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Developing Ardgotic Game to Improve Logarithm Learning Outcomes

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Abstract

This research aims to produce ardgotic learning media that can improve student learning outcomes on logarithm. This research consists of 5 development steps, namely analysis, design, development, implementation and evaluation. Ardgotic is a game developed from an othello type board game that requires players to win the games where logarithm is the topic. The results of this media validation reached 94.54%. Trials on 32 students of class X SMK showed a practically rate of 85.71%, both of which were in the very good category. The use of ardgotic media can improve learning outcomes logarithm by 0.697 or a moderate increase. Students find the appearance of the media attractives and the media can motivate them to learn logarithms. These results indicate that ardgotic media can be used to learn mathematics in different ways.

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INTRODUCTION

Logarithms are found in dalif life. Sinaga et al (2017) writes the use of logarithms in the fields of electronics, telecommunications, and acoustics. Logarithms are used in these fields as the human ear expresses sounds heard logarithmically. In astronomy, a logarithmic scale magnitude is used to measure the brightness of stars as the human eye expresses brightness logarithmically. The logarithm which is the inverse function to exponentiation has the characteristics derived from the properties of the exponent. The abstract nature of the logarithm learning materials reguires the student's imagination and readiness of conceptual thinking

In mathematics, the logarithm is introduced as the inversion to exponentiation. This suggests that the material is taught after the students have mastered the exponential functions, as stated in the math basic competency (Permendikbud No.37 tahun 2018) related to exponentiation and logarithms. The competency states that students can select and apply the rules of exponentiation and logarithm according to the characteristics of the problems, verify the steps, present realworld problems using algebraic operations (i.e., exponential and logarithmic functions) and solve the problems using the verified properties and rules. By solving logarithmic problems, students learn to select and apply the correct logarithmic functions.

However, some students are unable to use logarithm rules according the problems given. Hananta (2019) found that students made errors in using logarithm rules or properties. Yasin (2017) found that students never rechecked logarithm rules or properties they used in solving logarithm problems. All of these cause the students' low achievement of logarithm.

This low achievement was also evident in the result of the high school national exam, including that by the vocational students of *Akutansi dan Penjualan (AKP)* [Accounting and Marketing] major in 2018/2019. Tabel 1 below presents the percentage of the students' mastery of logarithm.

Table 1 suggests that in the national context, the students' mastery of logarithm is low. The mastery of the students in Central Java is better than that of the national context. The mastery of the students in Salatiga, Salatiga, Boyolali dan Magelang (regency) obtains 60 while that in Klaten, kab. Semarang dan Surakarta does not yet achieve 60. This result indicates that the accounting and marketing major students' mastery on logarithm is below expectation. Therefore, there is a need to find a way to improve the learning of logarithm in the level of vocational schools.

Table 1. The mastery of logarithm based on the national exam result of the vocational students of *Akutansi dan Penjualan (AKP)* [Accounting and Marketing] major in 2018/2019

City/Regency	Mastery (%)
Klaten	55,17
Kabupaten Semarang	54,13
Surakarta	54,68
Salatiga	62,44
Boyolali	60,75
Kabuten Magelang	70,11
Jawa Tengah (Central Java)	57,39
Nasional (national)	49,88

One way to improve the students' learning of logarithm is by designing learning media which suit the students' characteristics. Learning media is used to encourage and motivate students in learning. Latuheru (1998) stated that learning media were tools which had ways to deliver messages in a learning teaching activity. The use of media can increase the students' motivation to learn (Hamalik, 1986). Learning media can help explain the learning units clearly, which helps achieve the learning objectives. In addition, using learning media in class, learning methods become varied, which makes students interested in the teaching learning activity (Sudjana, 2002). One of the learning media going to be designed can take the form of a board game or a physical learning medium.

Board games can help students and teachers in teaching learning activities. Some studies suggest that board games are efficient in terms of their learning usage. Romanica (2018) developed board games themed *Pasar Tradisional* [traditional markets] to introduce the art of bargaining in the traditional market context. Yunita and Wirawan (2017) used board games to enhance the interest of the social studies major high school students in the basics of accounting. The results showed that board games could be developed so as to enhance the students' learning achievement in an interactive wat.

One board game which can be used for a learning medium is Othello. Othello is a famous Japanese board game. Othello, which is also called "reversi", begins with placing a pair of white discs and a pair of black ones at the center of the board. This two-player game requires a great strategy. Thus, students are demanded to develop a great strategy to win the game. In addition, playing this game fosters a sense of competition in students.

Othello is the ingredient of logarithm leaning media. The learning media developed from Othello is named ARDGOTIC. ARDGOTIC is expected to be

able to enhance the students' interest and achievement of logarithms. The research objective is to produce a valid, practical and effective ARDGOTIC as a learning medium for improving the achievement of logarithms.

METHOD

This research employed *Analysis, Design, Development, Implementation, Evaluation* (ADDIE) model. According to Dick and Carey (1996), ADDIE model could be designed for in class learning system. ADDIE consists of the analysis stage which analyzes the learning problems and the students' needs, the design stage which designs the learning media based on the analysis of the learning problems and the students' needs identified in the previous stage, the development stage which develops the design to attract the students' interest and improve their achievement of logarithm, the implementation which share the media with the students, and, finally, the evaluation stage whih reviews and follows up the analysis of the media's benefits and drawbacks. After having gone through the five stages, we produced a valid, practical, and effective learning medium to use in the learning.

The development of ARDGOTIC requires a valid, practical, and effective measurement. Therefore, an instrument of data collection was designed. This instrument consists of a validation sheet, pre-test, post-test, and learners' evaluation sheet. The validation of ARDGOTIC was conducted by an expert in math education and learning media. The medium's practicality and the students' interest in ARDGOTIC were based on the teachers' and students' assessment. The effectiveness of the medium was based on the results of pre-test and post-test, which was calculated using the following formula:

$$N - Gain = \frac{posttest\ score - pretest\ score}{maximum\ score - pretest\ score}$$

The calculation result was then verified against the assessment category displayed in Table 2.

Table 2. Classification of N-Gain Category

N-Gain score	Category
$G \geq 0{,}70$	High increase
$0{,}30 \leq G < 0{,}70$	Medium increase
$G < 0{,}30$	Low increase

Source: Winarto, 2018

The class and practicality indexes were calculated by using the following formula:

$$P(s) = \frac{S}{N} \times 100\%$$

where $P(s)$ is the sub variable percentage, S is the total score of each sub variable, and N is the maximum score.

The result was then classified based on Table 3.

Quantitative score range (x)	Qualitative category (x)
$81\% \leq skor \leq 100\%$	Very good
$61\% \leq skor < 81\%$	Good
$41\% \leq skor < 61\%$	Fair
$21\% \leq skor < 41\%$	Poor

Source: Winarto, 2018

RESULTS AND DISCUSSIONS

ARDGOTIC is an Othello-based board game which was developed to help students achieve the expected competency in logarithms. The development lasted for seven months starting from June until December 2020, involving 32 students of *Akutansi dan Penjualan (AKP)* [Accounting and Marketing] major of SMK Negeri 2 Salatiga. Although the research was conducted during the Covid-19 pandemic, the research procedure obeyed the government health protocols. The development of ARDGOTIC is explained as follows.

Analysis

The initial stage of ARDGOTIC development is to obtain information related to the nature of the learning materials, the characteristics of the students, and the condition of the learning. Logarithms are compulsory materials in semester 1 of for tenth graders of vocational schools. The 2013 curriculum, 2017 revision and *Permendikbud No.37 tahun 2018*, states that the basic competency in logarithms is the students' ability to select and apply logarithm rules and solve real problems related to logarithms using the properties of logarithms. The vocational students' characteristics were obtained through direct observations and interviews with the teachers and students. The information obtained suggests that vocational students are less interested in maths. Mathematics is considered difficult, rigid, and abstract. Logarithms are considered not directly connected to the world of work. Vocational students tend to emphasize practical things.

The learning medium developed must be able to draw the students' interest, improve the students' learning interaction, make enjoyable

learning atmosphere, challenge the students to learn more, as well as motivate them to make a good practical strategy to solve problems.

Design

An Othello-like board game was selected based on the result of the analysis stage. This type of game was selected as it foster students' interaction through the game. The procedure of logarithm learning and the selection of software to design the images, characters, and fonts were then completed. ARDGOTIC is a board game consisting a board, discs, question cards, and the game guidebook which also serves as the answer key or solution manual. The graphic design software used was *CorelDraw 2019*. This software works with Windows XP, Windows 7, and Windows 8. Figure 1 shows the ARDGOTIC logarithm.

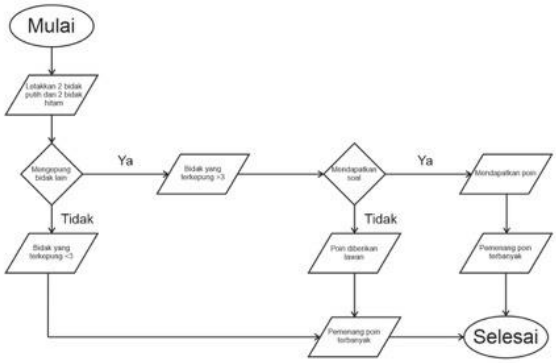


Figure 1. Steps in ARDGOTIC

The basic board design is green and white. The board is equipped with a score box. The question cards are in orange. The logo and one question and its answer or solution is printed on each card. The guidebook and answer key are in green. The color selection was based on the eye health and aesthetic aspect.

Development

A detailed design process was conducted by using *CorelDraw 2019*. The design paid attention to the aesthetic aspect as well as showed friendliness. The games rules were developed as to be played easily, to highlight interactions, and to help students master logarithms. *CorelDraw 2019* was used to deign the board, discs, and quetions cards. The game rules were designed by using Microsoft Word from Microsoft Office for Windows.

ARDGOTIC requires player teams to obtain the highest score by answering questions printed on the question cards, related to the logarithm properties. Figure 2 displays the board. The score boxes are placed on the upper part of the board to ease the competing teams to see their scores. The questions cards are cards containing questions on the logarithm properties. Each card is made of a 10x15 cm paper. Figure 3 displays a sample of a card design. This game comes with a guidebook for teachers to teach their students how to play ARDGOTIC. Figure 4 diplays the front page of the guidebook.

(a) (b)

Figure 2. The board and the variation of the discs' position: (a) scattered, (b) centered

(a) (b)

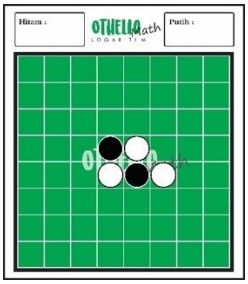
Figure 3. Question card: (a) front, (b) back

Figure 4. The front page of ARDGOTIC guidebook

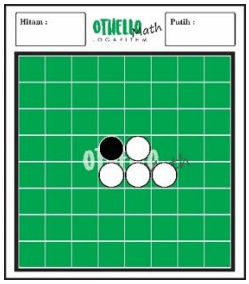
Learning logarithms begins with forming two competing teams of players. At first step, the teacher places two pairs of discs in the middle of the game; one pair of black discs and one pair of white discs. The discs care diagonally placed are shown by Figure 1.(b).

Next, the players decide who play first. The job of the players is to surround opponents' discs. For example, the white discs must surround black discs as shown by Figure 5.(a). The surrounded or outflanked discs are then flipped over to the opposite color. For example, the surrounded black discs as show in Figure 5(a) are flipped to white as shown by Figure 5.(b).

If a player can surround at least three opponent's discs, he or she gets a question card. If the player can correctly answer the question, he or she gets points as many discs as he or she flanks or frames. However, if the player is unable to answer the question, the points are rewarded to the opponent. The game is over when the board is full of discs or the players can no longer surround their opponents' discs. The players with the highest points win the game.



(a)



(b)

Figure 5. Discs' position on the board: (a) White discs surround or outflank black discs and (b) the surrounded black discs turn to white

Implementation

A validated "ARDGOTIC" game was played by teams of 32 students of SMK Negeri 2 Salatiga. Before the game began, all students were expected to recall logarithm requirements in order to know how to learn through ARDGOTIC. Before the teams were complete, the teacher simulated the game to emphasize the rules of the game. Then, the students learned logarithms through the ARDGOTIC team competition. While the students were playing, the teacher was observing, explaining logarithms, and collecting data. At the end of the impementation stage, the teacher had already acquired the data on the pre-test, post-test, and students' evaluation on ARDGOTIC and the overall learning. The data were then analyzed.

Evaluation

The evaluation was conducted to find the contribution of to the students' logarithm mastery. The scores of the students' pre-test and post test as well as the students' evaluation on the medium were used to find out if the learning medium was effective in improving the students' learning achivement. Table 4 shows the recapitulation of the pre-test and post-test of 32 vocational students in Salatiga

Table 4. Description of students' pre-test dan post-tes scores

Description	Pre-test	Post-test
Numbers of subjects	32	
Average	4,3	7,8
Standard deviation	2.53	1.00
Total score	136	250,5
Minimum score	0	6
Maximum score	10	10

The result of the effectiveness testing was taken from the result of pre-test and post-test. N-gain formula was employed to measure the increase. The

N-gain calculation suggests that the students' learning achievement has an increase of 0,697, which is classified as a medium increase. Therefore, ardgotic is said to be an effective learning medium.

The analysis of the students' opinion also shows that ARDGOTIC is interesting and that it makes the students interested in learning logarithms. Overall comments show a positive response for ARDGOTIC. One student's response states that ARDGOTIC is fun as it makes students learn through the game questions.

The validation result of the pre-test and post-test instruments shows that: (1) the questions are in line with the research objective, (2) the test directions are clear, (3) the question objectives are clear, (4) the questions are likely to be answered by the students, (5) the language uses the correct and appropriate Indonesian language, dan (6) the questions use simple words and sentence structures which are easy to understand. The validity testing result of the pre-test and post-test obtains an index of 93.3%, which means very good.

The validity index of ARDGOTIC is 94.54%, which means very good. This is because ARDGOTIC has some benefits, one of which is its interesting design addition, this game requires students to develop a good strategy and learn. ARDGOTIC receives a percentage of 85.71% in terms of practicality, which is classified as very good. This is due to the fact that the board is not too big to carry anywhere.

The analysis result of the students' opinion suggests that: (1) ARDGOTIC has an interesting display, (2) ARDGOTIC can motivate students to learn mathematics, (3) ARDGOTIC can serve as an alternative to learning mathematics.

Most students agreed if ARDGOTIC was used in the learning and if it was also designed for learning other topics. ARDGOTIC can ease the students' learning as they learn logarithms through playing. The analysis result of the students' opinion shows that the students gave a positive response to the use of ARDGOTIC.

The result of the observation shows that the students were quite enthusiastic about learning media which let students play and about board games which fostered a sense of competition in them. The teachers also stated that this type of media could be used as they helped students learn while playing.

CONCLUSION

The research findings conclude that ARDGOTIC is a valid, effective, and practical learning medium which can used to improve the students' learning achievement of logarithms. The validity testing result of ARDGOTIC yields a validity index of 94.54%, which means very good. The result of ARDGOTIC practicality testing shows a percentage of 85.71%, which means very good. The N gain score of the vocational students in Salatiga shows an increase of 0.697. Therefore, ARDGOTIC is concluded to be an appropriate learning medium. ARDGOTIC can be further developed to teach different learning materials. The use of learning media is not only for learning the materials but also for fostering a sense of competition in students.

REFERENCES

Adams, E. 2014. *Fudamentals of Game Design.* United States of America: New Riders

Bell, R.C. 2008. *Discovering Old Board Game.* UK: Shire Publication.

Diah, Maria Fransiska dkk. 2013. Studi Deskriptif Tentang Media Pembelajaran Ular Tangga untuk Meningkatkan Prestasi Berhitung Kelas II. *Kajian Ilmiah Psikologi* No. 1 Vol. 2

Dick and Carey. 1996. *The Sistematic Design of Intruction.* Fourth Edition: Harper Collins College Publisher.

Hamalik, Oemar. 1986. Media Pendidikan. Bandung.

Hananta, Florencia Ivani. 2019. Analisis Kesalahan Siswa dalam Menyelesaikan Soal Logaritma. *Jurnal Pendidikan Matematika Indonesia*, vol. 4 p.29-35.

Kemendikbud. 2013. *Permendikbud No. 70 tentang kompetensi dasar SMK kelas X semester ganjil*. Jakarta: Kemendikbud.

Kemendikbud, 2018. Permendikbud No.17 tahun 2018 tentang Kompetensi Inti dan Kompetensi Dasar Pendidikan Dasar dan Pendidikan Menengah. Jakarta: Kemendikbud.

Latuheru, John D. 1988. *Media Pembelajaran Dalam Proses Belajar-Mengajar Masa Kini*. Jakarta: Departemen Pendidikan dan Kebudayaan.

Lestari, Resti Madiana. 2018. Desain Pembelajaran Logaritma untuk Siswa SMA Kelas X. *Jurnal Gantang*. Vol. III

Ningrum, S.S & Mariono A. 2016. Pengembangan Media Visual Papan Permainan Pada Materi Bentuk Aljabar Mata Pelajaran Matematika Kelas VII SMP Siti Aminah Surabaya. *Jurnal Mahasiswa Teknologi Pendidikan,7(1), 1-12.*

Pamer UN 2018/2019. Hasil UN Matematika Materi Logaritma jurusan AKP. *https://hasilun.puspendik.kemdikbud.go.id/#201*

9!smk!daya_serap!99&99&999!T&03&T&T&3&!1!& diakses pada tanggal 3 Maret 2020

Pitadjeng. 2006. *Pembelajaran Matematika yang Menyenangkan*. Jakarta: Depdiknas.

Purnama, Sigit. 2013. Metode Penelitian dan Pengembangan. *LITERASI*, Vol. IV, No. 1

Romanica, Gladys Mega. 2018. *Perancangan Board Game Bertema Pasar Tradisional Yogyakarta*. Tugas Akhir. ISI Yogyakarta.

Sinaga, Bornok, dkk. 2017. *Matematika untuk SMA/MA/SMK/MAK Kelas X*. Kementerian Pendidikan dan Kebudayaan, Edisi Revisi Jakarta: Kementrerian Pendidikan dan Kebudayaan. Viii, h.216

Sudjana, Nana dan Ahmad Rivai. 2002. Media Pengajaran. Bandung: Sinar Baru Algesindo.

Triastuti, Desty. 2017. Pengembangan Media Papan Permainan Panjat Pinang. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan.* Vol.2 p. 1344-1350.

Utami, A. N., & Mampouw, H. L. 2020. Pengembangan Media Smart Trigo Untuk. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *04*(02), 939–949.

Wibowo, Endro Joko. 2013. Media Pembelajaran Interaktif Matematika untuk Siswa Sekolah Dasar Kelas IV. *Seminar Riset Unggulan Nasional Informatika dan Komputer FTI UNSA 2013*. Vol. 2 p.75-78.

Winarto, Alexander Christian Widya Eka. 2018. Pengembangan Mobile Learning Matematika Sebagai Suplemen Belajar SMA Kelas XI Pada Materi Irisan Kerucut. *Jurnal Pendidikan Matematika.* Vol. 2, No. 1. Hal 32-44.

Yasin, Arif Mukhamad. 2017. *Analisis Kesalahan Peserta Didik dalam Menyelesaikan Soal Pada Materi Logaritma di SMK Kartanegara Kediri Kelas X Semester Ganjil Tahun Ajaran 2016/2017.* Artikel Skripsi Universitas Nuasantara PGRI Kediri.

Yunita, Ismi A. & Adhicipta R. Wirawan. 2017. Perancangan Media Board Game menggunakan Pendekatan Edutainment untuk meningkatkan Minat Belajar Dasar Akuntansi pada Sekolah Menengah Atas Jurusan Sosial. Studi Kasus: Kelas XI Sosial SMA Galaxy Semester Gasal Tahun Ajaran 2016-2017. *Jurnal Akuntansi dan Teknologi informasi (JATI) Vol. 11 Tahun 2017.*