E-Animation Media to Improve the Understanding of Elementary School Science Learning

Zakirman[1], Chichi Rahayu[2✉], Wienda Gusta[3]
Universitas Terbuka, Indonesia[1]
Universitas Ekasakti Padang, Indonesia[2]
UPI YPTK Padang, Indonesia[3]
E-mail: zakirman.official@gmail.com[1], rahayuchichi@gmail.com[2], wienda84@yahoo.com[3]

Abstrak

Penelitian ini dilatarbelakangi oleh rendahnya ketuntasan belajar siswa pada pembelajaran IPA khususnya pada materi cahaya karena kurangnya penggunaan media pembelajaran yang sesuai dengan karakteristik materi di Kelas V SD. Tujuan penelitian ini untuk menganalisis pengaruh penggunaan media pembelajaran elektronik berbasis macromedia flash pada materi sifat-sifat cahaya dalam meningkatkan hasil belajar siswa kelas V SD. Hasil belajar yang digunakan sebagai data penelitian dibatasi pada ranah kognitif. Materi yang dipilih dalam penelitian adalah sifat-sifat cahaya. Jenis penelitian ini eksperimen semu, dimana sampel yang diambil dalam kegiatan penelitian adalah siswa kelas V SDN 12 Nan Sabaris. Instrumen yang digunakan adalah berupa tes pilihan ganda. Teknik analisis data menggunakan uji-t. Berdasarkan hasil analisis data diperoleh t-hitung dengan nilai 6,91 dan t-tabel dengan nilai 2,04. Hal ini bearti terdapat perbedaan yang signifikan antara hasil belajar siswa sebelum menggunakan media animasi dengan hasil belajar siswa setelah menggunakan media animasi. Dengan demikian dapat disimpulkan penggunaan e-animasi berpengaruh terhada hasil belajar siswa. Penggunaan e-animasi dapat menjadi alternative baru sebagai solusi untuk meningkatkan kualitas pembelajaran dan pemahaman siswa.
Kata Kunci: Media Pembelajaran Elektronik, Animasi, Hasil Belajar, Cahaya

Abstract

This research was motivated by the low mastery of student learning in science learning, especially in light-matter because of the lack of use of learning media that is in accordance with the characteristics of the material in Class V elementary school. The purpose of this study was to analyze the effect of using Macromedia flash-based electronic learning media on the material properties of light in improving the learning outcomes of fifth-grade elementary school students. Learning outcomes used as research data are limited to the cognitive domain. The material selected in the research was the properties of light. This type of research was quasi-experimental, where the samples taken in research activities were fifth-grade students at SDN 12 Nan Sabaris. The instrument used was a multiple-choice test. The data analysis technique used a t-test. Based on the results of data analysis, it is obtained t-count with a value of 6.91 and t-table with a value of 2.04. This means that there is a significant difference between student learning outcomes before using animation media and student learning outcomes after using animation media. Thus, it can be concluded that the use of e-animation affects student learning outcomes. The use of e-animation can be a new alternative as a solution to improve the quality of learning and student understanding.
Keywords: Electronic Learning Media, Animation, Learning Outcomes, Light

INTRODUCTION

Learning is a process of building curiosity in students (Zakirman, Lufri, Khairani, & Rahayu, 2020). Learning activities are a process of transferring knowledge from teachers to students. Material transfer can not be separated from how students are active in the learning process (Ulhusna, Diana Putri, & Zakirman, 2019). Most teachers experience various problems that are often encountered in learning activities. Cooperation between teachers and students is needed (Ulhusna, Putri, & Zakirman, 2020). The problem that often arises is students' lack of interest and motivation to learn, affecting understanding of concepts and student learning outcomes (Putri, Ulhusna, & Zakirman, 2020). The lack of interest and motivation of students to know can be assessed from the aspect of knowledge transfer that has been carried out by teachers, such as the use of aids in learning activities in the form of media. Media used will change the perspective and point of view of learning, changing how a person learns, processes, and obtains information (Saputra, Gürbüz, & Haryani, 2021).

Learning media are everything that is used to channel messages in the form of learning materials to stimulate students' attention, interest, and thoughts to learn (Santyasa, 2007). Media is used to channel messages and promote the learning process in students; media can also be said as teaching aids or teaching aids (Aqib, 2014). Several media types can be used in learning activities, namely print media such as pictures or charts and electronic media (Farrokhnia, Meulenbroeks, & van Joolingen, 2020), such as animations that can be made using Macromedia Flash software. In choosing the learning media to be used, the teacher also needs to examine several aspects, including the availability of facilities and infrastructure, the teacher's skills in using the media, and the material characteristics to be taught in the learning process. If several aspects of media selection have been considered/appropriate use of media, students' interest, motivation, and learning outcomes can increase. In addition to the three things above that need to be considered, a media must also meet several general principles of a learning media, namely: visible/easy to see, interesting/attractive, simple/simple, helpful/beneficial for students, accurate/on target, legitimate/reasonable. And they are structured / well structured.

There are many benefits that students get by using media in learning activities. The benefits of using learning media include: the media can instill correct, concrete, and realistic basic concepts, and the press can arouse students' interest and motivation to learn (Pavlin, Glažar, Slapničar, & Devetak, 2019). With an increase in interest and motivation to learn, of course, this will affect student learning outcomes (Çakıroğlu, Aydın, Özkan, Turan, & Cihan, 2021). For this reason, in every learning activity, every teacher needs to consider the use of learning media (Bachtiar, Meulenbroeks, & van Joolingen, 2021). Interest in learning in the last few years has decreased, especially in mathematics and Science (McGee, 2018). Inevitably, subjects ranging from elementary school to high school level are reasonably feared and tend to show a significant decline in grades. There are many things behind the decrease in the quality of learning, such as the lack of precise learning design, teaching materials, or the selection of learning support media.

Animation is one part of digital-based learning media (May-Can, Ah-Coo, & Peter C, 2018). In education, digital media allows students to reflect on their practice (Reyna, 2021). Animation also plays a role in increasing learning motivation and providing positive feedback. The use of animation in learning will create interactive learning conditions and strengthen exposure to material content (Brasier, Melville, Hershock, & Rule, 2019). The use of animation in learning activities can motivate students and make it easier for teachers to explain abstract material (Zakirman & Hidayati, 2017). In learning, teachers should pay attention to students' learning needs, such as media, by the level of cognitive development of children (Ulhusna et al., 2020). Digital-based media has recently become a serious concern and has significantly contributed to increasing student learning independence (Şılbır et al., 2020). Previous research has suggested that the use of animation can have a positive impact on science learning (Yaseen, 2018). Students can follow the presentation of the material independently and understand the rhythm of learning according to the speed and absorption of each student (Feille, Stewart,

Nettles, & Weinburgh, 2021). The development of science, information technology, and communication significantly changes the result of the learning process (Saputra et al., 2021).

The concept of science learning is part of an effort to understand nature with the method of observing the target, with structured procedures and explained by scientific reasoning in concluding (Kartikasari, Roemintoyo, & Yamtinah, 2014; Stevi & Haryanto, 2020). Therefore, it is essential to understand science material supported by suitable media such as animation media. The use of animation media is usually used in abstract material, one of which is material about light in science learning. Students can easily understand the properties of light if the teacher uses audiovisual learning media in the form of animation.

Previous research conducted by Some, Arbie, and Payu in 2013 stated that the average increase in student interest in learning progress scores in classes that used Macromedia flash-based animation learning media was 16.23% higher when compared to types whose learning did not use Macromedia-based animation teaching media Flash (Some, Arbie, & Payu, 2013). In addition, research conducted by Kusuwati in 2015 showed that fifth-grade students at SDN Mangkujayan II Ponorogo gave a positive response to the use of Macromedia flash-based learning media (Kusumawati, 2015). Hayati in 2018 also conducted related research and obtained the results that by using flash animation media the percentage of student mastery increased from 61% to 95% and increased student activity from 83% to 92% (Hayati, 2018). However, learning science at SDN 12 Nan Sabaris still has problems. The fact found in learning activities in class V SDN 12 Nan Sabaris is the lack of learning media. Students' interest and motivation are still low to participate in the learning process. Learning media is only limited to print media in learning activities.

The limited expertise of teachers causes the lack of variety in the use of learning media in compiling and operating several types of media, such as electronic media (Burn, 2016). A study that has been conducted in America states that humans can store verbal messages (written) 20%, audio-only 10%, and audiovisual 50%. If the media used is only said, this only optimizes 20% of students' ability to save. If you use media such as audiovisual, of course, it will optimize the student's ability to commit to 50%. In addition, as the holder of control in learning and facilitating students to achieve learning objectives, the teacher must be active and innovative in designing learning designs (Paulsen, Erin, Paulsen, & Andrews, 2021). Not all learning materials are suitable to be taught using verbal learning media such as print media. Some fabrics require teachers to use electronic media such as animation. The limitations of media in the classroom are thought to be one of the causes of the low quality of learning (Maya & Saragih, 2021).

Concerning the description above, the researchers are interested in using animation media for science subjects with the material properties of light in class V SDN 12 Nan Sabaris. The purpose of this study was to analyze the differences in student learning outcomes before using e-animation learning media with student learning outcomes after using e-animation media in science learning in elementary schools.

METHOD

This type of research is quasi-experimental. Quasi-experimental research designs, as the name suggests, use nonexperimental (or non-researcher-induced) variation in the main independent variable of interest, essentially mimicking experimental conditions in which some subjects are exposed to treatment and others are not on a random basis (Gopalan, Rosinger, & Ahn, 2020). The treatment used in this research is the use of e-animation media developed with Macromedia flash.

The population of this study was all students of SDN 12 Nan Sabaris. The sampling technique used is purposive sampling. The samples taken in the study were fifth-grade students at SDN 12 Nan Sabaris. Experimental research is carried out by comparing the before and after conditions. The research procedures carried out were: identifying problems by observing the class to be studied, collecting data on students' initial scores (before treatment), conducting treatment (learning using animated media), conducting tests after treatment, analyzing data, and drawing conclusions.

The data collection instrument in this research activity is an objective test. To test the hypothesis, the method of analysis used was the t-test. Before analyzing the data using the t-test, the prerequisite tests were first performed, namely the normality and homogeneity tests. Normality test can be performed using the Kolmogorov-Smirnov test. A homogeneity test can be done using C_Count. If the C_Count value has been obtained, compare the Count with the Cable price. If Count < Cable, the two data groups have homogeneous variance (Irianto, 2014).

RESULT AND DISCUSSION

Treatment is done by using Macromedia Flash-based animation media. This animation contains material about the properties of light. At the elementary school level, the material properties of light include a light that can penetrate clear objects, light can be reflected, light can be refracted, light can be decomposed, and light travels in a straight line. Light is energy in the form of electromagnetic waves. Elementary students still have difficulty understanding abstract concepts so they need media. This description of the properties of light can be demonstrated through Flash animation. An example of a Flash animation display for reflected light properties is shown in Figure 1 below.
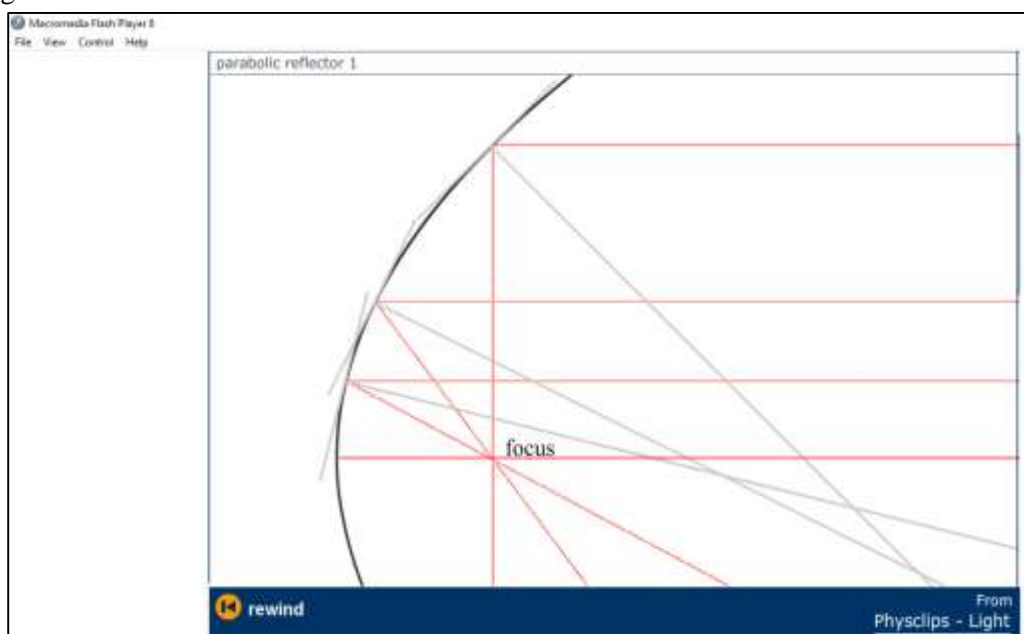

Figure 1. One of the Content Snippets of Animation Media Material

The results were obtained by comparing the students' initial scores before using animation media with students' after using animation media. Initial grades are obtained by collecting student score data before learning activities using Macromedia flash-based media. After being given treatment, data on student scores (learning to use Macromedia flash-based media) was obtained by providing objective tests to all fifth-graders at SDN 12 Nan Sabaris.

Based on student score data before being given treatment, the lowest score was 40, and the highest score was 75. The average value obtained for the initial score was 61.33. The lowest score received for the test after treatment was 60, and the highest was 90. The average score for the final test was 76.33. The following is a comparison of student learning outcomes before using animation media with student learning outcomes after using animation media:

Table 1
Comparison of Learning Outcomes Before and After Treatment

Indicator	Before	After
Lowest Value	40	60

Highest Value	75	90
Average	61,33	76,33

Based on the average value of the initial data with the final test, it can be seen that there is an increase in the average score of students after using animation media. To determine a significant increase in the student's average score, we used a t-test. It is a comparison of values between t_count and t_table.

Tabel 2
Summary t-test result

Variabel	X1	X2
Sumary	1855	2290
Average	61,83	76,33
Varians	119,1	50,48
Deviation Standard	10,91	7,11

The calculated t_value obtained is 6.91 and the t_table obtained is 2.04. This means the value obtained from the t count > t table.

The value of the t count > t table shows that there is a significant difference between learning outcomes before using animation media and after animation media. This means that there is a significant influence on learning outcomes after using animation media.

At this time, technology is growing in a short period and takes place very quickly. All life activities are influenced by technology, ranging from communication, education, and others (Hanif, 2020; Salim & Tiawa, 2015). The use of technology should be able to simplify and lighten human work. Technology also acts as a medium to help deliver messages, such as conveying information from teachers to students. The use of technology in learning is not obsolete, a renewable issue that continues to grow, and its effectiveness continues to be researched.

The concept of animation-based learning that is carried is part of the learning concept that is designed and adapted to the direction of 21st-century education (Musa, Ziatdinov, Sozcu, & Griffiths, 2015; Reyna, 2021). Digitization in learning is one way to realize the implementation of technology that contributes significantly to learning in the classroom. The presence of digital technology in learning implies that the digital generation is growing and prepares them to become a generation that excels in digital literacy (Jeong & Kim, 2017; Şılbır et al., 2020). Changes and advances in science and technology provide new hope for the world of education (Ciğerci, 2020; Dikmenli, Danabaş, Çelİk, & Tekİn, 2018). This can be reflected in the increasing quality of education and teaching in schools. Technology is suitable for application to various fields, one of which is teaching at the elementary school level(Chutataweesawas, Tanchareon, & Wilang, 2018; Hapsari, Hanif, & Roemintoyo, 2019).

Animation is one of the latest technological media that is ready to make various positive contributions to learning programs. Based on the research results, the use of animation media is proven to be effective in increasing students' understanding, especially in science learning. It can be seen that the value of the t count > t table (6.91 > 2.04) shows that there is a significant difference between learning outcomes before using animation media and after animation media. This means that there is a significant influence on learning outcomes after using animation media. The difference in learning outcomes between before and after using animated learning media is caused by differences in students' interest and motivation to learn. This result was in line with another previous research. Research conducted by Some, Arbie, and Payu in 2013 showed that teaching media, especially Macromedia flash, can increase students' interest in learning (Some et al., 2013). Abrulrahaman et al., in 2020 also conducted research about the implemented technologies such as 3D modeling and printing; Macromediaflash version 8.0 and augmented reality (AR) software respectively. It is worthy of note that all the above-mentioned multimedia tools were applicable in both the teaching and learning processes (Abdulrahaman et al., 2020). Moreover, Barak and Dori in 2011 found that the use of animated movies enhanced students

thinking skills, in terms of science understanding, knowledge implementation, and reasoning ability. Because reasoning ability is necessary for the generation of logical relationships, students that experienced the use of animated movies held fewer misconceptions than their control group peers. Their study also indicated that students who studied science with the use of animated movies developed the higher motivation to learn science, in terms of self-efficacy, interest and enjoyment, connection to daily leaving, and importance to the students' future, compared to students who studied science in a traditional way (Barak, Ashkar, & Dori, 2011).

This increase in learning interest can be observed in student behavior during learning activities (Serafín, 2020). When learning activities take place using animated media, many students are so enthusiastic about learning (Carrier, Scott, & Hall, 2012; Samudra, Flynn, & Wong, 2019). This can be seen from the students' questions during the learning activities. In addition, the increase in student interest in learning can be seen from the focus of these students in education. When animation media is used, most students pay close attention to the screen, and the class condition becomes calm (Fuchsova & Korenova, 2019; Ponza, Jampel, & Sudarma, 2018). The presentation of exciting animation media causes this increase in student interest in learning, and it does not make students bored and bored during learning activities. One of the crucial principles in making media is exciting or interesting points for students.

When viewed from the form of presentation of animated media, the media can already meet the attractive criteria because the media uses several colors that eliminate the impression of monotony (May-Can et al., 2018; Sukiyasa & Sukoco, 2013). In addition, this media is also equipped with moving images such as the animation of the path of light and the nature of light so that students will easily remember patterns, shapes, illustrations, and concrete evidence of the properties of light. Along with the increasing interest and motivation of students to learn will have an impact on the level of understanding and student learning outcomes. With e-animation, teachers have presented different learning experiences to students, thus engendering pleasant effects, outlining complex ideas in a more straightforward form so that they are easy to understand (Maya & Saragih, 2021).

Implementing animation in learning has many positive things because animation is an efficient way to convey the material. Animation allows for visualization of processes that may not be captured through other learning media (Upson-Taboas, Montoya, & Dean O'Loughlin, 2019). In the field of Education and teaching, animation has contributed to improving students' perception and understanding (Ploetzner, Berney, & Bétrancourt, 2021). Factors such as the description above can cause high learning outcomes for students whose learning activities use e-animation media compared to students who study without animated media. In the future, it is hoped that learning innovations will continue to be carried out using learning animations on other materials and at different grade levels.

CONCLUSION

E-animation has improved students' learning outcomes of class V SDN 12 Nan Sabaris, especially light-matter. In Science learning, many materials are abstract, so it needs visualization in the form of audiovisual media such as e-animation. The use of e-animation can make learning livelier and activate students in learning activities. Animation is proven to generate interest in learning and encourage student involvement in the learning process. The use of animation has a positive impact on student learning outcomes.

REFERENCES

Abdulrahaman, M. D., Faruk, N., Oloyede, A. A., Surajudeen-bakinde, N. T., Olawoyin, L. A., Imam-Fulani, Y., Azeez, A. (2020). Multimedia Tools in The Teaching and Learning Processes : A Systematic Review. *Heliyon*, *6*(June), e05312. https://doi.org/10.1016/j.heliyon.2020.e05312

Aqib, Z. (2014). *Model-model Media dan Strategi Pembelajaran Kontekstual (Inovatif)*. Bandung: Yrama Widya.

Bachtiar, R. W., Meulenbroeks, R. F. G., & van Joolingen, W. R. (2021). Stimulating Mechanistic Reasoning

in Physics Using Student-Constructed Stop-Motion Animations. *Journal of Science Education and Technology*, *30*(6), 777–790.

Barak, M., Ashkar, T., & Dori, Y. J. (2011). Learning Science via Animated Movies: Its Effect on Students' Thinking and Motivation. *Elsevier Science : Computers & Education*, *56*(3), 839–846. Retrieved from https://doi.org/10.1016/j.compedu.2010.10.025

Brasier, D. J., Melville, M., Hershock, C., & Rule, G. (2019). Pairing practice and feedback with animations optimizes student learning in online module. *Journal of Computer Assisted Learning*, *35*(6), 782–793. Retrieved from https://doi.org/10.1111/jcal.12388

Burn, A. (2016). Making machinima: animation, games, and multimodal participation in the media arts. *Learning, Media and Technology*, *41*(2), 310–329. Retrieved from https://doi.org/10.1080/17439884.2015.1107096

Çakıroğlu, Ü., Aydın, M., Özkan, A., Turan, Ş., & Cihan, A. (2021). Perceived learning in virtual reality and animation-based learning environments: A case of the understanding our body topic. *Education and Information Technologies*, *26*(5), 5109–5126. Retrieved from https://doi.org/10.1007/s10639-021-10522-2

Carrier, S. J., Scott, C. M., & Hall, D. T. (2012). Soundsational Science. *Science Activities: Classroom Projects and Curriculum Ideas*, *49*(1), 1–6. Retrieved from https://doi.org/10.1080/00368121.2011.566643

Chutataweesawas, S., Tanchareon, S., & Wilang, J. D. (2018). Producing Educational Learning Media Resources for Karen Children. *The 6th International and 2nd National Conference on Learning Innovation in Science and Technology*.

Ciğerci, F. M. (2020). Primary School Teacher Candidates and 21st Century Skills. *International Journal of Progressive Education*, *16*(2), 157–174. Retrieved from https://doi.org/10.29329/ijpe.2020.241.11

Dikmenli, Y., Danabaş, F., Çelİk, B. B., & TekİN, Ö. (2018). Effects of Animation Film Use on Earthquake Knowledge Level of 4th Grade Students. *Participatory Educational Research (PER)*, *5*(1), 86–95. Retrieved from http://eoi.citefactor.org/10.11203/per.18.7.5.1

Farrokhnia, M., Meulenbroeks, R. F. G., & van Joolingen, W. R. (2020). Student-Generated Stop-Motion Animation in Science Classes: a Systematic Literature Review. *Journal of Science Education and Technology*, *29*(6), 797–812. Retrieved from https://doi.org/10.1007/s10956-020-09857-1

Feille, K., Stewart, M., Nettles, J., & Weinburgh, M. (2021). Like the Kids Do : Engineering Design in Middle-School Science Teacher Professional Development. *Electronic Journal For Research in Science & Mathematics Education*, *25*(1), 5–19.

Fuchsova, M., & Korenova, L. (2019). Visualisation in basic science and engineering education of future primary school teachers in human biology education using augmented reality. *European Journal of Contemporary Education*, *8*(1), 92–102. Retrieved from https://doi.org/10.13187/ejced.2019.1.92

Gopalan, M., Rosinger, K., & Ahn, J. Bin. (2020). Use of Quasi-Experimental Research Designs in Education Research: Growth, Promise, and Challenges. *Review of Research in Education*, *44*, 218–243. https://doi.org/10.3102/0091732X20903302

Hanif, M. (2020). The development and effectiveness of motion graphic animation videos to improve primary school students' sciences learning outcomes. *International Journal of Instruction*, *13*(4), 247–266. Retrieved from https://doi.org/10.29333/iji.2020.13416a

Hapsari, A. S., Hanif, M., & Roemintoyo, G. (2019). Motion graphic animation videos to improve the learning outcomes of elementary school students. *European Journal of Educational Research*, *8*(4), 1245–1255. Retrieved from https://doi.org/10.12973/eu-jer.8.4.1245

Hayati, I. M. (2018). Pemanfaatan Media Animasi Flash Untuk Meningkatkan Hasil Belajar Siswa Kelas V Mata Pelajaran IPA di SDN Lebo Sidoarjo. *Elementary School*, *5*(1), 57–65.

Jeong, H. I., & Kim, Y. (2017). The acceptance of computer technology by teachers in early childhood education. *Inteactive Learning Environment*, *25*(4). Retrieved from https://doi.org/10.1080/10494820.2016.1143376

Kartikasari, A., Roemintoyo, R., & Yamtinah, S. (2014). The Effectiveness of Science Textbook Based on Science Technology Society for Elementary School Level. *International Journal of Evaluation and Research in Education (IJERE)*, *7*(2), 127–131. Retrieved from https://doi.org/10.11591/ijere.v7i2.13022

Kusumawati, N. (2015). Pengembangan Media Pembelajaran IPA Dengan Animasi Macromedia Flash Berbasis Model Pengajaran Langsung (Direct Instruction) di Sekolah Dasar. *Premiere Educandum*, *5*(2), 263–271.

May-Can, Y., Ah-Coo, K., & Peter C, W. (2018). Online Video for Self-Directed Learning in Digital Animation. *The Turkish Online Journal of Educational Technology*, *17*(3), 91–103.

Maya, Y., & Saragih, E. (2021). The Utilization of Animation in the Theory of Procedure Text Writing for Vi-Grade SD Methodist-2 Medan Students. *Advances in Language and Literary Studies*, *12*(2), 70–75. Retrieved from https://doi.org/10.7575/aiac.alls.v.12n.2.p.70

McGee, C. (2018). Artful Teaching and Science Investigations: A Perfect Match. *Gifted Child Today*, *41*(1). Retrieved from https://doi.org/10.1177/1076217517735861

Musa, S., Ziatdinov, R., Sozcu, O. F., & Griffiths, C. (2015). Developing Educational Computer Animation Based on Human Personality Types. *European Journal of Contemporary Education*, *11*(1), 52–71. Retrieved from https://doi.org/10.13187/ejced.2015.11.52

Paulsen, C. A., Erin, C., Paulsen, O., & Andrews, J. R. (2021). Engaging Children and Families in Active, Environmental Science Learning through Digital Media. *International Journal of Early Childhood Environmental Education*, *8*(2), 43–58.

Pavlin, J., Glažar, S. A., Slapničar, M., & Devetak, I. (2019).). The impact of students' educational background, interest in learning, formal reasoning and visualisation abilities on gas context-based exercises achievements with submicro-animations. *Chemistry Education Research and Practice*, *20*(3), 633–649. Retrieved from https://doi.org/10.1039/c8rp00189h

Ploetzner, R., Berney, S., & Bétrancourt, M. (2021). When learning from animations is more successful than learning from static pictures: learning the specifics of change. *Instructional Science*, *49*(4), 497–514. Retrieved from https://doi.org/10.1007/s11251-021-09541-w

Ponza, P. J. R., Jampel, I. N., & Sudarma, I. K. (2018). Pengembangan Media Video Animasi Pada Pembelajaran Siswa Kelas IV di Sekolah Dasar. *Jurnal EDUTECH Universitas Pendidikan Ganesha*, *6*(1), 9–19. Retrieved from http://dx.doi.org/10.23887/jeu.v6i1.20257

Putri, S. D., Ulhusna, M., & Zakirman, zakirman. (2020). Implementation of LKPD based on problems assisted by edmodo application to improve student learning motivation in class V students of SDN 19 Nan Sabaris. *Journal of Physics: Conference Series*, *1481*. https://doi.org/10.1088/1742-6596/1481/1/012088

Reyna, J. (2021). Digital media assignments in undergraduate science education: An evidence-based approach. Research in Learning Technology. *Research in Learning Technology*, *29*(1063519), 1–19. Retrieved from https://doi.org/10.25304/rlt.v29.2573

Salim, K., & Tiawa, D. H. (2015). The Student's Perceptions of Learning Mathematics Using Flash Animation Secondary School in Indonesia. *Journal of Education and Practice*, *6*(34), 76–80.

Samudra, P. G., Flynn, R. M., & Wong, K. M. (2019). Coviewing Educational Media: Does Coviewing Help Low-Income Preschoolers Learn Auditory and Audiovisual Vocabulary Associations? *AERA Open*, *5*(2). Retrieved from https://doi.org/10.1177/2332858419853238

Santyasa, I. (2007). *Landasan Konseptual Media Pembelajaran*. Jakarta: Prestasi Pustaka.

Saputra, D., Gürbüz, B., & Haryani, H. (2021). Android-based Animation for Chemical Elements and Experiments as an Interactive Learning Media. *Journal of Science Learning*, *4*(2), 185–191. Retrieved

from https://doi.org/10.17509/jsl.v4i2.28787

Serafín, Č. (2020). Illustrative Electrical Engineering in the Primary School Curriculum. *International Journal of Curriculum and Instruction*, *12*(Special Issue), 129–143. Retrieved from https://doi.org/10.5507/pdf.18.24454566

Şılbır, L., Coşar, A. M., Kartal, Y., Altun, T., Atasoy, M., & Özçamkan-Ayaz, G. (2020). Graphic symbol based interactive animation development process for deaf or hard of hearing students. *International Electronic Journal of Elementary Education*, *12*(4), 371–382. Retrieved from https://doi.org/10.26822/iejee.2020459466

Some, I. M., Arbie, A., & Payu, C. S. (2013). Pengaruh Penggunaan Macromedia Flash Terhadap Minat Belajar Siswa pada Mata Pelajaran Fisika. *Jurnal Pendidikan: FMIPA Universitas Negeri Gorontalo*.

Stevi, S., & Haryanto, H. (2020). Need Analysis of Audio-Visual Media Development to Teach Digestive System for Elementary School. *Journal of Educational Technology and Online Learning*, *4*(1), 22–29. Retrieved from https://doi.org/10.31681/jetol.672104

Sukiyasa, K., & Sukoco, S. (2013). Pengaruh media animasi terhadap hasil belajar dan motivasi belajar siswa materi sistem kelistrikan otomotif. *Jurnal Pendidikan Vokasi*, *3*(1), 126–137. Retrieved from https://doi.org/10.21831/jpv.v3i1.1588

Ulhusna, M., Diana Putri, S., & Zakirman. (2019). Validity of integrated calculus module two stay two stray learning model for use in communities independent learning groups. *IOP Conference Series: Earth and Environmental Science*, *314*(1). Retrieved from https://doi.org/10.1088/1755-1315/314/1/012061

Ulhusna, M., Putri, S. D., & Zakirman, Z. (2020). Permainan Ludo untuk Meningkatkan Keterampilan Kolaborasi Siswa dalam Pembelajaran Matematika. *International Journal of Elementary Education*, *4*(2), 130–137. Retrieved from https://doi.org/10.23887/ijee.v4i2.23050

Upson-Taboas, C. F., Montoya, R., & Dean O'Loughlin, V. (2019). Impact of cardiovascular embryology animations on short-term learning. *Advances in Physiology Education*, *43*(1), 55–65. Retrieved from https://doi.org/10.1152/advan.00121.2018

Yaseen, Z. (2018). Using student-generated animations: The challenge of dynamic chemical models in states of matter and the invisibility of the particles. *Chemistry Education Research and Practice*, *19*(4), 1166–1185. Retrieved from https://doi.org/10.1039/c8rp00136g

Zakirman, Z., & Hidayati, H. (2017). Praktikalitas Media Video dan Animasi Dalam Pembelajaran Fisika di SMP. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, *06*(April), 85–93. https://doi.org/10.24042/jpifalbiruni.v6i1.592

Zakirman, Z., Lufri, L., Khairani, K., & Rahayu, C. (2020). The effect of using play-think-pair-share (PTPS) model to improve student learning outcomes in magnet topic for elementary school. *The 2nd International Conference on Research and Learning of Physics*. https://doi.org/10.1088/1742-6596/1481/1/012078