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

To cite this article: A Suzianti et al 2019 IOP Conf. Ser.: Mater. Sci. Eng. 692 012046

View the article online for updates and enhancements.
Inclusive Design of Teaching Aids for Social Science Learning Process for Elementary and Middle School Students based on Creative Mini PC Raspberry Technology

A Suzianti\textsuperscript{a}, A Mubarak\textsuperscript{b}, F Edrisy\textsuperscript{c}, A R Sausan\textsuperscript{d}, C N Lalita\textsuperscript{e} and X Usman\textsuperscript{f}

Industrial Engineering Department, Faculty of Engineering Universitas Indonesia, Depok, Indonesia 16424

\textsuperscript{a}suzianti@eng.ui.ac.id; \textsuperscript{b}mubarak.andri@gmail.com; \textsuperscript{c}faizedrisy.21@gmail.com; \textsuperscript{d}adhwaranaa@gmail.com; \textsuperscript{e}cindylalita@gmail.com; \textsuperscript{f}xavusman@gmail.com

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
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 will be designed

c. Solve problems: the product solves the root causes of students’ difficulties in learning social science appropriately effectively

The following table weighs from each criterion 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.

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             | 0.432473|
| 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|
| Board game           | 0.47       | 0.38       | 0.47            | 0.324736|

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 cause for failure | Potential effects of failure | Current status | Severity | Likelihood | Detection | DPN | Recommendation | Severity | Likelihood | Detection | DPN |
|----|------------------------|----------------------------|-----------------------------|---------------|----------|-------------|-----------|-----|----------------|----------|-------------|-----------|-----|
| 1  | Product does not sell   | The price is too expensive | The product fails because it is not profitable | Being studied research and market testing | 5        | 3             | 4          | 60  | Innovating the shape and type of board games | 3        | 4             | 3          | 36  |
| 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 | The game’s rules are easy to obey and internalized | 4        | 4             | 3          | 40  | A simple improvement tool and fewer supporting components | 3        | 3             | 2          | 18  |
| 3  | Students prefer playing board game | Monotonous video | The product’s life cycle is very short | Make a game series | 3        | 4             | 3          | 20  | Add application features to the board game | 2        | 3             | 2          | 12  |

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.

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.
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.

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.
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.

References
[1] Apriliana, Diah (2014). Pengembangan Pembelajaran Sejarah dengan Scientific Approach Melalui Outdoor Study di Kelas XI IIS 4 SMA Negeri Ajibarang. Semarang. Indonesian Journal of History Education. Volume 3, pp 27-30
[2] Liu, E. Z. F., & Chen, P. K. (2013). The effect of game-based learning on students’ learning performance in science learning—A case of “Conveyance Go”. Procedia-Social and Behavioral Sciences, 103, 1044-1051
[3] Booz, Allen, & Hamilton. (1982). New Product Development for the 1980’s. New York: Booz, Allen & Hamilton, Inc.
[4] Cooper, RG & Kleinschmidt, EJ (1988). Resource Allocation and the New Product Process. Journal of Industrial Marketing Management, 17, pp 249-262.
[5] Thomas, RJ (1993). New Product Development – Managing and Forecasting for Strategic Success. John Wiley & Sons.
[6] Twigg, D (1998) Managing Product Development within a design chain. International journal of operations & production management, 18, 5.
[7] Odenweller, C. M., Hsu, C. T., & DiCarlo, S. E. (1998). Educational card games for understanding gastrointestinal physiology. Advances in Physiology Education, 275(6), S78
[8] Armstrong Gray & Kotler, Philip (2005). Marketing An Introduction (7th Edition). United States Of America, Pearson Education, Inc
[9] Allery, L. (2014). Make use of educational games. Education for Primary Care, 25(1), 65-66.
[10] Cavalho, J. C. Q. D., Beltramini, L. M., & Bossolan, N. R. S. (2018). Using a board game to teach protein synthesis to high school students. Journal of Biological Education, 52, 1-12.