Development of interactive media based on mathematics with HOMTS and learning by doing orientation

F Fadilah*, R Priyanda, and R Amalia
Department of Mathematics Education, Universitas Samudra, Kota Langsa, Indonesia
*fadilah@unsam.ac.id

Abstract. Mathematics learning needs to act as a bridge between students' everyday culture and mathematics in school. The digital age requires teachers to develop innovative interactive media that contains hands-on activities and can improve higher-order thinking skills. This research is a Research and Development (R&D) of interactive media, namely lectora inspire based on ethnomathematics with HOMTS orientation and learning by doing. The steps in this research are (1) potential problems; (2) data collection; (3) product design; (4) design validation; (5) design revisions; (6) product trials; and (7) product revisions. The results showed that lectora inspire based on ethnomathematics with HOMTS orientation and learning by doing is appropriate to be used as interactive media in learning linear equation systems for senior high school students.

1. Introduction
Education has an important role in preserving Indonesian culture which is currently starting to fade along with the times. Education cannot be separated from cultural values. Both are very closely related because they complement and support each other. The aim of education is to preserve and always improve the culture itself, it is through education that we can transfer that culture from generation to generation.

Mathematics is one of the subjects given at school. Ethnomathematics is the science of studying community culture, historical relics related to mathematics and mathematics learning [1]. Ethnomathematics uses the culture surrounding students in mathematics teaching [2]. Ethnomathematics uses broad mathematical concepts related to various mathematical activities, including grouping, counting, measuring, designing buildings or tools, playing, determining locations, and so on. Thus, as a result of the history of mathematical culture can have different forms and develop according to the development of the user community.

Through learning mathematics, students are encouraged to develop their thinking skills. Based on Bloom's taxonomy, those categorized as high order thinking skills (HOTS) are the activities of analyzing, evaluating, and creating. There are many mathematical elements or objects that can be used as a bridge to develop students’ HOTS. Educators can utilize learning definitions, theorems/conjectures, procedures, and even work on questions to develop students' HOTS [3]. The term HOMTS is devoted to the development of HOTS in mathematics.

Learning by Doing is a reference from education expert John Dewey. It's a hands-on approach to learning, meaning students must interact with their environment in order to adapt and learn [4]. Stimulating hands-on training through several assignments was very helpful for the students [5]. Important mathematics learning is developed not only focusing on cognitive abilities, but also students' affective and psychomotor. Through learning with a hands-on approach students can better understand
the study of abstract mathematical objects. Young generations are growing up in the prosperity of computer technologies and have different cognitive and affective characteristics, compared to adult generations [6].

Various policies have been pursued to improve the world of education to maintain the nation's culture, now Indonesia is entering the digital era so that every student and teacher must be able to conduct distance learning or online. Teachers are required to be able to provide interactive and communicative learning. Teaching and learning are considered complex processes, influenced by different multiple factors, including use of media or instructional aids, which results active involvement of learners and makes teaching more interactive [7]. So that, Teacher-designed learning in each mathematics topic will have an effect on students’ mastery of mathematical concepts [8].

However, the process of learning mathematics and teaching media that are used today tend to be too theoretical, and are artificial. Besides the mathematics teaching media used in schools are too formal so that the mathematics found by children in everyday life is very different from what they find in school. Mathematics teaching material based on ethnomathematics proves effective towards solving problem skill and student mathematical critical thinking [9]. Therefore, teaching media are needed that can bridge between mathematics in the everyday world based on local culture and school mathematics. In addition, mathematics learning needs to develop higher-order thinking skills and the concept of learning by doing.

The development of instructional media which is filled with Acehnese culture or in this case is an interactive media based on ethnomathematics to be able to bridge the mathematics between the local community and the mathematics in schools is important to be implemented. The objectives of this study are: Developing interactive media based on HOMTS-oriented ethnomathematics and Learning by Doing that are valid for future use.

2. Methods
This research was conducted using the “Research and Development” approach.

![Figure 1. Stages of development research [10]](image)

The development stages used in this study are based on Figure 1, namely: The focus of this study is on the development of Lectora Inspire as an interactive media based on ethnomathematics with HOMTS orientation and learning by doing on the system of linear equations for class X semester 1 students. Information was carried out with interviews to find data on MAN 1 Aceh Tamiang which would then be used as research locations. Interviews were conducted at the Aceh Tamiang Education and Teaching Office. Next, a literature study is carried out relating to the problem to be studied, namely ethnomathematics in the local community. Field studies were also carried out at the Museum Kota Langsa and Rumoh Aceh in Hutan Lindung. At the product design stage, the initial stage of interactive media development is carried out by determining competency standards, basic competencies, achievement indicators in accordance with the material to be used in the development of interactive media and also adapted to ethnomatematics in the Aceh area and the applicable curriculum. Further validation was
carried out by an interactive media expert validator, a material expert validator, and an Aceh cultural expert validator. Validation uses a validator sheet consisting of several validation indicators made by the researcher. The indicators made must be based on the results to be achieved, the suitability of the contents with the basic competencies and indicators of achievement that are set, and the relationship with the ethno-mathematical approach. Table 1 is a percentage criterion of validity.

Table 1. Criteria for eligibility of percentage analysis [11]

| Percentage     | Information                  |
|----------------|------------------------------|
| 80.00 - 100    | Good/Valid/Eligible          |
| 60.00 - 79.99  | Good enough/Fairly Valid/Fair enough |
| 50.00 - 59.99  | Less Good/Invalid/Inadequate |
| 0 - 49.99      | Not Good (Replaced)          |

Based on the comments and suggestions of the validators, a revision of the interactive media was carried out. Furthermore, trials were conducted 6 mathematics teachers and 15 students from the designated schools. Based on the results of the trial, improvements were made to the products developed.

3. Result and Discussion

3.1 Potential and problems

The focus of the problem in this research is the development of Lectora Inspire as an interactive media on the material of the Class X linear equation system. The media was developed by optimizing the cultural potential of Aceh, High Order Mathematic Thinking Skills (HOMTS) and learning integrated by doing in the media.

3.2 Data/information collection stage

Based on interviews in related agencies, MAN 1 Aceh Tamiang obtained data on the situation of teachers and students and there has been no media development as will be carried out. In addition, based on a study in the Museum of Kota Langsa and Rumoh Aceh in Hutan Lindung obtained various media materials related to ethnomathematics.

3.3 Product design

Interactive media used are lectora inspire which consists of (1) 1 slide cover; (2) Competence and learning experience 1 slide; (3) 1 slide concept map; (4) deepening of the material 15 slides; (6) 4 slide project assignments; and (7) the final 10 slide test.

The material deepening section, project assignments and final teas contain HOMT questions and learning by doing and are also related to Aceh's customs and culture.

3.4 Design validation

The validators consisted of 2 media experts, 2 material experts and 1 Aceh cultural expert. Table 2 is the validation results of the validators.

Table 2. The validation result.

| Validator  | Didaktic | Construct | Tecnic | Total  | Average | Average Score | Category |
|------------|----------|-----------|--------|--------|---------|---------------|----------|
| Media 1    | 87,12    | 82,03     | 82,00  | 251,15 | 83,72   | 83,21         | VALID    |
| Media 2    | 82,77    | 83,31     | 82,00  | 248,08 | 82,69   | 85,51         | VALID    |
| Material 1 | 88,19    | 85,00     | 85,00  | 258,19 | 86,06   |               |          |
| Material 2 | 87,05    | 84,82     | 83,00  | 254,87 | 84,96   |               |          |
| Aceh Culture | 88,00   | 87,20     | 87,00  | 262,20 | 87,40   | 87,40         |          |
| Average    | 86,63    | 84,47     | 83,80  |        |         |               |          |
3.5 Design revision
Based on the validator's suggestions and comments on the validation sheet, there are several things that need to be revised, namely: (1) the material is not only a two-variable linear equation system, but also three variables; (2) the deepening of the material is expected not only to include HOMTS questions but also activities which are learning by doing for students; (3) puzzles added to the project task in solving problems related to the material; (4) ethnomatematics questions used should be more varied; and (5) soft color selection design that is not too bright.

3.6 Product trial
Trials were conducted on each of the 6 mathematics teachers and 15 students from the school that was determined using a questionnaire instrument with a Strong Agree, Agree, Disagree and Strongly Disagree. Table 3 shows the results of the questionnaire responses of teachers and students to the media developed 91.90% with very good criteria.

Table 3. Questionnaire responses of teachers and students

| Aspect                  | Number of statement | Total Rating | Percentage of each aspect (%) |
|-------------------------|---------------------|--------------|-------------------------------|
| Ease of understanding   | 1,2,3               | 241          | 19.13                         |
| Learning independence   | 4,5                 | 149          | 11.83                         |
| Active learning         | 6,7,8,9             | 307          | 24.37                         |
| Interest in the media   | 10,11,12            | 226          | 17.94                         |
| Media presentation      | 13,14,15            | 235          | 18.65                         |
| Total                   |                     | 1158         | 91.90                         |
| Maximum                 |                     | 1260         | 100.00                        |

3.7 Product revision
Here are the results of the revision of Lectora Inspire after product testing.

Figure 2 contains a cover with material on the system of linear equations, with competency points, concept maps, in-depth material, project assignments and final tests by Fadilah, S.P., S.Pd.; Rizki Amalia, S.Pd.; Roni Priyanda, S.Pd., M.Pd.
Figure 3 contains problems related to local culture, then the students must solve the questions and conclude the results of their discussion.

Figure 3. Deepening of Acehnese culture-based material and HOMTS and learning by doing – oriented

The deepening of the material consists of 15 slides, one of which is shown in Figure 3. The deepening of the material contains material that is not only rote but also directs students to learn by completing. The direction of the material was designed with input from Aceh’s customs and cultural traditions. Ethnomatematics is a mathematical bridge with culture. Shirley believes that currently the field of ethnomatematics, namely mathematics arising and developing in society and in accordance with local culture, is central to the learning process and teaching methods. This opens up the pedagogical potential that takes into consideration the students’ knowledge gained from learning outside the classroom [12]. Some of innovative learning are Cooperative learning, adventure learning, group project, apprenticeship, and learning by doing [13].
Figure 4 contains further questions or stabilization of material that students must do based on predetermined instructions.

(Well, now try to solve the math puzzle. There are 7 colorful squares which means the mathematician’s name is 7 letters. In each box, there is a system of two-variable linear equations that must be solved to find the coordinates. Now, these coordinate points are used to determine the letters in the table of letters which are like the Cartesian diagram. How to match the letters is like a Cartesian chart rule. This can also train students who are still confused about drawing points on the Cartesian diagram.)

**Figure 4. Project assignments**

Figure 4 shows a slide project project by giving a puzzle but the solution is related to the material that has been discussed. Math projects give students the opportunity to work cooperatively; as previously mentioned, collaborative working assists them to get better than working independently [14].

(Langsia City has city forest or protected forest which is 18 km long, while 3 times the length is 7/10 times the width, can you determine the area and circumference of the rectangular Langsia City Forest)

**Figure 5. Final test**

At the end of the section there are 10 questions with HOMTS related to the material being studied and based on Aceh’s customs and culture. The HOTS problem must be able to measure the transfer of knowledge, problem-solving and critical thinking [15].
4. Conclusion
The development of Lectora Inspire as an interactive media based on ethnomathematics with HOMTS orientation and learning by doing on linear equation system material is feasible to use with the validation results of 85.7%. The results of the test questionnaire were limited to 6 teachers and 15 students, which scored very good at 91.90%. Therefore, this interactive media can be used next.

5. References
[1] Richardo R, 2017 Literasi (Jurnal Ilmu Pendidikan) 7, 2 pp. 118-125
[2] Fitrianawati M Sintawati M Marsigit M Retnowati E, 2020 Ethnomathematics Journal 7, 1 pp. 1-12
[3] As’ari A R, 2019 Mengembangkan HOTS (High Order Thinking Skill) Melalui Matematika (Universitas Negeri Malang)
[4] Dewey J, Impact and Theory (https://study.com/academy/lesson/john-dewey-on-education-impact-theory.html)
[5] Aguado N A, 2009 Journal of Public Affairs Education 15, 2 pp. 251-260
[6] Suh H, 2011 International Journal for Educational Media and Technology 5, 1 pp. 50-61
[7] Naz A A Akbar R A, Journal of Elementary Education 18, 1-2 pp. 35-40
[8] Amalia R Saiman S Sofiyan S Mursalin M, 2018 J.Phys.:Conf. Ser. 1088 012110 p. 2
[9] Imswatama A Lukman H S, 2018 International Journal of Trends in Mathematics Education Research 1, 1 pp. 35-38
[10] Sugiyono, 2010 Metode penelitian pendidikan: pendekatan kualitatif, kuantitatif, R&D (Bandung: Alfabeta) pp. 297-298
[11] Sukmadinata N S, 2005 Metode Penelitian Pendidikan (Bandung: Remaja Rosda Karya)
[12] Shirley L, 2001 Using Ethnomathematics to find Multicultural Mathematical Connection.¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬¬‐