The Card Logic Logarithm as an Interactive Media in Teaching Logarithm: a Development Study

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Abstract. This study aimed to develop an interactive media namely card logic logarithmic (CLL) that are valid, practical, and have the potential effect of increasing student interest and learning outcomes in learning logarithm in Senior High School. The developmental research method by Van den Akker used in this study, with a formative evaluation by Martin Tesmer. The Jan Van Den Akker's method consists of three stages, namely preliminary research, prototyping stage, and formative evaluation. Based on the results, it was found that: (1) the CLL media have been produced for teaching logarithm which are valid, practical, and effective; (2) the CLL media have been assessed by validators with a validity value of 4.54 with a valid category; (3) the CLL media have been assessed by validators with a practical value of 4.28 in the very high category; and (4) the CLL media in the aspect of effectiveness based on the learning outcomes test showed 87.1% of students scored above the standard.

1. Introduction

Mathematical learning can be done in various forms and ways. As expressed by Gagne in Wena that effective learning must be carried out in various ways and using various learning media[1]. In learning activities, teachers must-have tips and art to combine learning models and the media used so that they will be able to create an effective and efficient learning process.

Heinich et al. stated that the purpose of media is to facilitate communication and learning[2]. Learning media is a tool or equipment to implement processes that enable educators and learners to carry out learning activities [3]. Widodo and Wahyudin stated that learning media is a tool that can be used to convey the message to the students for learning can be achieved[4]. Each learning medium used has unique characteristics, so it needs careful planning in using the media in learning.

Besides, the learning media is a component that is interconnected with other components in order to create expected learning situations, abstracts the abstract to reduce the occurrence of verbalism disease, increase student stimuli in learning activities, reduce misunderstandings of learners to the explanations given educators. The limited experience possessed by the learners, enabling direct interaction between learners with their environment, generating uniform observation, and motivating and stimulating children to learn [5]–[7].

Ismail stated that the use of game-based media has advantages that can provide experience, attract students' interest, train the brain with creativity in playing and learning, and can compete healthily with new problem models to be solved[8]. In practice, many concepts are easily presented in the form of games that are actually by the creativity and intelligence of students but still go through limited limitations according to the learning objectives. Chang et al. stated that the results revealed more flow experiences and higher problem-solving and problem-posing abilities in the experimental group[9].
In previous studies, obtained several studies, namely effectiveness in terms result of student study, showed a different mean of 81.41 become 85.12. Any increased result of student study showed significance value 0.001 with significance 0.005 [10]. There is a significant effect of using a domino card prop on mathematics achievement[11]. The use of picture card media with think pair share techniques provides a more pleasant learning atmosphere and triggers students to think critically to solve problems related to the images on the card [12].

Based on the preliminary observations, it was obtained that students of class X IPA of SMA Negeri 1 Jerowaru, learning that is commonly applied so far, uses expository methods, in which learning is centered on teachers, passive students, and less involved in learning. This causes students to experience boredom, which results in a lack of interest in learning. Interest in learning will grow and be maintained if teaching and learning activities are carried out varied, both through variations in models and interactive learning media. For this reason, new learning strategies are needed to empower students further[13].

In addition, based on the results of preliminary observations in class X IPA of SMA Negeri 1 Jerowaru, East Lombok, in learning logarithm material, concluded unfavorable results. It can be proven from the lack or lack of student interest in student questionnaires, the lack of media because it only uses expository methods and low student grades. The average score of assignments and examinations shows less than the minimum completeness standard with a score of 75.

Based on the above discussion, researchers develop interactive media based on card logic logarithm (CLL) games as a solution to existing problems. The media developed in this study is a three-dimensional media in the form of cards arranged by two count symbols (+), subtraction (-), multiplication (x), and division (:) at the end of the card. On the CLL Card, there is the concept of logarithms, which are divided into eight types of card groups based on eight logarithmic properties, namely logarithmic traits 0, trait 1, trait 2, trait 3, trait 4, trait 5, trait 6, trait 6 and trait 7. One group of cards has four cards, so the CLL card has 32 cards. The current research was aimed at answering the following questions is how to develop interactive media based on LL card games that are valid, practical, and have potential effects of increasing interest and residual learning outcomes in the logarithmic?

2. Method

Method development in this study using method Van Den Akker with Martin Tessmer's formative evaluation. The Van Den Akker method is a circular or twisted development research starting from analysis, design, evaluation, and there are revisions in it to the desired goals[14], [15]. Detailed media development methods are presented in Table 1:

| Stage               | Description                                                                                                                                 |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| Preliminary Research| Starting from the identification of learning problems, analyzing the main problem, and making an idea or development ideas within the framework of the concept through a literature review. Collecting data on problems encountered by the teacher in the class and looking for and relevant with the development of previous media about the problem. |
| Prototyping Stage   | The thing to do is to design a media game design guide, design a CLL media, and design an RPP, optimize the design results through the design cycle to make the next result a second prototype. |
| Formative Evaluation| At this stage, an evaluation of the effectiveness of the prototype application was carried out.  
  a. Self-Evaluation  
  Conduct student ability level analysis (low/medium/high) and analyze student learning environment. Besides that, analyzing the curriculum includes students, teachers, and logarithm material by following the curriculum used now with the |

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Table 1. Detailed Media Development Methods
development of CLL and RPP media.

b. Stage prototype
The result of the design of self-evaluation is the third prototype. Then submitted to the expert review conducted by experts review and student to one in parallel. Expert review acts as a test of validity criteria, while one to one students acts as a test of practical criteria.

c. Small-Group
Conducting tests (tests, interviews, and questionnaires) on six students consisting of 2 high, medium, and low ability students according to a predetermined schedule. After the small group trial is carried out, a review will be carried out, its function to be written on the review sheet as an effective criterion that is taken an essay test, and the results of a questionnaire/interview given to see the practicality of the media.

d. Field Test
This stage was carried out in class X IPA of SMAN 1 Jerowaru East Lombok in the form of tests, questionnaires, and interviews. Media results must meet three quality criteria, namely validity, practicality, and effectiveness [14].

1.1. Data Collection
This research was conducted at SMA Negeri 1 Jerowaru, East Lombok. Research subjects include evaluation subjects and test subjects. The evaluation subjects consisted of mathematics lecturers and instructional media lecturers, as well as mathematics teachers at SMA Negeri 1 Jerowaru as observers. The test subjects were students of class X IPA of SMA Negeri 1 Jerowaru, East Lombok.

The data obtained in this research development are quantitative and qualitative. Quantitative data were obtained from student learning achievement tests. Qualitative data obtained from the expert assessment of the media, student response data and assessment data on the implementation of logarithm learning implemented. The trial method used was the Van Den Akker trial design.

To get a valid, practical and effective CLL media, a research instrument is needed. The instruments required in this study consisted of: (1) expert validation sheets; (2) learning achievement test; (3) student response questionnaire; (4) interview guidelines for the depth of understanding of the material; and (5) Observation Sheet on the implementation of learning. Van Den Akker's method consists of validity in the expert evaluation and oba test to see the practicality and effectiveness [14].

1.2. Data Analysis
Data analysis techniques used in this study are qualitative and quantitative analysis. Qualitative data analysis is the investigation of data with questions on certain aspects. Quantitative data analysis is the investigation of data using certain numbers with statistical tools in processing data. Analysis of the data in this study consisted of: (1) validation analysis; (2) THB analysis; (3) analysis of student and teacher activities; (4) analysis of the ability of teachers to manage to learn; (5) questionnaire; and (5) interview analysis.

3. Results and Discussion

3.1 Results

Trial Data
Based on Jan Van Den Akker's method with Martin Tessmer's formative evaluation, the results of the development research are detailed as follows:

a. Analysis
In the analysis of student needs obtaining the level of mathematical understanding of students using school media stated 19.4% good, 67.7% moderate, and 12.9% less. In the teacher's analysis of problems in mathematics learning, 33.3% are in the material, and 66.7% are in the media. Besides that, analyzing preliminary research consists of five steps,
namely the beginning-end analysis, student analysis, concept analysis, task analysis, and specific learning objectives.

b. The Design

In the design of arranging learning implementation schedules, besides designing research prototypes are designing lesson plans and CLL media so that prototypes are obtained. The design phase consists of two main steps, namely the selection of the format and initial design.

c. Evaluation

In the evaluation phase, it is tested one by one, expert review, small group, and field test.

Based on the results of the trial, the CLL media prototype changed after revising several stages of the Akker method as follows:

a. One-to-one revised CLL media prototype

Weaknesses of this CLL media prototype are: (1) the questions in the media are still considered to be at a difficult level; (2) card distribution to odd-numbered groups, the number of cards leveled; (3) give students a deadline to answer questions, about how many minutes, so that the time is efficient and the game will continue according to the lesson plan; and (4) set the time in RPP for CLL media maximum in the core activities should not exceed 40 minutes.

b. Expert Review Revised CLL Media Prototype

The results of the expert review are presented as follows:

![Figure 1. Expert Review Revised CLL Media Prototype](image1)

Weaknesses of this CLL media prototype are: (1) the print quality has a significant influence on the media because the logarithmic properties in the media are adjusted to the color, so print well so that the distinction of pink from red can be distinguished; and (2) how the media is cut also affects the neatness and feasibility of the media when used.

c. Small Group Revised CLL Media Prototype

The results of the small group review are presented as follows:

![Figure 2. Small Group Revised CLL Media Prototype](image2)

The prototype at this stage has been said to be valid, practical, and has the potential effect of being tested on the next step, the field test stage.

Rules for the use of CLL media in groups as follow:

1) Players consist of 2, 4, and 8 players.
2) Thirty-two cards are shuffled and dealt face down to each player.
3) The first player to start the game is the player who has a logarithmic card with 0 properties with the symbol color 0 is red. If one player has the card, then he must issue the card at the beginning of the game.

4) The next player is the player sitting to the right of the first (previous) player.

5) Paste the end of the card counting symbol (left/right) that already exists with the tip of the card counting symbol that we have. Can stick the left or the right; there are no rules.

6) Players count and give answers on a sheet of paper. If the answer is correct according to the teacher, then the player can continue the game. If not, then the player must draw the throwing card and save it again, and continued by the next right player.

7) In this game, the measurement of student ability and the level of understanding of logarithms can be seen in the speed of thinking, wrong or correct answers, and reduced cards on each player.

Individual media game rules as follow:
1) Players do all the cards themselves to train or find out the level of understanding ability in the player.
2) Performed by the player under the supervision of an assessor/teacher, with the same goal that is to train or find out the level of ability and understanding of the players themselves, but the different cards that are distributed to players are cards that have been selected or selected by teacher according to the level of ability of the student. This is done so that the results of the assessment of the answers can be analyzed again validly, and there are no ambiguous answers in the assessment.

d. Validation Results
The results of the analysis of media validation obtained an average rating of 4.54 validators with a very high category. The results of the analysis of the practicality of the media obtained an average of judgments on the validator of 4.28 with a very high category. Instruction plan analysis results obtained on average from the evaluators of 4.42 with a very high category.

e. Learning Outcomes Test
From the results of determining the validity of learning outcomes test with an average r-count of 0.454 which is greater than r-table of 0.355 reliability of 0.754 with a very high-reliability category, the degree of difficulty of the questions averaging 75.28% with an easy category according to the conditions of students' abilities in school. The test of learning outcomes of this study is said to be valid. From the test of student learning outcomes after being analyzed showed 87.1% more than standard, so learning with Card Logic Logarithmic media said to be effective against student learning outcomes.

f. Student and Teacher Activities
The results of the analysis of observers' observations when learning took place during five meetings obtained percentage criteria within the ideal time limit so that learning logarithmic chapters using LL media is said to be effective against student activities and teacher activities.

g. Teacher's Ability to Manage Learning
The results of observational analysis when learning took place during five meetings obtained an average value of a total score of 4.15 with a good category so that the ability of teachers to manage to learn using CLL media is said to be effective.

h. Questionnaire
The results of observers observation analysis when learning took place during 5 meetings obtained questionnaire student responses responded positively by 95.3% with a very good category, so CLL media said effective because of positive student responses.

i. Interviews
The results of the student interview analysis stated that understanding using CLL media and learning tools was 98.4% with a very good category, so CLL media was said to be effective because students could understand CLL media very well.
3.2 Discussion
Based on the research results that have been described, it is obtained: (1) the CLL media has been produced in the logarithmic chapter which is valid, practical, and effective; (2) the CLL media have been rated valid by validators with a validity value of 4.54, so that the CLL media is declared; (3) the CLL media was assessed on the practical aspect by the validators with a practical value of 4.28 with a very high category so that CLL media is declared practical as a learning media; and (4) the CLL media is assessed in the aspect of effectiveness, based on the results of student learning outcomes tests showing 87.1% obtained results above the standard so that CLL media is declared effective as a learning media. The results of this study are supported by the findings; effectiveness in terms result of student study showed different mean 81.41 become 85.12. Any increased result of student study showed a significance value 0.001 with significance 0.005 [10]. There is significant effect of using a domino card prop on mathematics achievement [11]. The use of picture card media with think pair share techniques provides a more pleasant learning atmosphere and triggers students to think critically to solve problems related to the images on the card [12]. In addition, the method used in this research is a circular or twisted development research starting from analysis, design, evaluation, and there are revisions in it to the desired goals [14].

4. Conclusion
Based on the result of this research and discussion that has been described above: (1) through the Van Den Akker model, the LLC media have been produced in the logarithmic, which valid, practical, and effective.

References
[1] M. Wena, “Strategi pembelajaran inovatif kontemporer suatu tinjauan konseptual operasional,” Jakarta bumi aksara, 2009.
[2] R. Heinich, M. Molenda, J. D. Russell, and S. E. Smaldino, “Instructional technology and media for learning,” New Jersey, Columbus. MULTI MEDIA PEMBELAJARAN, vol. 141, 2005.
[3] J. Gillen, J. K. Staarman, K. Littleton, N. Mercer, and A. Twiner 2, “A ‘learning revolution’? Investigating pedagogic practice around interactive whiteboards in British primary classrooms,” Learn. Media Technol., vol. 32, no. 3, pp. 243–256, 2007.
[4] S. A. Widodo, “Selection of Learning Media Mathematics for Junior School Students.,” Turkish Online J. Educ. Technol., vol. 17, no. 1, pp. 154–160, 2018.
[5] T. Nurseto, “Membut media pembelajaran yang menarik,” J. Ekon. dan Pendidik., vol. 8, no. 1, 2011.
[6] M. Ali, “Pengembangan Media Pembelajaran Interaktif Mata Kuliah Medan Elektromagnetik,” J. Edukasi@Elektro, vol. 5, no. 1, pp. 11–18, 2009.
[7] A. Sudrajat, “Media pembelajaran,” Line http://akhmadsudrajat.wordpress.com [diunduh tanggal 9 April 2010], 2008.
[8] A. Ismail, “Education games,” Yogyakarta: pilar media, 2006.
[9] K.-E. Chang, L.-J. Wu, S.-E. Weng, and Y.-T. Sung, “Embedding game-based problem-solving phase into problem-posing system for mathematics learning,” Comput. Educ., vol. 58, no. 2, pp. 775–786, 2012.
[10] A. Mardati and M. N. Wangid, “Pengembangan media permainan kartu gambar dengan teknik make a match untuk kelas I SD,” J. Prima Edukasia, vol. 3, no. 2, pp. 120–132, 2015.
[11] M. Nurfitriyanti and W. Lestari, “Penggunaan Alat Peraga Kartu Domino terhadap Hasil Belajar Matematika,” JKPMM (Jurnal Kaji. Pendidik. Mat.), vol. 1, no. 2, pp. 247–256, 2016.
[12] Y. F. Sukri and F. Indriani, “MEDIA PERMAINAN KARTU GAMBAR DENGAN TEKNIK THINK PAIR SHARE,” Prosiding, vol. 3, no. 1, 2018.
[13] M. Scardamalia and C. Bereiter, “Higher levels of agency for children in knowledge building: A challenge for the design of new knowledge media,” J. Learn. Sci., vol. 1, no. 1, pp. 37–68.
[14] J. Van den Akker, K. Gravemeijer, and S. McKenney, “Introducing educational design research,” in Educational design research, Routledge, 2006, pp. 15–19.

[15] M. Tessmer, “Formative evaluation alternatives,” Perform. Improv. Q., vol. 7, no. 1, pp. 3–18, 1994.