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Augmented reality development using multimedia development life cycle (MDLC) method in learning media

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ABSTRACT

Practical classroom learning in the multimedia department requires props, where props range from damage. To address this need, learning media are made by applying Augmented Reality. Learning media presents actual images without holding and seeing the objects in real terms so that there is no damage to the props. This research was conducted to create learning media for students of SMK Negeri 1 Banyuwangi majoring in multimedia as an Android-based teaching aid. Stages of research using the development method in the form of Multimedia Model Life Cycle (MDLC). The concept stage analyzes and applies the Augmented Reality (AR) method, the design stage performs application planning according to the needs of learning media. The data collection stage conducted interviews with teachers and students while the stages of making learning media used Blender, Unity and Visual Studio software. At the trial stage of the application by making a guidebook, it was carried out for students at SMK Negeri 1 Banyuwangi. For the stages of distributing learning media using the Likert scale method through distributing questionnaires. The results of the application trials and questionnaire distribution, the responses of students about learning media, the results show the interpretation of respondents by combining a value of 72.22%, which means students accept this learning media. The results of this research can create learning media for multimedia majors that can reduce the risk of damage to props and provide cool and fun learning media.

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1. INTRODUCTION

The progress of science is very fast currently both in the world of education, industry, offices, service, and all aspects of human life. In particular, the growing development of digital technology so that all life processes cannot be separated from the digital world, such as laptops, digital TV, smart phones, and other digital equipment [1]–[5].

With the utilization of the capabilities of smart phones that are used for needs in various fields, they are developed using applications that are able to support their respective uses, including being used for educative learning media [6]–[10]. In the learning process that will be made later it will be more interesting and fun if in the learning process a method or media is applied as a tool in carrying out learning [11]–[14].

At present there are many learning media that utilize digital media such as mobile which provide updates in their presentation [15]–[17]. By utilizing mobile media to build applications using augmented reality technology as a learning medium Mobile-based Augment Reality (AR) applications have the advantage of being easy to move [18]–[22].

Augmented reality has great potential as an educational tool. One of the advantages that can be obtained from the Augment Reality (AR) application for educational purposes is to increase understanding of the object being studied. Augmented Reality (AR) is more effective as other learning media compared to other media such as books, videos, and ordinary computer use [23]–[27].

Utilization and application of the Augment Reality (AR) method is very appropriate for implementing multimedia learning media [28]. Because most of the equipment studied in the multimedia department is mostly expensive and there is a risk of damage if it is often used interchangeably. Research [29] explains that game tools are expensive, namely special features in the form of consoles for interaction including joysticks with the use of PlayStation consoles, touch screens on Android, and mice or keyboards on PCs. The NS technology used in the game makes it impossible for some people to buy it, so it can only be played by certain groups of people. Now with Android-based games included in smartphones, games can be played by all groups.

The learning method in the world of education is one of them for learning logic. In addition to reading books, there are currently new learning methods that are more interesting in three dimensions to increase understanding in learning logic gates using Augmented Reality [30], [31].

In accordance with some descriptions of the existing problems, the authors conducted research with the title "Development and Application of Augmented Reality in Learning Media for the Multimedia Department at SMK Negeri 1 Banyuwangi". To realize this research the authors used the Multimedia Development Life Cycle (MDLC) method, this method applies concepts to develop learning media, while evaluating user satisfaction with multimedia elements.

To realize learning media later, of the three methods in Augment Reality (AR), in this study researchers will use the same Marker-Based Tracking method in research [32] where Marker-Based Tracking works by detecting markers to determine location and orientation the camera, with the camera, is calibrated then the system can then display the virtual object at a predetermined place.

In research [32] also implemented Marker-Based Tracking which works by detecting markers to determine the location and orientation of the camera, with the camera calibrated then the system can then display virtual objects in a predetermined place.

Meanwhile, to measure the value of user satisfaction, this study also uses the Likert Scale method which is also applied by research [33] at the evaluate stage which contains trial steps and analysis of trial results through questionnaire analysis/questionnaire in the Likert scale distributed. From the distribution of quisoners which were distributed and processed using the Liker scale method, it produced information on user satisfaction with the applications resulting from this study [34].

2. METHOD

To realize this research so that we can complete it, we use the Multimedia Development Life Cycle (MDLC) method [35]–[37]. The stages of the MDLC method include the initial stage of concept and design, the second stage of material collection, the third stage of manufacture, the fourth stage is testing, and the last stage is distribution [38]. The flow of the Multimedia Development Life Cycle (MDLC) method can be seen in Figure 1. The initial stage that is carried out is conceptualizing, making a system analysis of learning media by seeking information on the needs of learning media. Gathering information is done through literature, interviews and field studies [39], [40]. While the stages of system design in learning media are carried out by realizing the system requirements for learning media from the analysis stages that have been carried out.

The next stage is gathering material by studying existing literature and is suitable for research development and is needed to design instructional media, in addition to conducting interviews with teachers and students to add research material. After that, the stages of making learning media were carried out using Unity software as the first step in making learning media. Then, blender software is also needed to be use

design 3-dimensional images and visual studio software to add coding so that images can be rotated 360 degrees.

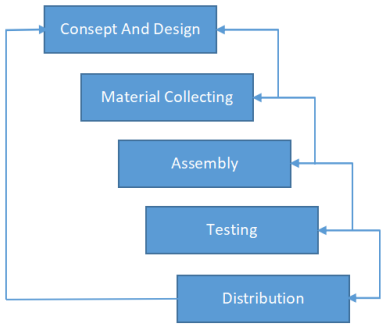

Figure 1. Multimedia development life cycle (MDLC) method

Furthermore, the next stage is to test the application to users of learning media by adding a guidebook for using learning media. The trial was carried out on students of Banyuwangi State Vocational High School 1 in grades 11 and 12. And the last stage was the distribution of learning media using the Likert scale method through distributing questionnaires. For the Likert scale method, we use by applying the formula used in research with the determination of percentages and weight values we use the Likers Scale on each question to be assessed, while the value weight table is shown at 1 and for the percentage table in Table 1.

Table 1. Value weight

Answer	Value
SS	5
S	4
N	3
TS	2
TSS	1

Table 2. Percentage value

Answer	Description
80% - 100%	SS/ Strongly (Agree, Good, Like)
60% - 79.99%	S / Agree, Good or Like
40% - 59.99%	N / Enough or Neutrall
20% - 39.99%	TS / Disagree or Not Good
0% - 19.99%	TSS / Strongly (Disagree, Bad or Very Less)

After the data is obtained from the research location and has been collected, the next step is to classify the data. Although this research is descriptive, the data obtained are of two types, namely qualitative data and quantitative data (data in the form of numbers). Therefore, in analyzing quantitative data, data analysis will be used and then described based on logic by not forgetting the results of observations from interviews (face to face) in drawing conclusions.

Meanwhile, quantitative data in the form of numbers will use statistical analysis and be calculated using the Formula (1):

$$P = \left(\frac{F}{N}\right) \times 100\% \quad (1)$$

Description:
P = Percentage (%)
F = Frequency searched
N = Number of respondents

3. RESULTS AND DISCUSSIONS

Implementation of research using the Multimedia Development Life Cycle (MDLC) method, there are six stages that are passed, namely concept, design, collection of materials, assembly, testing and distribution. The stages of concept and design in learning media are carried out as one in the process. The stages carried out in the research are as follows:

3.1. Concept and Design

For the first stage in the preparation of learning media, a system analysis was carried out on the needs of learning media by students of SMK Negeri 1 Banyuwangi by paying attention to user comfort and ease in the process of using learning media. The design presented in the learning media and carried out by students will open the application for the first time, then the system will display the main menu. From the main menu display, students select the main menu, and the system will display the camera. After the camera service appears, students point the camera at a new marker, the system will display 3D objects. the stages of using learning media are in Figure 2.

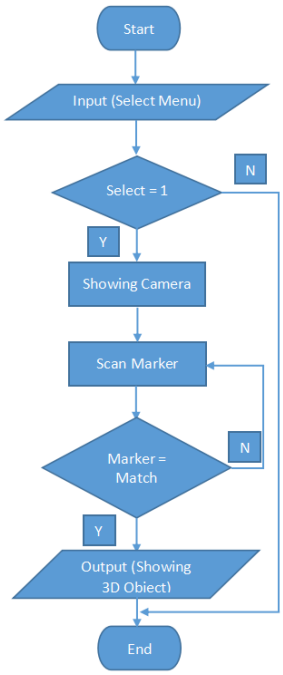

Figure 2. Learning media design flow

3.2. Material Collection

After analyzing and designing the system at the previous stage, materials are needed for making learning media. The materials needed include pictures of teaching aids from multimedia learning obtained from multimedia subjects at SMK Negeri 1 Banyuwangi. For the display needs of learning media obtained by conducting interviews with teachers and students majoring in multimedia. The next requirement is the software needed to create learning media including supporting applications namely Unity, Blender, Add-Ons Vuforia SDK and Visual Studio.

3.3. Assembly

In making this learning media, the steps that need to be carried out as a first step in making a learning media application are needed, so the first thing to do is to install a supporting application, namely Unity, then install another supporting application, namely Blender. The next stage is to make initial settings for the unity application as preparation for using the Unity application. In this step it is necessary to create a Unity account, after the account is created then log in using the account that was registered, then immediately select the "New" button to create a new project. After that, the next step is to create an account and log in to the Vuforia website https://developer.vuforia.com/downloads/sdk. After the account is created, then create a database on the new Vuforia account as the source of the images to be scanned. The final stage is uploading the target image into the vuforia database, then creating a 3D object design in the Blender application.

By following the same steps, you can add several objects that will be made last at the stage of importing the 3D object design into the Unity application. As a development from previous research, there are some that have been added, while the stage is to make the animation play by adding the coding for the animation to play in the Visual Studio application, the additional coding is in the main menu function and the control menu. Next, set the autofocus coding so that the camera in the application can adjust focus automatically. For an explanation of each part of the 3D object, it is necessary to add an explanation design to each part of the 3D object as information about the object.

This Multimedia learning media is equipped with a user manual that will be used by the user. This guidebook is made according to the material in the application. The final step after everything is ready to be

used for the manual and application, then the last step is to build the application into an APK format so that it can be installed on the Android platform.

3.4. Testing

At the implementation and trial stages there is a flow that users need to understand and do when using this multimedia learning media. The initial steps taken by application users are as follows:

1. Choose scan, the camera will appear

Selection of scan images opens the camera to scan images which will later be used as input data for the application. From the input image the application will output a visual image that can present information in 3G. With this 3G form image can provide information like the original. The display of the 3G image presentation can be seen in Figure 3.

Figure 3. 3G image display

2. Pointing the camera at the marker for the scan process

At this stage, in addition to the application users can view images visually in the form of 3G, users can also rotate 3G images in all directions or 360 degrees. The image playback is given a description of each function of the image that can provide information to the user about the details of the 3G image presented by the application. Any images that are presented are pictures of Mulimedia material including DSLR Cameras, Handycams, Tripods, Lightning Video Cameras, Greenscreens, Reflectors, Drones, and Flash. For example, the tools presented in multimedia learning media can be seen in Figure 4 and Figure 5.

Figure 4. 3G images equipped with camera data information

Figure 5. 3G images that can be played

3. Market Suitable for 3D Object

This stage includes the step of matching the input image with the information presented by the application. If the marker presented matches the input image, the appropriate application is presented and the application is complete. However, if the maker that serves is not suitable, then you can start from the beginning again.

3.5. Distribution

At this stage, after the application has been tested, the application is distributed to students at SMK Negeri 1 Banyuwangi majoring in Multimedia with the aim of evaluating learning media. To be able to evaluate, the author distributes questionnaires to users using a google form with 15 questions asked. The 15 questions include:

1. Do you know about Learning Media?
2. Have I used Multimedia Learning Media before?
3. I feel helped by Multimedia Learning Media?
4. Do you feel happy using Multimedia Learning Media?
5. Do you understand using Multimedia Learning Media?
6. Are you not confused about running this learning media?
7. Very easy to use Multimedia Learning Media?
8. Is the file size of Multimedia Learning Media large?
9. Easy and fast when using Multimedia Learning Media?
10. What learning media is used when learning Multimedia only?
11. Is the display not boring and the menu easy to use?
12. The user manual provides detailed and not boring information?
13. Learning Media Mulimedia is very helpful for students to add information visually?
14. Learning Media Can Mulimedia help students' understanding of Multimedia?
15. I agree with the existence of Multimedia Learning Media?

From these 15 questions, we gave 90 students of SMK Negeri 1 Banyuwangi grades 10, 11, and 12 majoring in multimedia to fill in the answers after they used multimedia learning media. From the data that has been entered then entered in the Likers scale Formula (2) as follows:

$$P = \left(\frac{F}{N}\right) \times 100\% \quad (2)$$

Description:
P = Percentage (%)
F = Frequency searched
N = Number of respondents

Based on the results of distributing questionnaires from 15 questions to 90 students, they are as follows:

1. Students answered strongly agree (SS) = 26
2. Students answered agree (S) = 39
3. Students answered enough (N) = 13
4. Students answered disagree (TS) = 6
5. Students answered not strongly agree (TSS) = 6

So, the calculation of the total score or the frequency sought (F)

1. Strongly Agree (26 x 5) = 130
2. Agree (39 x 4) = 156
3. Neutral (13 x 3) = 39
4. Disagree (6 x 2) = 12
5. Not Strongly Agree (6 x 1) = 6

While the highest score (strongly agree) Likerst is the highest weight multiplied by the number of respondents, namely 5 x 90 = 450. For the agree score is the total weight for agreeing multiplied by the number of respondents, namely 4 x 90 = 360. And for the lowest score (Not Strongly Agree) Likerst is the lowest weight multiplied by the number of respondents, namely 1 x 90 = 90. So, for the assessment of respondents' interpretations based on answers that agree on the feasibility of multimedia learning media based on scores who answered strongly agree and agree are as follows:

1. Score Strongly Agree

$$P = \left(\frac{F}{N}\right) \times 100\ \%$$

$$P = \left(\frac{130}{450}\right) \times 100\%$$

$$P = 28.89\%$$

2. Score Agree

$$P = \left(\frac{F}{N}\right) \times 100\ \%$$

$$P = \left(\frac{156}{360}\right) \times 100\%$$

$$P = 42.33\%$$

So, to see the percentage of respondents' interpretation assessment by connecting the values that answered strongly agree and agree was 72.22%. Thus, seeing the percentage value above 50%, it can be concluded that multimedia learning media is accepted and can be used by students of SMK Negeri 1 Banyuwangi.

4. CONCLUSION

This research activity has been carried out by differentiating it from previous studies in rotating the image by 360 degrees and accompanied by information on each display so that it can display the image. After the media was created, trials were carried out and socialization was carried out to students of SMK Negeri 1 Banyuwangi. To find out the responses from students about multimedia learning media, the questionnaire was distributed, and the results were seen using the Likers scale method. The results of the collected questionnaire data show the interpretation of the respondents by combining the value of 72.22%. With this research, it can provide learning media for multimedia majors that can be accepted by students and reduce the risk of damage to multimedia teaching aids.

REFERENCES

[1] D. E. Morkovkin, A. A. Gibadullin, V. N. Nezamaikin, and N. I. Isaichykova, "Assessment of digital equipment of higher educational institutions," in *Journal of Physics: Conference Series*, 2020, vol. 1691, no. 1, p. 12165.

[2] A. Alirezaei, H. B. Bagheri, and M. R. Kabaran Zadeh, "Explanation of Digital Equipment Model and Process Technology in Downstream Petrochemical Industrial Units," *Int. J. Digit. Content Manag.*, 2022.

[3] A. K. Nugroho, I. Permadi, and M. Faturrahim, "Improvement Of Image Quality Using Convolutional Neural Networks Method," *Sci. J. Informatics*, vol. 9, no. 1, pp. 95–103, May 2022, doi: 10.15294/sji.v9i1.30892.

[4] I. Suwarno, A. Cakan, and N. M. Raharja, "Current trend in control of artificial intelligence for health robotic manipulator," *J. Soft Comput. Explor.*, vol. 4, no. 1, pp. 1–12, 2022.

[5] G. McLean and A. Wilson, "Shopping in the digital world: Examining customer engagement through augmented reality mobile applications," *Comput. Human Behav.*, vol. 101, pp. 210–224, Dec. 2019, doi: 10.1016/j.chb.2019.07.002.

[6] A. Ismail, G. Rahayu, M. A. K. Putera, N. N. Aghniya, and S. Gumilar, "Development of augmented reality as physics learning media on electric concepts," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 1098, no. 4, p. 042006, Mar. 2021, doi: 10.1088/1757-899X/1098/4/042006.

[7] S. L. Rahayu, Fujiati, and R. Dewi, "Educational Games as A learning media of Character Education by Using Multimedia Development Life Cycle (MDLC)," in *2018 6th International Conference on Cyber and IT Service Management (CITSM)*, Aug. 2018, pp. 1–4, doi: 10.1109/CITSM.2018.8674288.

[8] R. Vicente-Saez, R. Gustafsson, and L. Van den Brande, "The dawn of an open exploration era: Emergent principles and practices of open science and innovation of university research teams in a digital world," *Technol. Forecast. Soc. Change*, vol. 156, p. 120037, Jul. 2020, doi: 10.1016/j.techfore.2020.120037.

[9] N. Egbert, J. Thye, W. O. Hackl, M. Müller-Staub, E. Ammenwerth, and U. Hübner, "Competencies for nursing in a digital world. Methodology, results, and use of the DACH-recommendations for nursing informatics core competency areas in Austria, Germany, and Switzerland," *Informatics Heal. Soc. Care*, vol. 44, no. 4, pp. 351–375, Oct. 2019, doi: 10.1080/17538157.2018.1497635.

[10] G. Kane, "The Technology Fallacy," *Res. Manag.*, vol. 62, no. 6, pp. 44–49, Nov. 2019, doi: 10.1080/08956308.2019.1661079.

[11] A. Buchori, P. Setyosari, I. Wayan Dasna, and S. Ulfa, "Mobile augmented reality media design with waterfall model for learning geometry in college," *Int. J. Appl. Eng. Res.*, vol. 12, no. 13, pp. 3773–3780, 2017.

[12] K. Budiman, A. Putra, Alamsyah, E. Sugiharti, M. A. Muslim, and R. Arifudin, "Implementation of ERP system functionalities for data acquisition based on API at the study program of Universities," *J. Phys. Conf. Ser.*, vol. 1918, no. 4, p. 042151, Jun. 2021, doi: 10.1088/1742-6596/1918/4/042151.

[13] Y. D. Puspitarini and M. Hanif, "Using Learning Media to Increase Learning Motivation in Elementary School.," *Anatol. J. Educ.*, vol. 4, no. 2, pp. 53–60, 2019.

[14] H. Mora, M. T. Signes-Pont, A. Fuster-Guilló, and M. L. Pertegal-Felices, "A collaborative working model for enhancing the learning process of science & engineering students," *Comput. Human Behav.*, vol. 103, pp. 140–150, 2020.

[15] D. A. A. Pertiwi, M. Yusuf, and D. A. Efrilianda, "Operational Supply Chain Risk Management on Apparel Industry Based on Supply Chain Operation Reference (SCOR)," *J. Inf. Syst. Explor.*, vol. 01, no. 01, pp. 17–24, 2023.

[16] I. B. Sadiku, W. Ajayi, W. Sakpere, T. John-Dewole, and R. A. Badru, "Effect of Traditional and Software-Defined Networking on Performance of Computer Network," *Sci. J. Informatics*, vol. 9, no. 2, pp. 111–122, Oct. 2022, doi: 10.15294/sji.v9i2.31315.

[17] S. Wahjuni, S. H. Sanjiwo, W. Wulandari, and A. R. Akbar, "The Development of Chicken Coop Automatic Remote Visual Monitoring System," *Sci. J. Informatics*, vol. 9, no. 2, pp. 161–168, Nov. 2022, doi: 10.15294/sji.v9i2.34630.

[18] L. A. Laurens Arredondo, "Mobile augmented reality: A pedagogical strategy in the university setting," *Metaverse*, vol. 1, no. 2, p. 9, Jul. 2020, doi: 10.54517/met.v1i2.1774.

[19] D. Efrilianda, M. Muslim, A. Putra, and A. Purwinarko, "Software development internal audit quality with ISO 9001," *J. Phys. Conf. Ser.*, vol. 1567, no. 3, p. 032037, Jun. 2020, doi: 10.1088/1742-6596/1567/3/032037.

[20] N. Tuli and A. Mantri, "Evaluating usability of mobile-based augmented reality learning environments for early childhood," *Int. J. Human–Computer Interact.*, vol. 37, no. 9, pp. 815–827, 2021.

[21] M. I. Nounou *et al.*, "Mobile-based augmented reality application in pharmacy schools implemented in pharmaceutical compounding laboratories: Students' benefits and reception," *Pharmacy*, vol. 10, no. 4, p. 72, 2022.

[22] Y. Georgiou and E. A. Kyza, "Bridging narrative and locality in mobile-based augmented reality educational activities: Effects of semantic coupling on students' immersion and learning gains," *Int. J. Hum. Comput. Stud.*, vol. 145, p. 102546, 2021.

[23] G. Lampropoulos, E. Keramopoulos, K. Diamantaras, and G. Evangelidis, "Education Augmented Reality and Virtual Reality in Education: Public Perspectives, Sentiments, Attitudes, and Discourses," *Educ. Sci.*, vol. 12, no. 11, p. 798, 2022, doi: 10.3390/educsci12110798.

[24] A. D. Lestari, D. A. A. Pertiwi, and M. A. Muslim, "Increasing package delivery efficiency through the application of the prim algorithm to find the shortest route on the expedition route," *J. Student Res. Explor.*, vol. 1, no. 1, pp. 7–14, 2023.

[25] A. Ismail, I. Festiana, T. I. Hartini, Y. Yusal, and A. Malik, "Enhancing students' conceptual understanding of electricity using learning media-based augmented reality," in *Journal of Physics: Conference Series*, 2019, vol. 1157, no. 3, p. 32049.

[26] R. A. Liono, N. Amanda, A. Pratiwi, and A. A. S. Gunawan, "A systematic literature review: learning with visual by the help of augmented reality helps students learn better," *Procedia Comput. Sci.*, vol. 179, pp. 144–152, 2021.

[27] N. Windayani, F. S. Irwansyah, and E. N. Asyiah, "Making augmented reality learning media in conformation of alkane and cycloalkane concepts," in *2019 IEEE 5th International Conference on Wireless and Telematics (ICWT)*, 2019, pp. 1–5.

[28] A. N. S. I. Septiani and T. Rejekiningsih, "Development of Interactive Multimedia Learning Courseware to Strengthen Students' Character.," *Eur. J. Educ. Res.*, vol. 9, no. 3, pp. 1267–1280, 2020.

[29] M. F. Azim, E. W. Hidayat, and A. N. Rachman, "Android Battle Game Based on Augmented Reality with 2D Object Marker," *J. Online Inform.*, vol. 3, no. 2, p. 116, Jan. 2019, doi: 10.15575/join.v3i2.255.

[30] S. Kumar, "A Comparative Study of Significance of Mobile Cloud Computing in the Modern World," *Int. J. Res. Eng. Sci. Manag.*, vol. 3, no. 7, pp. 3–5, 2020.

[31] D. Intan, S. Saputra, L. Murjiatiningsih, H. Hermawan, and S. W. Handani, "cARica : Enhancing Travelling Experiences in Wonosobo Through Location-Based Mobile Augmented Reality," *J. Soft Comput. Explor.*, vol. 4, no. 1, pp. 23–30, 2022.

[32] C. Avila-Garzon, J. Bacca-Acosta, Kinshuk, J. Duarte, and J. Betancourt, "Augmented Reality in Education: An Overview of Twenty-Five Years of Research," *Contemp. Educ. Technol.*, vol. 13, no. 3, p. ep302, Apr. 2021, doi: 10.30935/cedtech/10865.

[33] H. Putri, I. Shadiq, and G. G. Putri, "Interactive Learning Media for Cellular Communication Systems using the Multimedia Development Life Cycle Model," *J. Online Inform.*, vol. 6, no. 1, p. 1, 2021, doi: 10.15575/join.v6i1.544.

[34] K. Kapp, M. Sivén, P. Laurén, S. Virtanen, N. Katajavuori, and I. Södervik, "Design and Usability Testing of an Augmented Reality (AR) Environment in Pharmacy Education—Presenting a Pilot Study on Comparison between AR Smart Glasses and a Mobile Device in a Laboratory Course," *Educ. Sci.*, vol. 12, no. 12, p. 854, 2022.

[35] F. N. Kumala, A. Ghufron, P. P. Astuti, M. Crismonika, M. N. Hudha, and C. I. R. Nita, "MDLC model for developing multimedia e-learning on energy concept for primary school students," in *Journal of Physics: Conference Series*, 2021, vol. 1869, no. 1, p. 12068.

[36] S. Purwanti, R. Astuti, J. Jaja, and R. Rakhmayudhi, "Application of the Multimedia Development Life Cycle (MDLC) Methodology to Build a Multimedia-Based Learning System," *Budapest Int. Res. Critics Inst. Humanit. Soc. Sci.*, vol. 5, no. 1, pp. 2498–2506, 2022.

[37] S. Shafiq, A. Mashkoor, C. Mayr-Dorn, and A. Egyed, "A Literature Review of Machine Learning and Software Development Life cycle Stages," *IEEE Access*, 2021.

[38] F. N. Kumala, A. Ghufron, P. P. Astuti, M. Crismonika, M. N. Hudha, and C. I. R. Nita, "MDLC model for developing multimedia e-learning on energy concept for primary school students," *J. Phys. Conf. Ser.*, vol. 1869, no. 1, p. 012068, Apr. 2021, doi: 10.1088/1742-6596/1869/1/012068.

[39] M.-A. Kaufhold, N. Rupp, C. Reuter, and M. Habdank, "Mitigating information overload in social media during conflicts and crises: design and evaluation of a cross-platform alerting system," *Behav. Inf. Technol.*, vol. 39, no. 3, pp. 319–342, 2020.

[40] H. Aguinis and A. M. Solarino, "Transparency and replicability in qualitative research: The case of interviews with elite informants," *Strateg. Manag. J.*, vol. 40, no. 8, pp. 1291–1315, 2019.