Development of Multiplayer Educational Game as Learning Media to Introduce to Computer Hardware

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ABSTRACT

Computer hardware and its components are material contents that should be taught in junior high school (SMP) level, particularly grade 7th. However, the learning strategy used is still employing traditional approach that make teacher-centered learning style rather than student-centered. This study aims to develop a multiplayer educational game as learning media to introduce computer hardware and its components so that can change the style to student-centered learning. The method used is research and development that consists of five stages, namely analysis, design, development, implementation, and evaluation (ADDIE). Participants involved in this study was 29 SMP students of grade 7th. Before used to collect data, the developed game and the instrument were validated by experts, namely media expert (score: 83%) and material expert (score:93). To evaluate the usability, the test of system usability scale (SUS) questionnaire was adopted that consists if 10 statements Result shows that the usability score is 80.6 indicates category excellent. It can be concluded that the multiplayer educational game is suitable for learning, mainly subject computer hardware

1. INTRODUCTION

We can feel the advancement of information technology today directly in everyday life. Along with the passage of technology and information, humans always demand to develop and innovate [1]. One way to face advances in technology and information is to learn and make the best use of information technology. One of the benefits of information technology is that it is used as a tool for learning in schools [2]. Informatics is one of the Junior High School subjects previously known as ICT (Information and Communication Technology). Based on the written statement in Permendikbud No. 36/2018, there is an amended article, namely article 10A: Implementing Informatics learning as an elective

subject is carried out starting from the 2019/2020 school year according to school readiness. One of the materials in informatics learning is Introduction to Computer Systems. One of the factors for the large number of students who are not able to learn this hardware introduction material is the limited media used today [3].

One of the materials in the informatics subject of class VII junior high school is an introduction to computer systems. Introduction to computer systems is essential for students to learn to know the various hardware components in the form of input hardware, processing hardware, output hardware, secondary storage hardware, and devices contained in other computers. In addition to knowing the hardware in the computer, students must also understand the function of the hardware. Success in the learning process can be determined by two main components, namely media and learning methods. The use of appropriate learning methods and media it is crucial to raise the standard of student learning [4]. A large number of learning media that are less interactive can make students become bored with learning. Therefore, creating interesting learning media can facilitate the learning process in the classroom [5]. Learning media can stimulate the mind, channel messages, and create students' willingness to learn [6]. One of the factors for the large number of students who are not able to learn this hardware introduction material is the limited media used today. One of the essential elements of learning is learning media. The better the learning media [7]. The better it will encourage a better learning process [8]. Therefore, learning media has an essential role in introducing hardware to students.

Science and information technology are experiencing very rapid development among the public, affecting the world of education, especially among students . Along with the development of technology, there are many new learning media. Educational games are a learning medium that contains games and contains learning materials that can be used to educate and direct students in a fun learning process. Games are game media where several rules give rise to competition between two players or playing groups [9]. Education can be interpreted as learning and teaching between students and teachers. This activity is usually carried out directly or indirectly to individuals or groups to increase students' potential. Learning using the concept of learning while playing makes students more active in learning activities [10]. Games can motivate a person to learn so that the learning process becomes more interesting [11]. Games can motivate a person to learn, making learning more enjoyable. However, most children nowadays mostly play games that do not provide benefits and knowledge for them, so it only has an addictive impact on playing the game.Educational games can attract students to learn because there are interesting images, text, and audio [12]. The large number of educational games that cannot be played in multiplayer can be a factor in players' lack of interest in playing educational games. Educational games today can increase the high potential in the world of education. However, there are still learning game that do not offer challenging games to fulfill the demands of each player, and there are still many players who prefer other

competitive games to educational games [13]. Educational games aim to provide knowledge to students during the learning process, can stimulate students' thinking and inventiveness, create contemporary and non-monotonous play media, and improve the quality of student learning [14]. Most educational games today can only be played single-player or alone by facing the enemies in the game. With multiplayer games, players can feel the game's competition in real time, which can increase player interest in playing educational games. With multiplayer games, players can feel the game's competition in real-time, which can increase player interest in playing educational games [15]. Computer hardware educational games are designed to make it simpler for students to comprehend the subject, especially computer hardware materials. Computer hardware educational games are designed to be very interactive so that students can be more active in following the learning process [16].

Multiplayer games are carried out by at least two or more people. The existence of multiplayer games can create a sense of competitiveness between students. This multiplayer game-based learning media is expected that the learning process, which was initially monotonous, will become more interactive and can motivate students to learn computer hardware.There is potentially gained in multiplayer educational games in the form of an essential role in measuring cognitive and social abilities among students Menurut [17]. In addition to playing, multiplayer educational games can also be used to play between students, which is fun. This multiplayer educational game is made to resemble a game that is often played by children today, namely a game that can be played with their friends and has a mission that can attract students to play this multiplayer educational game.

Considering the outcomes of observations and freely conducted interviews at SMP Negeri 4 Ngawi, many students need help understanding the material, especially the introduction of computer hardware caused by learning media that is still conventional and less attractive to students. In addition, the current students of SMP Negeri 4 are also happy to play competitive games. Games are one of the popular media among children. Based on existing problems, learning media based on multiplayer game educational games is expected to help teachers and students in the learning process of introducing computer hardware or hardware effectively [18]. So that the students are expected to be motivated to continue learning. Therefore, there will be a great curiosity or curiosity to play games and learn to understand computer hardware. So that learning the introduction of computer hardware or hardware will be more fun and more varied. This research will develop educational games with the advantage that they can be played by more than one player, which will be an attraction in the educational games developed.

2. RESEARCH METHOD

Research and development (R&D) techniques are used for this research. Methods of research and development are steps or processes that aim to create a new product or enhance one that already exists and accountable product. The product in question does not have to be an object or hardware, but it can also be software [19]. The ADDIE model of development was employed in this study. Compared to other development models, the ADDIE model is complete [20]. This model can be used in product development, such as models, learning methods, teaching material media, and learning strategies. There are five main steps in the development of this ADDIE model, including Analysis followed by design, development, implementation, and evaluation.
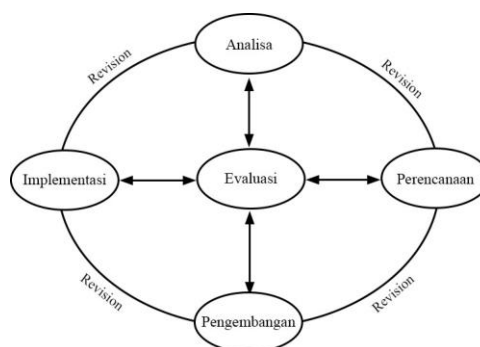

Figure 1. ADDIE Stage

This study will be carried out until the Evaluation stage because it is adjusted to the title, namely the development of a multiplayer-based educational game for the introduction of computer hardware that can be used as a learning medium for students.

Before the implementation of students, product trials are carried out independently, namely media expert trials and material expert trials, to determine the shortcomings and feasibility of media. After the trial stage, the media analysis stage that has been developed is then carried out. Then the trial of learning media will be continued to be carried out to grade VII students of SMP Negeri 4 Ngawi.

The subject of this media test was carried out by an expert in his field who contributed to facilitating the development of learning media, namely: two lecturers of Informatics Engineering Education, University of Muhammadiyah Surakarta's Faculty of Teacher Training and Education who is experts in their fields as media experts in this research and material experts who are experts in their fields, namely teachers who teach informatics subjects from SMP Negeri 4 Ngawi, and Class VII students of SMP Negeri 4 Ngawi totaling 29 students.

Data gathered for this study are qualitative data and quantitative data. The instruments used to collect data are: media expert instrument sheets, material expert instrument sheets, and student satisfaction questionnaires for the media developed. The

expert media instrument is a sheet that contains a feasibility assessment questionnaire and suggestions on the media being developed. A material expert instrument sheet, namely a sheet that provides a feasibility assessment questionnaire and suggestions about the material in the media so that the feasibility of the material from the media developed can be known. The student satisfaction questionnaire, namely for the press, developed a sheet containing the assessment score based on a predetermined number scale so that the level of student satisfaction with the media that has been developed can be known.

The data collection technique in this study uses a questionnaire in which several indicators and answers can be chosen directly by media experts, material experts, and student satisfaction questionnaires with the media developed. This questionnaire is created by loading a Likert scale. This research led to the creation of "Arena Hardware," a multiplayer-based educational game that may be utilized as a teaching tool.

The development stage of the multiplayer educational game "Arena Hardware" which is used for learning media introduction to computer hardware class VII SMP Negeri 4 Ngawi, was developed with the ADDIE model stages, namely: Analysis stage (analysis of problems and student needs), Design (determining the media design to be set), Development (The production process of learning media to be used), Implementation (applying learning media products that have been developed), and Evaluation (evaluating products that have been developed)

Analysis

There are several stages of this analysis, namely analyzing the Core Competencies and Basic Competencies in the Informatics class VII junior high school lesson. In addition, researchers also make observations about the learning process in the classroom during informatics class hours. This observation activity aims to find out what obstacles occur during the lesson, the learning media employed and the students' requirements. And the results of observations made by researchers in the classroom show that students of SMP Negeri 4 Ngawi need new learning media to support their learning needs. One media suitable for students of SMP Negeri 4 Ngawi is multiplayer-based educational game learning media.

Design

The design stage is carried out after analyzing the current needs of students. At this stage, researchers determine the planning a multiplayer-based educational game design that is used as a learning medium in getting to know computer hardware. The game has a 3D view and can be played online. The main display has a button to find an opponent to play, create an arena, and an exit button. In addition, in the hardware arena, there is a box containing materials and how to play.

Development

At this stage, the process of developing a product that has been designed in advance is carried out. This product was developed using unity 3D software. At this stage, a reference collection of assets used in the product is also carried out, and making questionnaire instruments.

3. RESULTS AND DISCUSSION

The outcomes of the multiplayer-based educational game product "Arena Hardware" that has been developed as shown in the picture 2-6 :

Figure 2. Homepage

On the homepage, there are buttons for searching for opponents to play, creating arenas, trying to play, and exiting the game. Before entering the gameplay section, players must create a room, and then other players join the room that has been created.

Figure 3. Main display game

In this game, players play by finding and collecting hardware components in the hardware arena. How to play using W, A, S, and D buttons to control the player, and mouse to move the camera, left mouse button to shoot enemies. To win the game, players must find a mysterious box containing questions and then answer correctly. The player who answers the most questions correctly is the winner.

Figure 4. Material

The appearance of this material appears when loading the game. This material can be observed by players before entering the homepage.

Figure 5. Quiz arena

In this game, a mysterious box contains questions about some hardware functions. If the player answers correctly, the score increases, and if the wrong score, it will decrease.

Figure 6. End of game view

In this view, there is a scoreboard and the game's results. The winner is the one with the highest score. There is a Play again button if you want to play again.

A consultation is conducted with the supervisor to create a good product in developing this product. After this, the product that has been developed is carried out a product test process by experts to find out the feasibility of the product so that it can be used as a learning medium. After the product has been developed, a media feasibility test is carried out to learn hardware recognition. This assessment stage is called a validation test conducted by an expert in their field. The feasibility of the media developed is assessed by a) Material test, namely the process of testing the content of the material in the media carried out by teachers who teach informatics subjects class VII SMP Negeri 4 Ngawi, b) Media testing is a testing process carried out by UMS informatics engineering education lecturers to assess aspects of usability, functionality, and visual communication of the developed product. The following are the results of product tests by media experts and material tests:

Table. 1 Media Test Results

No.	Aspects	Resp.1	Resp.2	Average	Category
1	Usability	88%	80%	84%	**Very decent**
2	Functionality	96%	84%	90%	**Very decent**
3	Visual communication	80%	72%	76%	**Decent**
	Total	**88%**	**79%**	**83%**	**Very decent**

Table.2 Material test percentage results

No.	Aspects	Resp.1	Resp.2	Average	Category
1	Aspects of Learning Design	89%	93%	91%	**Very decent**
2	Aspects of Visual Communication	93%	96%	95%	**Very decent**
	Total	**91%**	**95%**	**93%**	**Very decent**

Table 1 shows the outcomes of the multiplayer-based educational game product "Arena Hardware" that has been developed as shown in the picture below of tests conducted by two media experts. It can be stated that the Usability aspect gets an average percentage of 84% in the very decent category, the Functionality aspect gets an average percentage of 90% in the very decent category, and the Visual Communication aspect 76% in the decent category. Media Experts 1 percentage obtained was 88%, and researcher two as much as 79%. Furthermore, the percentage obtained from the average of the two testers is 83%, which means that this multiplayer-based educational game media is included in the category of very decent by media experts.

Table 2 shows that the average results of material tests conducted by content experts on the learning design aspect were obtained 91% with a very decent category. The visual communication aspect got an average score of 95% with a very decent variety. The total average score of the material test got 93% with a very decent category. So multiplayer-based educational game media is very feasible to be used as a hardware introduction learning media for students.

Implementation

This implementation stage conducts product trials from the design and development stage of the multiplayer-based educational game "Arena Hardware" which media experts have tested and material experts continued for trials on students. In student trials later, they conduct media tests using direct educational games that have been developed as learning media.After conducting a media test, To gauge how satisfied students were with utilizing a designed multiplayer-based instructional game, a satisfaction survey was handed to the class. The table displays the survey's findings regarding student satisfaction.

Table 3. Student questionnaire results

Participants	Question Item										Score sum	SUS Score value
	1	2	3	4	5	6	7	8	9	10	sum	value
Participants 1	5	4	3	4	4	4	4	4	4	2	38	95
Participants 2	4	3	3	4	4	4	4	4	4	2	36	90
Participants 3	4	2	2	1	1	3	3	3	3	2	24	60
Participants 4	4	1	4	2	4	1	3	3	4	3	29	72.5
Participants 5	2	1	3	1	2	2	3	3	2	3	22	55
Participants 6	4	2	0	1	4	4	4	3	3	2	27	67.5
Participants 7	3	2	3	3	3	3	3	3	4	3	30	75
Participants 8	4	3	3	3	3	4	4	3	4	2	33	82.5
Participants 9	3	4	4	3	4	2	3	4	4	2	33	82.5
Participants 10	4	3	4	2	3	4	3	3	4	2	32	80

Participants 11	4	3	3	3	3	3	3	3	3	3	31	77.5
Participants 12	4	4	4	4	3	4	4	4	4	2	37	92.5
Participants 13	4	4	4	4	3	3	3	2	4	2	33	82.5
Participants 14	3	2	3	3	3	3	4	3	3	3	30	75
Participants 15	4	4	4	4	3	3	3	3	4	3	35	87.5
Participants 16	3	4	4	3	4	4	4	4	4	4	38	95
Participants 17	4	3	2	2	3	4	3	3	4	2	30	75
Participants 18	4	4	4	3	4	3	3	3	3	4	35	87.5
Participants 19	3	4	4	3	4	4	4	4	3	3	36	90
Participants 20	4	3	4	3	4	2	1	3	4	3	31	77.5
Participants 21	3	2	3	3	3	3	3	3	4	3	30	75
Participants 22	3	4	4	4	3	3	3	4	4	2	34	85
Participants 23	4	4	3	4	4	4	3	3	3	2	34	85
Participants 24	3	4	4	3	4	2	1	4	4	2	31	77.5
Participants 25	3	4	3	4	4	4	3	4	3	2	34	85
Participants 26	4	3	3	2	4	2	2	1	3	3	27	67.5
Participants 27	4	4	4	4	4	4	4	4	3	4	39	97.5
Participants 28	4	3	4	2	4	2	4	2	4	2	31	77.5
Participants 29	3	4	3	3	4	4	4	4	4	3	36	90
Total												**2340**

The calculation of the System Usability Scale (SUS) score is as follows:

$$Score\ SUS = \frac{\sum x}{n}$$

Information:

x   = Scores from participants

$\sum x$ = Total Participant Score

n   = Number of participants
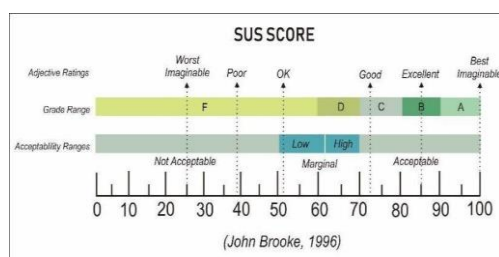
$$Score\ SUS = \frac{2340}{29} = 80,6$$

Figure 6. SUS Score

The data above results from a questionnaire of students' average scores filled by 29 grade VII students of SMP Negeri 4 Ngawi. The data was obtained by calculating the SUS (System Usability Scale), which contains ten statements that must be answered by users of multiplayer-based educational games, namely students of SMP Negeri 4 Ngawi. The data from the table shows that the score of 80.6 is included in the EXCELLENT category with a B grade and is included in the acceptable category. These findings indicate that multiplayer-based educational games are either acceptable or appropriate for usage as a teaching tool for pupils.

Evaluation

The evaluation stage is the last in the development of learning media. In this stage, an evaluation of media has been tested by media experts, material experts, and students. It can be seen from the test that media experts get an average value of 83% which can be interpreted to mean that the media that has been developed enters Categories are worthy of being used as a learning medium in the classroom. The results of the material test conducted by the material expert, namely the teacher who teaches Informatics class VII at SMP Negeri 4 Ngawi Getting an average score of 93%, included in the category, is very worthy of being used as a learning medium. Likewise, the results of the evaluation from students can be seen through the SUS score from the questionnaire that has been filled in by students getting a score of 80.6 in the EXCELLENT category with a grade scale B. Learning media for this multiplayer-based educational game is very feasible to use, but in the future, there are some improvements such as adding material and in-game questions to make the media even better. The results of the research that I have made have similarities with the study conducted by [21] discusses educational games for learning media for elementary school children in getting to know the concept of style material. [22] discusses educational games used to help children read, write, and count. The research conducted by [23] discusses the development educational games to improve student learning outcomes in mathematics subjects in grade 1 elementary school.

4. CONCLUSION

Based on the results and discussion, it can be concluded that the multiplayer educational game is usable as learning media, particularly to introduce computer hardware and its component. It can be seen from the evaluation of SUS questionnaire is 80.6, includes excellent category. The media test results conducted by two experts showed a percentage of 83%, which was included in the very decent category. The results of the material test conducted by two material experts were 93%, with a very decent category.

REFERENCES

[1]   R. Permana, R. D. A. Budiman, D. Ramadhani, and A. A. Putra, "Website Development for Alumni of Education Information Technology and Computer," *J. Teknol. Inf. dan Pendidik.*, vol. 15, no. 1, pp. 28–37, 2022, doi: 10.24036/jtip.v15i1.526.

[2]   M. B. Orikana, H. Yulia, and K. Krismiyati, "Effectiveness of Online Learning viewed from Students' Online Interaction," *J. Teknol. Inf. dan Pendidik.*, vol. 15, no. 1, pp. 105–119, 2022, doi: 10.24036/jtip.v15i1.576.

[3]   A. F. Ramadhan, A. D. Putra, and A. Surahman, "Aplikasi Pengenalan Perangkat Keras Komputer Berbasis Android Menggunakan Augmented Reality (Ar)," *J. Teknol. dan Sist. Inf.*, vol. 2, no. 2, pp. 24–31, 2021.

[4]   A. P. Muji, A. Ambiyar, I. Aziz, and H. Hidayat, "The implementation of Quizizz-based online evaluation in higher education: An exciting alternative for evaluation," *Int. J. Res. Couns. Educ.*, vol. 5, no. 2, pp. 186–194, 2021, doi: 10.24036/00478za0002.

[5]   S. Naylor and B. Keogh, "Concept cartoons: What have we learnt?," *J. Turkish Sci. Educ.*, vol. 10, no. 1, pp. 3–11, 2013.

[6]   Rohani, "Diktat Media Pembelajaran," *Fak. Ilmu Tarb. dan Kegur. Univ. Islam Negeri Sumatera Utara*, pp. 1–95, 2019.

[7]   P. Panyahuti, "Validity Test of Motion Graphics Media as A Wide Area Network Learning Media," *J. Teknol. Inf. dan Pendidik.*, vol. 15, no. 1, pp. 21–27, 2022, doi: 10.24036/jtip.v14i3.572.

[8]   T. Nurrita, "Pengembangan Media Pembelajaran Untuk Meningkatkan Hasil Belajar Siswa," *MISYKAT J. Ilmu-ilmu Al-Quran, Hadist, Syari'ah dan Tarb.*, vol. 3, no. 1, p. 171, 2018, doi: 10.33511/misykat.v3n1.171.

[9]   Y. Effendi, "Rancangan Aplikasi Game Edukasi Berbasis Mobile Menggunakan App Inventor," *J. Intra-Tech*, vol. 2, no. 1, pp. 39–48, 2018.

[10]   I. G. Suryawirawati, B. Ramdhan, and A. Juhanda, "Pada Konsep Pemanasan Global Dengan Tes Diagnostik (TWO-TIER TEST) Setelah Pembelajaran," vol. 1, no. 1, pp. 93–105, 2018.

[11]   L. Wahyudi, I. Wiryokusumo, and A. Fatirul, "Pengembangan Game Edukasi Fractal Adventure untuk Pembelajaran Bilangan Pecahan," *Edcomtech J. Kaji. Teknol. Pendidik.*, vol. 6, no. 2, pp. 199–209, 2021, doi: 10.17977/um039v6i12021p199.

[12]   R. Nurcholis, A. I. Purnamasari, A. R. Dikananda, O. Nurdiawan, and S. Anwar, "Game Edukasi Pengenalan Huruf Hiragana Untuk Meningkatkan Kemampuan Berbahasa Jepang," *Build. Informatics, Technol. Sci.*, vol. 3, no. 3, pp. 338–345, 2021, doi: 10.47065/bits.v3i3.1091.

[13]   K. Park, K. E. Boyer, and J. C. Lester, "Generating Educational Game Levels with Multistep Deep Convolutional Generative Adversarial Networks," *2019 IEEE Conf. Games*, pp. 1–8, 2019.

[14]   R. dan F. Ramadaniah, "The development of interactive educational games to improve character values in early childhood," *Int. J. Res. Couns. Educ.*, vol. 05, no. 02, pp. 224–231, 2021.

[15]   S. Y. Saputra and S. Subari, "Game Multiplayer 'Mini Car Circuit' Berbasis Android," *J-Intech*, vol. 7, no. 01, pp. 58–66, 2019, doi: 10.32664/j-intech.v7i01.406.

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[16]   D. P. Hermawan, "Efektivitas Penggunaan Game Edukasi Komputer Untuk Meningkatkan Hasil Belajar Siswa Mata Pelajaran TIK Kelas VII SMP Negeri 1 Kota Mungkid," *Gospod. Mater. i Logistyka*, vol. 26, no. 4, pp. 185–197, 2013.

[17]   B. M. M. Alom, C. Scoular, and N. Awwal, "Generic log files and algorithms developed for educational multiplayer games," *Int. J. Adv. Comput. Res.*, vol. 7, no. 33, pp. 223–232, 2017, doi: 10.19101/IJACR.2017.733029.

[18]   R. R. Pratama and A. Surahman, "Perancangan Aplikasi Game Fighting 2 Dimensi Dengan Tema Karakter Nusantara Berbasis Android Menggunakan Construct 2," *J. Inform. dan Rekayasa Perangkat Lunak*, vol. 1, no. 2, pp. 234–244, 2021, doi: 10.33365/jatika.v1i2.619.

[19]   Sutama, *Metode penelitian pendidikan*. Cv. Jasmine Gumpang Agung III no. C. 5, rt12/III, Gumpang, Kartasura, Sukoharjo., 2019.

[20]   E. Mulyatiningsih, "Metode Penelitian Terapan Bidang Pendidikan," p. 35,110,114,120,121, 2013.

[21]   M. Erfan1], A. Widodo2], Umar3], and Radiusman4Tursina Ratu, "Pengembangan Game Edukasi 'Kata Fisika' Berbasis Android untuk Anak Sekolah Dasar pada Materi Konsep Gaya Muhammad," vol. 3, no. 2017, pp. 54–67, 2020, [Online]. Available: http://repositorio.unan.edu.ni/2986/1/5624.pdf.

[22]   B. N. Pelealu, T. Afirianto, and W. S. Wardhono, "Pengembangan Game Edukasi Mobile Augmented Reality untuk Membantu Pembelajaran Anak dalam Membaca, Menulis, dan Berhitung," *J. Pengemb. Teknol. Inf. dan Ilmu Komput.*, vol. 3, no. 2, pp. 1492–1499, 2019, [Online]. Available: http://j-ptiik.ub.ac.id.

[23]   R. E. N. Arifah, S. Sukirman, and S. Sujalwo, "Pengembangan Game Edukasi Bilomatika untuk Meningkatkan Hasil Belajar Siswa pada Mata Pelajaran Matematika Kelas 1 SD," *J. Teknol. Inf. dan Ilmu Komput.*, vol. 6, no. 6, p. 617, 2019, doi: 10.25126/jtiik.2019661310.