	Innovating the shape and type of board games	3	4	3	36
		Do not attract customer											
		Disrupted with media											
2	The game is not carried out according to instructions	Teacher does not understand how to play the game	Students do not understand the material optimally	The game's rules are easy to obey and manual book	4	4	3	48	A simpler improvement tool and fewer supporting components	3	3	2	18
		Inadequate supporting facilities											
		Students are not serious when playing the game											
		Participants answer the questions fraudulently											
3	Students got bored playing the board game	Monotonous video	The product's life cycle is very short	Make a game series	3	4	3	36	Add application features to the game board	2	3	2	12
		Question does not change											

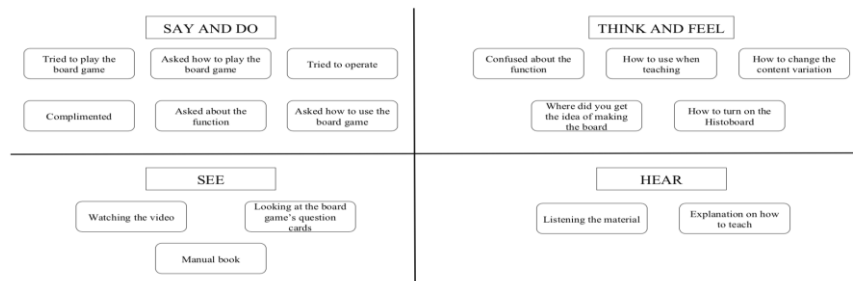
As can be seen in Table 4, the biggest risk is the product does not sell in the market because of several factors such as the price is too expensive, not according to needs, and is disrupted with other teaching media so that market research and market testing is important before producing this product [8] and continuous innovation must be done so that the teaching media is not monotonous.

2.3 Idea Decision

Our group determined that the selected social science teaching aids product, namely board games in the form of Indonesian maps. Based on the rating and weighted score assessment, it was concluded that this board game product has a higher value than the other three toy products.

2.4 Use of Empathy Mapping

Empathy mapping is a tool used to determine what is said and done by users is quite easy and determine what users think and feel by observing and observing the behavior and responses of activities and conversations with users. Empathy mapping is divided into four quadrants. After conducting research and surveys, we were able to make an empathy mapping of the use of this Histoboard teaching aids to one of the Social Sciences teachers at SMPN 131 Jakarta. This Empathy mapping is divided into four quadrants, as shown in Figure 2.

**Figure 2.** Empathy Mapping

3. Feasibility Study Analysis

3.1 Customer's Needs

Histoboard is a technology-based product in the form of a map of Indonesia which has two modes namely learning mode that can be used by teachers to explain subject matter through instructional education video media, and the second mode is a game mode that can help students in understanding subjects such as social science which has a lot of material to memorize [9,10]. The target customers of this Histoboard product are students with Education levels ranging from Elementary Schools (SD) to High Schools (SMA), which are the generation with a tendency as technology adopters. To find out the conditions, interests and difficulties experienced by students in learning social science, we distributed questionnaires to students from elementary to high school level. The results of the questionnaire can be seen as follows.

**Figure 3.** Questionnaires Results

As shown in Figure 3, it resulted that 46% of students who filled out the questionnaire needed media or teaching aids that could help and facilitate them in understanding social science lessons. Next, we provide additional questions to find out what features are needed in a media or teaching aids making it easier for students to understand social science lessons. We provide several choices of methods that can help students in understanding social science lessons, which are educational videos related to the subject matter, questions and practice questions, interactive games, explanations of material in the form of text, explanation of material in the form of images, and at an affordable price as can be seen in Figure 4.

**Figure 4.** Questionnaires Result

3.1.1 Hierarchy of Consumer's Needs. We formed a hierarchy or levels that will facilitate the design process of technology-based teaching aid products for social studies lessons going forward. The attributes in the questionnaire are presented in the "Level 1" column, while the "Level 2" column is a more specific development of the attributes in the "Level 1" column as can be seen in Table 5.

3.1.2 Level of Importance Based on Consumer's Needs. Because not all the needs and desires of consumers can be translated into a product, it is necessary to prioritize these attributes that are expected by consumers for a teaching aid product for history lessons. Based on the results of the questionnaire, the following level of importance of attributes in accordance with consumer expectations as can be seen in Table 6. The final product is shown in Figure 5.

Table 5. Consumer's Needs Hierarchy

Level 1	Level 2
Features to play educational videos related to learning material	Video series related to teacher's learning syllabus Videos will be shown after the teacher's explanation in order to help the students understand better Video content that is interesting, creative, interactive, and with short duration
Features with pop quizzes	Pop quizzes related to teacher's learning syllabus Answers and quizzes explanations Learning materials in interactive games mode
Features with interactive games	Games in groups to improve teamwork and also communication skills between students There are some challenges filled with questions related to the learning materials in games
Features with material explanation in texts	Learning materials that will be delivered with PowerPoint presentation Material summary that will help the students better Learning materials that will be delivered with animation
Features with material explanation in pictures	Using PowerPoint with a visually interesting contents Material explanation with pictures about social science Teaching aid with easily understandable design
Teaching aid design that is comfortable to use	Unique interface design that could not make students easily bored Ergonomics interface design
Light teaching aid	Light teaching aid
Affordable price	Teaching aid with the right packaging Price range Rp. 500.000-Rp. 600.000

**Table 6.** Level of Importance Based on Consumer's Needs

Consumer's Needs	Level of Importance
Educational videos based on the learning material	5
Pop quizzes	4
Interactive games	3
Material explanation in texts	3
Material explanation in pictures	5
Teaching aid that is comfortable to use	5
Portable teaching aid	4
Affordable price	4

Figure 5. Histoboard

4. Conclusion

From our research, clearly the need to increase student's interest in learning social science is evident and indisputable. The learning method used when teaching social science is known to be very monotonous and the subject itself is hard for the students to understand.

In this paper we get that social science has a boring content, which the students prefer calculation more than memorization, the social science teacher is not yet optimal when teaching because they still use the one-way learning method and do monotonous gesture notation and sometimes they do not attend classes, and social science still uses monotonous teaching media, which has thick textbooks and lots of writing, and usually explained only verbally.

To provide solutions for creating products that contain a new teaching method for social science subjects is by using New Product Development (NPD). Through this NPD stage, the teaching aids on social science lessons that are produced was able to solve the problems for the learning and teaching process in the environment of junior and senior high schools. After conducting idea generation using a number of methods, including Fault Tree Analysis, Morphological Matrix, as well as brainstorming for ideas of early product of learning aids to be made, our group determined that the selected social science teaching aids product, namely board games in the form of Indonesian maps. Based on the rating and weighted score assessment, it was concluded that this board game product has a higher value than the other three toy products.

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