Development of Articulate Storyline-Based Media for Momentum and Impulse Material in Grade X Senior High Schools, Indonesia

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Abstract

This study aims to develop an android application-based learning media that is literacy-oriented on Momentum and Impulse material and can be run on most devices owned by students. The creation goes through several stages in its formation. Through an application on a computer or laptop called Articulate Storyline, it is developed in such a way as to become a learning media that can be used in everyday learning. With the development model used is the ADDIE model. This model was chosen because it has research steps that are systematically arranged. The steps of the ADDIE research and development procedure consist of five stages, namely Analyze, Design, Develop, Implementation and Evaluation. Which is intended for teachers and students of State High School (SMAN) 2 Pare and State Islamic High School (MAN) Paser with supporting data for material and media validation tests. The results of the study produced 91% for the media validation test and 83% for the results of the material validation test and it can be said that the learning media is very suitable for use. While the test results for teachers and students at MAN Paser and also SMAN 2 Pare each showed 90% and 94% for teachers and 90% and 89% for students.

Keywords: Momentum and Impulse, Media Development, Articulate Storyline, Class X.

INTRODUCTION

The ability to understand physics is the most important thing that students must have to achieve maximum learning success. However, until now students are less interested in physics lessons because they are considered difficult [1]. According to Bouchée et al. [2], physics lessons that include concepts, applications, and calculations and analysis make students feel that physics lessons are not easy to understand. Students are generally lazy and less interested in following lessons or completing assignments, so that students' ability to understand physics material in physics learning is still lacking. Mastery of physics concepts requires students' competence in connecting one physics concept with another physics concept, for example in the material of impulse and momentum [3]. The substance of impulse and impulse is one of the most important physics lessons. When studying this material, students often make mistakes in answering questions. Understanding the concepts that students have mastered in order to be able to correctly explain questions related to the material of impulse and momentum [4]. Previous research results showed that 30% of students were confused with the concept of momentum, 24% were confused with the concept of momentum and 68% of students did not know the vector properties of momentum [5]. Similar research was also conducted on 500 high school students in England, it was also concluded that momentum is a scalar quantity [6].

Based on the results of interviews with teachers at SMAN 2 Pare, it shows that the process of learning and teaching physics in the classroom is not optimal, as evidenced by the low grades of students at SMAN 2 Pare. According to physics teachers, this is because students' thinking patterns are not well-developed, resulting in less logical thinking and a lack of skill in analyzing problems given by teachers at SMAN 2 Pare. Especially in the material on momentum and impulse, many students have difficulty understanding what the teacher is saying, which is that momentum and impulse are knowledge that students should understand to move on to the next chapter. According to the results of the interview, many students already have smartphones but have not used them optimally and the learning media used are still in the form of student worksheets (LKS) and module books.

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Learning media is a communication technology that can be used for learning purposes. In addition, supporting media has many advantages such as B. supporting teachers in delivering their teaching materials. Supporting media is also seen as a means of communication, bridging abstract ideas and the real world [7]. The learning process of educational units must be interactive, inspiring, entertaining, challenging, encouraging students to participate actively and providing sufficient space for initiative, creativity, and independence according to the abilities, interests, and physical and psychological development of students. [8]. Therefore, learning media must be interactive so that students can interact and use it directly [9]. With the help of interactive multimedia, subjects feel real because they are presented clearly, can stimulate different feelings to interact, visualizations in the form of text, images, sound, video and animation are more impressive and captured by students [10]. The results of media analysis in previous studies showed several weaknesses, including (1) the learning environment is classical or suitable for one class. (2) Only Power Point media is used as an information carrier. (3) Learning media only includes writing and images. (4) The learning environment used by teachers does not apply to students. Although the learning environment is used in learning, teachers cannot create it to improve student learning achievement and enthusiasm for receiving learning materials [11]. Considering that current learning has experienced significant developments over time, it is necessary to develop a learning environment that does not make students bored. One of them is the use of an interactive learning environment based on articulate storyline [12].

Therefore, the development of physics learning media on momentum and impulse material using *Articulate Storyline* is an essential effort aimed at producing valid and practical learning media. The objective of this study is to create effective and accessible educational tools that can enhance the teaching and learning process, particularly in the context of physics education for Grade X students.

LITERATURE REVIEW

Instructional Media

The learning media used can be Multimedia. According to Suchyadi et al. [13], multimedia learning is learning that uses computers to create and combine text, graphics, sound, moving images (video and animation) that allow users to navigate and interact. , to create, and communicate. Thomas [14] note that the classification of media used for learning consists of the following: 1) print media; 2) presentation; 3) phonogram; 4) moving image/film media; 5) Multimedia. Multimedia is a product of the development of digital technology. This resource is able to offer its users a multifaceted learning experience [15]. Interactive multimedia can be used to present abstract things to students so that they engage attention and interest through learning multimedia without weakening the overall learning function.

Articulate Storyline

Articulate Storyline is a tool that can be used to create presentations. Similar to Microsoft Power Point, Articulate Storyline offers several advantages that show richer and more creative presentations. This software also has features such as timelines, movies, images, characters and other easy-to-use features. Articulate narrative characters and other easy-to-use characters. Articulate Storyline is a multimedia authoring tool that can be used to create interactive learning tools whose contents are a combination of text, images, graphics, sound, animation and video. The results of Articulate Storylines are web-based (html5) or as application files that can be used on various devices such as laptops, tablets, smartphones, and cellphones [16]. Previous studies found that students who used Articulate Storyline 2 had an average score above 75 [17].

Momentum and Impulse

As a teaching aid in the learning process, the use of the learning environment, especially momentum and impulse materials, is often only related to power points or LKS which often make students bored with such learning models. Hasanah [18], the use of mass media in learning is still not very varied. During one semester, teachers only use teaching aids as learning media two or three times. Teachers often rely on PowerPoint slides that primarily display images and text. Such media can appear monotonous, lack interactivity, remain static, and are not always optimally utilized to explain physics concepts effectively in the classroom. This kind of learning process tends to be less engaging, leading to suboptimal student comprehension and weak mastery of concepts. Therefore, it is crucial to develop innovative learning media that address these issues by enhancing student engagement and improving conceptual understanding.

METHOD

The development model used is research and development (Research and Development) which refers to the ADDIE research and development model. The selection of this model is because it is specifically in media development research [19]. This model can be called a procedural model because it has systematic steps. The steps of the ADDIE research and development procedure consist of five stages, namely Analyze, Design, Develop, Implementation and Evaluation. The use of the ADDIE development model has the advantage that at each stage an evaluation is carried out in order to improve each stage of the development steps. Evaluation is intended to strengthen and improve product quality.

The steps for developing ADDIE are as follows: (a) analyze is continued with the evaluation stage, (b) design is continued with the evaluation stage, (c) development is continued with the evaluation stage, and (d) implementation is continued with the evaluation stage. The Analyze stage is carried out by interviewing teachers at SMAN 2 Pare which aims to obtain data on learning difficulties experienced by students in physics subjects. After being reviewed further and knowing the learning difficulties experienced by students, the interview process is continued to find out which chapters are difficult for students to understand during the learning process. It can be concluded that a chapter is difficult to understand.

Design stage after knowing the most difficult material in physics learning due to lack of student interest due to monotonous learning media. The design stage is continued by designing learning media and looking for some ideas that can be used to create learning media that can attract students by combining several types of learning media models such as audio, video, animation to attract students' interest in learning media in chapters that are difficult to understand. The Development stage of preparing learning media for the most difficult material by consulting with the supervising lecturer to obtain learning media that is considered very feasible to be applied during physics learning, especially for materials that are difficult to understand because the learning media is boring. As well as expert lecturers in the material and media who provide additional evaluations and suggestions to achieve maximum learning media to be applied.

The Implementation stage is the stage of application or delivery to students and teachers to find out the results of making learning media. Has it become a very suitable learning media to be applied to the daily physics learning process? And is there any input or suggestions during the application operation process. With each stage going through an evaluation process to achieve maximum results. For limitations, only readability tests are carried out on teachers and students. The types of data in research and development are qualitative and quantitative data. Qualitative data are obtained from the results of suggestions and proposals from material and media validators, teachers (field practitioners), and students. While quantitative data are obtained from the results of validation by validators, teachers (field practitioners), and student response questionnaires.

Product testing is carried out by validators with indicators that can help the process of improving the product. Readability of a product is one of the assessments, because a product may have parts that are not readable or typos. The product is also tested on the content to find out whether the material discussed is concrete or not and also does not confuse students. The subjects selected to test the products that have been made are those who are experts in the material used and experts in making learning media. Validation subjects are carried out by lecturers who are material experts and lecturers who are media experts.

The results obtained in this study were obtained from the values given by the validator on the trial results. The values in the trial results refer to a numeric scale (4, 3, 2, 1). The data obtained must meet the variables to increase student learning motivation and conceptual understanding. Data collection was carried out using a questionnaire using a Likert and Guttman scale to test the feasibility by the validator. The readability test to teachers and students used the Likert scale in **Table 1**. While the material expert validator tested the truth of the material and the scale used was the Guttman scale.

Table 1 Likert Scale Assessment Criteria

Score	Criteria
Likert Scale	
1	Strongly disagree/very bad/very unattractive
2	Disagree/less good/less attractive
3	Agree/good/attractive
4	Strongly agree/very good/very unattractive
Guttman Scale	
1	Correct
0	Incorrect

The analysis technique of quantitative data used to analyze the feasibility test result data is the calculation of the average value. This value is used for all validation sheets from both experts and individuals. The calculation uses equation 1, with the percentage of the total assessment score (P), the number of subject scores (Σx_i), and the maximum score (Σx) [17],

$$P = \frac{\Sigma x_i}{\Sigma x} x 100\% \qquad (1)$$

After getting the percentage results of the assessment scores, the data is then analyzed based on the criteria of feasibility and practicality. These criteria are presented in **Table 2**.

Table 2 Product Feasibility and Practicality Criteria [20]

| Average score (X)	Eligibility criteria
85.01% - 100.00%	Very worthy
70.01% - 85.00%	Worthy
50.01% - 70.00%	Quite worthy
01.00% - 50.00%	Less worthy

Alam [21] stated that a learning device can be applied to learning activities if it gets a percentage result of validation and readability of more than 70%. Scores that do not meet the criteria will be revised for the component. Qualitative data is obtained from comments and suggestions from validators, by looking for deficiencies in the product results. Revisions will be made by considering criticism and suggestions from validators.

RESULT AND DISCUSSION

Media Creation Results

The development of interactive media based on articulate storylines on vibration and wave material has the potential to increase learning motivation and facilitate conceptual understanding. Because the media uses software that is similar to PowerPoint, it is easier to use. In addition, this media offers features that are not found in Powerpoint, such as button trigger features, characters, and publication of various types of output, one of which is the HTML 5 site [22]. The product resulting from this research and development is an android-based application to help students understand the concept of momentum and impulse in SMA/MA. The product is a smartphone application (.apk) named "Momentum and Impulse". The application developed on the basis of articulate storyline is one of the advantages where the size of the installation file is small and only requires a little storage memory. The size of the installation file itself is 18 MB and only requires storage memory below 24 MB when installed, here are some displays in the application.

The image used in the application icon is an illustration of a thermometer and the sun with the application icon display as in **Figure 1**.
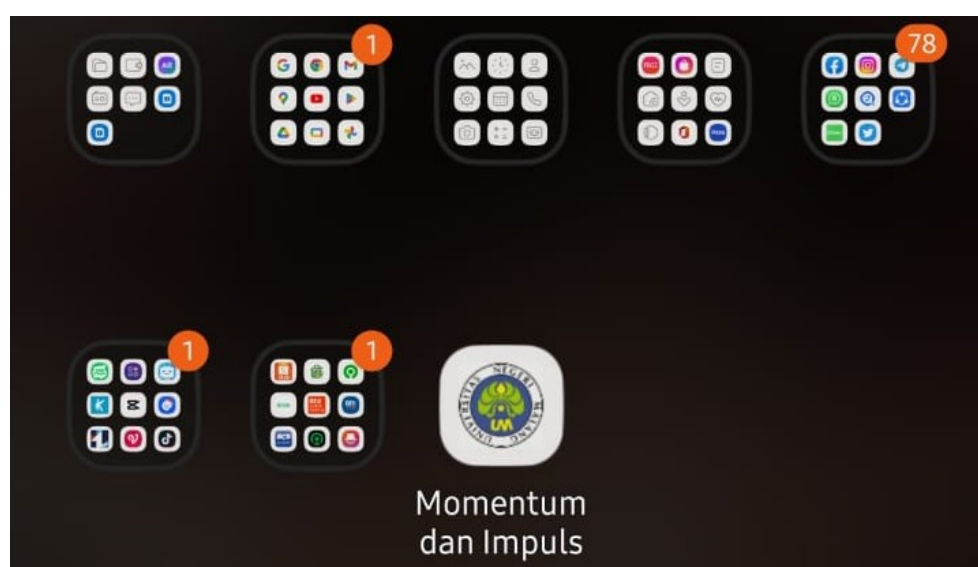
Figure 1. App icon display when installed

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Figure 2. (a) Initial display, (b) Login, (c) Menu, and (d) Content display on the Basic Competency Slide

In the application that has been planned optimally, a display of material that can be used with several points of advantage is produced, such as for the initial display of the menu which is designed in such a way as to attract the attention of students in running the application. The competency of momentum and impulse material is in accordance with the competency regulated by the curriculum. Such as the display of the choice of material consisting of several sub-chapters starting from momentum, impulse, and also the relationship between momentum and impulse. After selecting one of the sub-chapters, a display of several different stages in running the application will appear as shown in Figure 2 (a). As shown in Figure 2 after selecting one of the sub-chapters such as Figure 2 (b), a display containing several stages will appear, each stage has a different display model

When entering a sub-chapter containing the stages of work, you will only be able to fill in stage 1 first, which is an explanation of one sub-chapter with the type of matching one, two, or three words in one paragraph as in Figure 2 (c) to test users in observing the material presented. After the work in stage 1 is complete, you will immediately enter stage 2 which contains several example questions with the type of filling in numbers into the fields provided as in Figure 2 (d).

Validation Test Results

The test data collection was filled by 2 teachers, one teacher at MAN Paser and the other at SMAN 2 Pare. The test on teachers contained several aspects that were assessed, namely the use of language, application display, application operation, material presented and the benefits of the application. While the results by media and material experts showed results that could be considered feasible because they had reached the feasible criteria on the Likert and Guttman scales. The following are the results of the media and material validation test and also the test on teachers.

Table 3. Media and Material Validation Test

No	Rated aspect	Average value	Criteria
	Media		
1	Application View	86%	Very worthy
2	Application Operation	89%	Very worthy
3	Materials Presented	95%	Very worthy
4	Application Benefits	94%	Very worthy
Total average		**91%**	**Very worthy**

No	Rated aspect	Average value	Criteria
	Material Validation		
1	Use of Language	100%	Very worthy
2	Momentum and Impulse Material	67%	Worthy
Total average		**83%**	**Very worthy**

According to the assessment of media and material validation experts, the results can be said to be very feasible to be implemented in schools, the results of the media and material validation test showed 91% and 83% with suggestions or recommendations given separately. While the results of the test on teachers can be said to be very feasible to be applied to students with results of 90% for teachers at MAN Paser and results of 94% at SMAN 2 Pare.

Table 4. Readability Test by teacher

No	Rated aspect	Average value		Criteria
		MAN Paser	**SMAN 2 Pare**	
1	Language Usage	92%	83%	Very worthy
2	Application Appearance	88%	92%	Very worthy
3	Application Operation	93%	100%	Very worthy
4	Presented Materials	86%	93%	Very worthy
5	Application Benefits	91%	97%	Very worthy
Total average		**90%**	**94%**	**Very worthy**

Readability Recapitulation Test Results

Data collection was conducted online considering that the target schools are located in the Kalimantan islands, precisely in MAN Paser, East Kalimantan and in SMAN 2 Pare with 25 respondents. 15 children from MAN Paser and 10 children from SMAN 2 Pare. The following is a recapitulation of the results of the MAN Paser student reading comprehension test in Table 8 and a recapitulation of the results of the SMAN 2 Pare student reading comprehension test in **Table 5**.

Table 5. Recapitulation of MAN Paser students' readability test

No	Rated aspect	Average value		Criteria
		MAN Paser	**SMAN 2 Pare**	
1	Application view	88%	89%	Very worthy
2	Application operation	89%	90%	Very worthy
3	Material presented	90%	89%	Very worthy
4	Application benefits	92%	89%	Very worthy
	Total rata-rata	**90%**	**89%**	**Very worthy**

Overall the results of the readability test can be categorized as Practical with an average value of MAN Paser being 90% and SMAN 2 Pare being 89%. The media developed can be said to have met the category of media that has an appeal and is easy to use as an aid in the implementation of learning and teaching physics.

Discussion

The results of the study indicate that interactive media based on Articulate Storyline developed on momentum and impulse material can be categorized as a learning media that is very feasible to use. Based on the validation test by media and material experts, this application obtained an average score of 91% and 83%, while tests on teachers at MAN Paser and SMAN 2 Pare reached 90% and 94% respectively, with the category "very feasible". The results of the readability test by students also support this finding, with an average score of 90% at MAN Paser and 89% at SMAN 2 Pare. This media has been proven to be able to attract students' attention, is easy to operate, and is effective in delivering material, and meets educational curriculum standards. Critically, although this application provides excellent validation results, there are several aspects that require further attention. One of them is the validation of the material on the "Momentum and Impulse Material" component, which obtained a score of 67%, only falling into the "adequate" category. This indicates an opportunity to increase the depth or accuracy of the material presented to be more optimal. In addition, although the small file size is an advantage, further development can explore other interactive features that can enhance the student learning experience, such as virtual reality-based physics simulations.

In comparison with previous studies, such as those conducted by Alfurqan and Susanti [23], the results of this study emphasize the superiority of Articulate Storyline as an interactive media that is easy to use and has superior features such as trigger buttons and HTML5-based output. However, compared to other studies that integrate gamification features or problem-solving-based learning, this application still has room for further innovation. Research by Haupt et al. [24], for example, shows that the integration of game elements can increase student engagement more significantly.

CONCLUSION

Based on the research results, learning media based on Articulate Storyline for momentum and impulse material for class X has been successfully developed with media and material validation results of 91% and 83% respectively, indicating that this product is very feasible to use. The teacher readability test at MAN Paser and SMAN 2 Pare reached 90% and 94%, while students scored 90% and 89%. This media is Android-based with .apk format and can improve student understanding through interactive design. However, further development is recommended so that the media can support various smartphone platforms. Further research also needs to focus on effectiveness tests to measure its impact on student learning outcomes before and after the use of learning media.

REFERENCES

[1] U. N. Tsany, A. Septian, and E. Komala, 'The ability of understanding mathematical concept and self-regulated learning using macromedia flash professional 8', *J. Phys.: Conf. Ser.*, vol. 1657, no. 1, p. 012074, Oct. 2020, doi: 10.1088/1742-6596/1657/1/012074.

[2] T. Bouchée, M. Thurlings, L. de Putter - Smits, and B. Pepin, 'Investigating teachers' and students' experiences of quantum physics lessons: opportunities and challenges', *Research in Science & Technological Education*, vol. 41, no. 2, pp. 777–799, Apr. 2023, doi: 10.1080/02635143.2021.1948826.

[3] S. M. D. Alonzo and V. M. Mistades, 'Students' conceptual understanding and problem-solving of the Work-Energy and Impulse-Momentum Theorems in a flipped classroom', *J. Phys.: Conf. Ser.*, vol. 1882, no. 1, p. 012003, May 2021, doi: 10.1088/1742-6596/1882/1/012003.

[4] H. F. Rahim, M. R. A. Taqwa, A. Hidayat, and S. Sutopo, 'Students' conceptual understanding level in momentum and impulse: Based on resource theory', *AIP Conference Proceedings*, vol. 3106, no. 1, p. 060007, May 2024, doi: 10.1063/5.0215413.

[5] B. Stein, H. Stein, and I. Galili, 'The Concept of Observer in Science Teaching in Middle School: Pre-Instructional Knowledge as a Lever for Learning rather than an Obstacle', *Education Sciences*, vol. 13, no. 1, Art. no. 1, Jan. 2023, doi: 10.3390/educsci13010095.

[6] S. Sadrizadeh *et al.*, 'Indoor air quality and health in schools: A critical review for developing the roadmap for the future school environment', *Journal of Building Engineering*, vol. 57, p. 104908, Oct. 2022, doi: 10.1016/j.jobe.2022.104908.

[7] A. Wahid *et al.*, 'Augmented Reality Model in Supporting Instruction Process: A Critical Review', in *Proceedings of Ninth International Congress on Information and Communication Technology*, X.-S. Yang, S. Sherratt, N. Dey, and A. Joshi, Eds., Singapore: Springer Nature, 2024, pp. 69–83. doi: 10.1007/978-981-97-3305-7_6.

[8] D. Rahmawati, M. M. A. Utama, and I. H. Nisa, 'SAVI Learning Model is a Solution for Teachers in Active Learning', *1*, vol. 9, no. 1, pp. 60–71, Jun. 2022, doi: 10.32505/tarbawi.v9i1.4221.

[9] F. Tuma, 'The use of educational technology for interactive teaching in lectures', *Annals of Medicine and Surgery*, vol. 62, p. 231, Feb. 2021, doi: 10.1016/j.amsu.2021.01.051.

[10] T. N. Fitria, 'Augmented Reality (AR) and Virtual Reality (VR) Technology in Education: Media of Teaching and Learning: A Review', *International Journal of Computer and Information System (IJCIS)*, vol. 4, no. 1, Art. no. 1, Feb. 2023, doi: 10.29040/ijcis.v4i1.102.

[11] W. Winarto, A. Syahid, and F. Saguni, 'Effectiveness the Use of Audio Visual Media in Teaching Islamic Religious Education', *International Journal of Contemporary Islamic EDUCATION*, vol. 2, no. 1, Art. no. 1, Aug. 2020, doi: 10.24239/ijcied.Vol2.Iss1.14.

[12] F. Daryanes, D. Darmadi, K. Fikri, I. Sayuti, M. A. Rusandi, and D. D. B. Situmorang, 'The development of articulate storyline interactive learning media based on case methods to train student's problem-solving ability', *Heliyon*, vol. 9, no. 4, Apr. 2023, doi: 10.1016/j.heliyon.2023.e15082.

[13] Y. Suchyadi, N. Safitri, and O. Sunardi, 'The Use Of Multimedia As An Effort To Improve Elementary Teacher Education Study Program College Students Comprehension Ability And Creative Thinking Skills In Following Science Study Courses', *JHSS (Journal of Humanities And Social Studies)*, vol. 4, no. 2, Art. no. 2, Sep. 2020, doi: 10.33751/jhss.v4i2.2549.

[14] M. Thomas, 'Multimodality and media archaeology: Complementary optics for looking at digital stuff?', *Digital Scholarship in the Humanities*, vol. 36, no. 2, pp. 482–500, Jun. 2021, doi: 10.1093/llc/fqaa024.

[15] F. Kamalov, D. Santandreu Calonge, and I. Gurrib, 'New Era of Artificial Intelligence in Education: Towards a Sustainable Multifaceted Revolution', *Sustainability*, vol. 15, no. 16, Art. no. 16, Jan. 2023, doi: 10.3390/su151612451.

[16] U. Purwaningsih, E. A. Ismaya, and Khamdun, 'The Influence of IDOLA Media Based on Articulate Storyline 3 on Elementary School Science Learning Outcomes', *Asian Journal of Assessment in Teaching and Learning*, vol. 13, no. 1, Art. no. 1, Jun. 2023, doi: 10.37134/ajatel.vol13.1.10.2023.

[17] F. Daryanes, D. Darmadi, K. Fikri, I. Sayuti, M. A. Rusandi, and D. D. B. Situmorang, 'The development of articulate storyline interactive learning media based on case methods to train student's problem-solving ability', *Heliyon*, vol. 9, no. 4, Apr. 2023, doi: 10.1016/j.heliyon.2023.e15082.

[18] M. Hasanah, 'Analysis Of Students' Interest In Learning And Motivation Learning Physics: A Case Study At Sman 9 Banda Aceh Year 2023/2024', *International Conference on Education, Science, Technology and Health (ICONESTH)*, pp. 276–286, 2023, doi: 10.46244/iconesth.vi.104.

[19] L. Schreurs and L. Vandenbosch, 'Introducing the Social Media Literacy (SMILE) model with the case of the positivity bias on social media', *Journal of Children and Media*, vol. 15, no. 3, pp. 320–337, Jul. 2021, doi: 10.1080/17482798.2020.1809481.

[20] M. Aliman and I. K. Astina, 'Improving Environmental Awareness of High School Students' in Malang City through Earthcomm Learning in the Geography Class.', *International Journal of Instruction*, vol. 12, no. 4, pp. 79–94, 2019.

[21] T. G. M. R. Alam, 'Comparative analysis between pre-test/post-test model and post-test-only model in achieving the learning outcomes', *Pakistan Journal of Ophthalmology*, vol. 35, no. 1, 2019.

[22] N. Dzikrika* *et al.*, 'Development of Interactive Multimedia on Electron Configuration Concept', *Jurnal Pendidikan Sains Indonesia*, vol. 12, no. 2, Art. no. 2, Apr. 2024, doi: 10.24815/jpsi.v12i2.36061.

[23] A. Alfurqan and M. D. Susanti, 'Effectiveness of Visual Media Use in Islamic Religious Education Learning in Junior High School', *Attanwir : Jurnal Keislaman dan Pendidikan*, vol. 12, no. 2, Art. no. 2, Sep. 2021, doi: 10.53915/jurnalkeislamandanpendidikan.v12i2.92.

[24] M. R. Haupt, A. Jinich-Diamant, J. Li, M. Nali, and T. K. Mackey, 'Characterizing twitter user topics and communication network dynamics of the "Liberate" movement during COVID-19 using unsupervised machine learning and social network analysis', *Online Social Networks and Media*, vol. 21, p. 100114, Jan. 2021, doi: 10.1016/j.osnem.2020.100114.

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