The development of 3D animated video for mathematics learning in elementary schools

Meria Ultra Gusteti¹, Ronal Rifandi², Trysa Gustya Manda², Melani Putri³

¹Mathematics Education Study Program, STKIP Adzkia, Padang, Indonesia
²Mathematics Department, Universitas Negeri Padang, Padang, Indonesia
³Student of Mathematics Education Study Program, STKIP Adzkia, Padang, Indonesia

*meria.ug@stkipadzkia.ac.id

Abstract. The background of this research is due to the limited learning media in the form of 3D animated videos for Mathematics subjects. This study aims to develop a valid 3D animated video on the material of the addition and subtraction of integers in elementary schools. The development model used is the DDD-E model. The 3D animated video developed was validated by three validators in terms of the content and the media. The average validation value for content validation and media validation are 3.33 and 3.67 respectively. These results indicate that the 3D animated video developed is in very valid criteria.

1. Introduction

The industrial revolution 4.0 is marked by the rapid development of technology in all aspects of life. Many aspects of life are controlled by the integration of technology that is developing in this era [1]. One aspect that has played an important role in the industrial revolution is education. Education must be able to produce excellent generation who can compete in the era of industrial revolution 4.0 [2]. As the others, education in this era is characterized by the use of digital technology in the learning process [3], [4]. The use of digital technology in learning has become increasingly needed since the Covid-19 pandemic. This pandemic is changing the learning system from a face-to-face to a virtual face-to-face, distance learning, or online learning.

Online learning is certainly not as easy as imagined, especially for teachers. Online learning that is not properly packaged will lead to bored and monotonous learning. In this condition, teachers need attractive and proper media to support online learning, especially in the form of animated videos. Indeed, in Indonesia, there are many researchers have already developed instruction videos media to support mathematics learning at various level of education [5]–[8]. However, the availability of animated videos, especially three-dimensional (3D) animated, is inadequate. This causes the teacher difficulty in delivering material, especially for abstract material. In elementary school mathematics learning, the material for adding and subtracting integers, especially for negative numbers, is categorized as an abstract material for students. Therefore, we need the right media to make it concrete for the students to learn about it.

One characteristic of elementary school students is that they tend to prefer concrete and tangible things. According to Piaget, children aged 7 and 11 years have the ability to remember and think logically, a child is able to see an event from another person's point of view [9]. Hence, at this stage, children generally prefer to play, work in groups, and imitate things that are real in front of them [10].
Therefore, mathematics teachers should try to bridge what students already have in their initial knowledge to the abstract mathematics in order to help them developing the mathematical concept. In addition, the teacher should also consider to provide students with learning mathematics contextually. However, the challenge is to do that bridge and the contextual learning during the distance learning period due to the Covid-19 pandemic.

According to experts, learning media is a tool to deliver messages and makes it easier to learn something. Animated media is an alternative in teaching, especially for material that is considered difficult, too verbalistic and needs visualization. The utilization of animated videos in the learning process can improve the learning outcomes and its quality because of their attractive form. In addition, video media makes it easier for students to remember and understand the material because it does not only involve one sense. Moreover, using the technology-based media such as appropriate animated videos will support the effectiveness of online learning process during the pandemic. Arsyad stated that the many number sensory organs involved in receiving and processing information will make a person more likely to understand and remember it for a long time. Furthermore, Dale’s research results show that 75% of learning outcomes come from the sense of sight, 13% from the deaf sense and 12% from the other senses.

Based on the aforementioned description, this study aimed to develop a valid mathematics instruction media in the form of 3D animated video to support elementary school students in learning mathematics.

2. Method
This is a research and development with DDD-E model. According to Tegeh, this model is specifically designed to develop multimedia learning, which consists of four stages, namely: 1) Decide, namely deciding or setting goals, program material or discussion, 2) Design, namely designing or designing the program structure, 3) Develop, namely producing media and making displays, 4) Evaluate, namely checking the overall design and development process.

Activities at the decide stage are determining themes, learning outcomes or objectives, scope and multimedia theme, and also analyzing media and media users. The design stage is the visual thinking stage by producing the overall product by compiling a material mapping, content outline, material overview, script, flowchart, and storyboard. The next stage is developing phase, which is developing the product into a 3D animated video. The materials that have been prepared are illustrated in a video which is composed of several elements, such as text, images, animated, and audio. Furthermore, the 3D animated video editing process is carried out using Blender Software. After the animated video is developed, it is followed by video validation. Videos are validated by three experts on the content and the media. At this stage, the video is revised according to the validators’ suggestions. The evaluation process continues at each stage of development to improve the quality of the developed product.

This study used a questionnaire as an instrument based on a Likert scale with a scale of 4. The collected data then analyzed by dividing the total score over the number of the validators. Further, the result is converted to the validity criteria as can be seen from Table 1.

| Interval        | Category        |
|-----------------|-----------------|
| \( R \leq 0.80 \) | Not Valid       |
| \( 0.80 < R \leq 1.60 \) | Less Valid     |
| \( 1.60 < R \leq 2.40 \) | Quite Valid    |
| \( 2.40 < R \leq 3.20 \) | Valid          |
| \( R > 3.20 \)    | Very Valid      |
3. Result and discussion
The result of this research and development is a 3D animated video in Mathematics for grade VI in Elementary Schools. The 3D animated video then validated to determine the feasibility of product. The validation that is done is validation of content and media by three experts. The validation aims to see the validity of content and media in the developed videos.

3.1. Content Validation
Indicators and validation result on content validity is can be seen in Table 2.

| No | Indicators                                                                 | Val.1 | Val.2 | Val.3 | Average | Category |
|----|-----------------------------------------------------------------------------|-------|-------|-------|---------|----------|
| 1  | The suitability of material presented with the daily life of students        | 3     | 3     | 3     | 3.00    | Valid    |
| 2  | The suitability of material presented with the level of development students | 4     | 4     | 3     | 3.67    | Very Valid |
| 3  | The suitability of the material presented in the animated video with the competencies to be achieved | 4     | 3     | 3     | 3.33    | Very Valid |
| 4  | The conformity of the Qur'an verses which are presented in the animated video with the material presented | 3     | 3     | 4     | 3.33    | Very Valid |
| 5  | The material presented in the video is easy to understand                    | 4     | 4     | 3     | 3.67    | Very Valid |
| 6  | The material presented in the video is attractive                            | 3     | 3     | 3     | 3.00    | Valid    |
| 7  | The accuracy of material delivery through animated videos.                  | 4     | 3     | 3     | 3.33    | Very Valid |

Average: 3.57, 3.28, 3.14, 3.33, Very Valid

From Table 2, it can be seen that the result for five indicators in the content validation are in very valid category and the remaining two gain valid category. In average, it can conclude that the content validation of the developed 3D animated video is in very valid category. The validity of the content is important especially for a learning media, since this media should be fit with the topic of the lesson being taught for the students [21].

3.2. Media Validation
The indicators for assessing the validity of the media together with its result are presented in Table 3.

| No | Indicators                                                                 | Val.1 | Val.2 | Val.3 | Average | Category |
|----|-----------------------------------------------------------------------------|-------|-------|-------|---------|----------|
| 1  | Conformity with the background display                                       | 4     | 3     | 3     | 3.33    | Very Valid |
| 2  | The suitability of animation with the explained topic                        | 4     | 3     | 3     | 3.33    | Very Valid |
| 3  | Text and animation compatibility                                            | 4     | 4     | 3     | 3.67    | Very Valid |
| 4  | The suitability of the accompanying music with the narrative                 | 4     | 4     | 4     | 4       | Very Valid |

From Table 3, it can be seen that the result for five indicators in the media validation are in very valid category and the remaining two gain valid category. In average, it can conclude that the media validation of the developed 3D animated video is in very valid category.
| No | Indicators                                                                 | Val.1 | Val.2 | Val.3 | Average | Category     |
|----|----------------------------------------------------------------------------|-------|-------|-------|---------|--------------|
| 5  | Animations are clear and attractive                                       | 4     | 3     | 3     | 3.33    | Very Valid   |
| 6  | The videos are in the good quality                                        | 4     | 3     | 4     | 3.67    | Very Valid   |
| 7  | The illustrations are easy to understand and suitable for everyday life    | 4     | 3     | 4     | 3.67    | Very Valid   |
| 8  | Video content is coherent according to the material                        | 4     | 4     | 4     | 4       | Very Valid   |
| 9  | The video duration is adequate                                            | 4     | 4     | 4     | 4       | Very Valid   |

Average: 4 | 3.44 | 3.56 | 3.67 | 3.67 | Very Valid |

Based on Table 3, the media validity is in the very valid category with the score of 3.67. This result fit with the category for a valid learning media proposed by Mulyardi [20]. Therefore, we can confirm that the developed media fulfil the requirement as a learning media for mathematics in the particular topic.

3.3. The revision of 3D animated video

In the expert validation phase, the validators were also asked to give their comments and suggestion to improve the design of the developed video. The following Table 4 summarize some improvements made based on the validators’ suggestion.

Table 4. Display before and after revision of the developed 3D animated video

| No | Before revision | After revision |
|----|----------------|----------------|
| 1  | ![Before Image](image1.png) | ![After Image](image2.png) |
|    | Improvement: the valley appearance in the animation is clearer            |
| 2  | ![Before Image](image1.png) | ![After Image](image2.png) |
|    | Improvement: the size of each valley be equalized                         |
No | Before revision | After revision
---|----------------|----------------|
3 | Three sand mountains represent +3 | Improvement: The mountains are clearer |
4 | Three valleys represent -3 | Improvement: the valley appearance is clearer and equalized |
5 | 2 mountains + 3 valleys | Improvement: the size of the mountains are more equal |
6 | Improvement: the answer (-2)-(-3)=1 is removed, so that students can answer first when the video is paused. |

From Table 4, it can be seen some improvements made by the researchers based on expert suggestion. It is in line with the view that experts’ feedback of the developed media will help the researcher in modifying it to be more appropriate, effective and usable [22].
4. Conclusion

Based on the result of this study, it can be concluded that the developed mathematics instruction media in the form of 3D animated video to support elementary school students in learning mathematics is in the category of very valid. Furthermore, in order to complete the mission of the media development in this study, it needs to continue the phase until conducting the effectivity test of the designed media.

References

[1] Gleason N W Ed., 2018 Higher Education in the Era of the Fourth Industrial Revolution Singapore: Palgrave Macmillan.

[2] Prastyanti R A and Purnomo S, 2019 Legal Considerations in Digital Marketing Int. Manag. J. June p. 113–121.

[3] Widya Rifandi R and Rahmi Y L, 2019 STEM education to fulfil the 21st century demand: a literature review J. Phys. Conf. Ser. 1317 p. 12208.

[4] Rifandi R Rahmi Y L Widya and Indrawati E S, 2020 Pre-service teachers’ perception on science, technology, engineering, and mathematics (stem) education J. Phys. Conf. Ser. 1554 p. 012062.

[5] Batubara H H and Ariani D N, 2016 Pemanfaatan Video sebagai Media Pembelajaran Matematika SD/MI Muallimuna J. Madrasah Ibtidaiyah.

[6] Meryansumayeka M Yusuf M and Suganda V A, 2018 Pengembangan Video Pembelajaran Berbasis PMRI untuk Mendukung Mental Calculation Siswa dalam Permasalahan Aritmatika Sosial J. Elem.

[7] Purwanti B, 2015 Pengembangan Media Video Pembelajaran Matematika dengan Model Assure J. Kebijak. dan Pengemb. Pendidik. 3, 1 p. 42–47.

[8] Rifandi R Ahmad D and Gusteti M U, 2020 Praktikalitas Media Video Tutorial sebagai Suplemen Digital Learning pada Mata Kuliah Persamaan Diferensial Biasa J. Eksakta Pendidik. 4, 1 p. 27–33.

[9] Piaget J, Sep. 2008 Intellectual Evolution from Adolescence to Adulthood Hum. Dev. 51, 1 p. 40–47.

[10] Lukman A Hayati D K and Hakim N, 2019 Pengembangan Video Animasi Berbasis Kearifan Lokal pada Pembelajaran IPA Kelas V di Sekolah Dasar Elem. J. Ilm. Pendidik. Dasar 5, 2 p. 153–166.

[11] Rifandi R, 2017 Supporting Students ’ Reasoning About Multiplication of Fractions by Constructing an Array Model J. Res. Adv. Math. Educ. 1, 2 p. 99–110.

[12] Meirisa A Rifandi R and Masniladevi M, Sep. 2018 Pengaruh Pendekatan Pendidikan Matematika Realistik Indonesia (PMRI) Terhadap Keterampilan Berpikir Kritis Siswa SD J. Gantang 3, 2 p. 127–134.

[13] Gusteti M U Seifinal and Syafti O, 2018 Pengaruh Pembelajaran Kontekstual dengan Teknik Hands On Mathematics Terhadap Kemampuan Komunikasi Matematik Siswa Kelas IX MTS Darussalam Kabupaten Pesirir Selatan J. Kepemimp. dan Pengur. Sekol. 3, 2 p. 217–225.

[14] Widjayanti W R Masfingatin T and Setyansah R K, 2018 Media Pembelajaran Interaktif Berbasis Animasi Pada Materi Statistika Untuk Siswa Kelas 7 Smp J. Pendidik. Mat. 13, 1 p. 101–112.

[15] Fadhli M, 2015 Pengembangan Media Pembelajaran Berbasis Video Kelas Iv Sekolah Dasar J. Dimens. Pendidik. dan Pembelajaran 3, 1 p. 24–29.

[16] Hasanah U and Nulhakim L, 2015 Pengembangan Media Pembelajaran Film Animasi Sebagai Media Pembelajaran Konsep Fotosintesis J. Penelit. dan Pembelajaran IPA 1, 1 p. 91.

[17] Astini N K S, 2020 Pemanfaatan Teknologi Informasi dalam Pembelajaran Tingkat Sekolah Dasar pada Masa Pandemi Covid-19 J. Lemb. Penjaminan Mutu STKIP Agama Hindu Amlapura 11, 2 p. 13–25.

[18] Azhar A, 2011 Media pembelajaran Jakarta: Rajawali Pers.

[19] Mutia R Adlim A and Halim A, 2018 Pengembangan Video Pembelajaran Ipa Pada Materi
Pencemaran Dan Kerusakan Lingkungan J. Pendidik. Sains Indones. 5, 2 p. 110–116.

[20] Muliyardi, 2006, Pengembangan Model Pembelajaran Matematika dengan Menggunakan Komik di Kelas I Sekolah Dasar, Surabaya: Pasca Sarjana UNESA.

[21] Sumiati A, 2007 Metode pembelajaran Bandung CV Wacana Prima.

[22] Rahmi Y L Novriyanti E Ardi A and Rifandi R, 2018 Developing Guided Inquiry-Based Student Lab Worksheet for Laboratory Knowledge Course in IOP Conference Series: Materials Science and Engineering.