JURNAL PENDIDIKAN DAN PENGAJARAN
Volume 55 Nomor 1 2022, 64-76
E-ISSN: 2549-2608; P-ISSN: 2301-7821
DOI: http://dx.doi.org/10.23887/jpp.v55i1.34501

Interactive Multimedia in Shallow Foundation Support Capacity Material

Riyan Arthur[1*], Erna Septiandini[2], Nousseva Renna[3]

[1,2,3] State University of Jakarta, Jakarta, Indonesia
*Corresponding author: arthur@unj.ac.id

Abstrak

Pendidikan perlu dimodernisasi agar sejalan dengan perkembangan teknologi, misalnya multimedia interaktif yang dapat diakses melalui perangkat digital seperti komputer/laptop. Beberapa faktor yang menjadi kendala dalam pembelajaran adalah keterbatasan waktu pembelajaran di dalam kelas, materi yang sulit abstrak materi, keterbatasan alat dan media serta motivasi belajar yang rendah. Media pembelajaran perlu dipilih secara tepat sesuai dengan tujuan dan bahan pembelajaran agar dapat digunakan secara efektif dan efisien untuk mencapai tujuan pembelajaran. Tujuan dari penelitian ini adalah menghasilkan suatu produk berupa Multimedia Interaktif pada materi daya dukung pondasi dangkal di Program Studi Pendidikan Teknik Bangunan. Metode penelitian ini adalah metode research and development (R&D) dengan model ADDIE yang terdiri dari tahapan analysis, design, develop, implement, dan evaluation. Multimedia interaktif yang dikembangkan mendapat 80,7% dengan kategori tepat oleh ahli materi dan 79,4% dengan kategori tepat oleh ahli media. Berdasarkan hasil uji coba terbatas terjadi peningkatan nilai rata-rata pre test sebesar 54,5 dan post test sebesar 79,75. Hasil validasi ahli materi dan ahli media serta uji coba terbatas menunjukkan bahwa multimedia interaktif yang dikembangkan dinyatakan layak dan siap diimplementasikan pada materi daya dukung pondasi dangkal..

Kata kunci: *Media Pembelajaran Interaktif, Media Pembelajaran, Pembelajaran Pandemi, Daya Dukung Yayasan Dangkal, Teknik Sipil*

Abstract

Education needs to be modernized so that it is in line with technological developments, for example, interactive multimedia that can be accessed through digital devices such as computers/laptops. Some of the factors that are problematic in learning are limited learning time in the classroom, difficult materials abstract material, limitations on tools and media as well as low learning motivation. Learning media need to be chosen appropriately in accordance with the objectives and learning materials so that they can be used effectively and efficiently to achieve learning objectives. The purpose of this research is to produce a product in the form of Interactive Multimedia on the material shallow foundation support capacity in the Building Engineering Education Study Program. The method of this research is research and development (R&D) method with the ADDIE model consisting of the stages of analysis, design, development, implementation, and evaluation. The interactive multimedia that was developed got 80.7% with the proper category by material experts and 79.4% with the proper category by media experts. Based on the results of the limited trial, there was an increase in the average value of the pre-test by 54.5 and the post-test by 79.75. The results of validation by material experts and media experts as well as limited trials show that interactive multimedia that has been developed is declared feasible and ready to be implemented in the material shallow foundation support capacity.

Keywords: Interactive Learning Media, Media Learning, Pandemic Learning, Shallow Foundation Support Capacity, Civil Engineering

History:
Received : May 17, 2021
Revised : May 20, 2021
Accepted : October 28, 2021
Published : April 25, 2022

Publisher: Undiksha Press

1. INTRODUCTION

Foundation Engineering course is a mandatory and important course for an engineer because the foundation is a construction on the basic part of the building structure and serves to carry the load from the upper structure to the foundation ground (Akinosho et al., 2020). The carrying capacity of the land to the foundation is one of the important factors in the planning of the foundation (Gong, 2020). Therefore students must be able to understand,

analyze, and apply the type of foundation and parameters needed to design the foundation (Liu, 2020; Polter & Scherer, 2017). Some of the factors that are problematic in learning are limited learning time in the classroom, difficult materials abstract material, limitations on tools and media as well as low learning motivation (Arthur et al., 2020). Therefore educators must choose the right learning media in accordance with the purpose and learning materials so that the media used serves effectively and efficiently in achieving learning objectives (Lee, 2016; McKenzie, 2009).

The development of technology has influenced various aspects including education aspects and has a big influence on learning so education modernization is needed with the use of technology in the learning process (Fernandez et al., 2017). The utilization of technology can develop creativity and make learning activities effective and efficient as well as form learners to learn independently (Bayyurt et al., 2014; Beverborg et al., 2015; Coetzer et al., 2020; Ivanovic et al., 2018). The availability of learning that can be accessed through digital devices is still limited, therefore educators are required to innovate by connecting technology to learning (Encheva et al., 2019). One form of technological development innovation in education is to create learning media that can be accessed through digital devices such as computers/laptops so that the development of learning media can add to the traditional teaching paradigm as well as concrete evidence of technological development by utilizing digital devices (Bayyurt & Karataş, 2011).

In fact, learning media is a means of delivering messages (McKenzie, 2009). Learning media makes learning take place appropriately and effectively, making abstract and complex concepts simple, concrete, and easy to understand (Hite et al., 2019; Peña-Ayala & Cárdenas-Robledo, 2019). The criteria for choosing learning media is conformity with learning objectives, availability of technology conformity with materials, the use of relatively cheap costs, and conformity with the interests, needs, and conditions of students (Lee, 2016; Suyitno et al., 2020; Zaneldin et al., 2019). Based on these criteria, one of the suitable media used is interactive multimedia. Interactive multimedia has characteristics that distinguish it from other media that have more than one type of media and can be used independently (Arthur et al., 2021; Rajendra & Sudana, 2017; Reyna et al., 2017).

Therefore, it is recommended that the use of learning media used in the form of multimedia or a combination of several media to make learners interested because the eyes and ears work together and are able to improve the learning outcomes of learners, understanding, and absorption of learners (Arthur et al., 2021; Nurtanto et al., 2020; Suraweera et al., 2018). In addition, the use of multimedia can increase the interest and learning experience of students (Vagg et al., 2020). Multimedia should be interactive to increase the motivation of students. Interactive multimedia allows students to interact with technology because it is equipped with control tools that can be used as desired users so that it can be done independently (Emami et al., 2020; Tiarasari et al., 2018). Interactive Multimedia is a medium of message delivery that allows interaction between humans and technology (Rajendra & Sudana, 2017; Reyna et al., 2017). The use of interactive learning media that can be accessed anywhere and anytime is expected to increase interest, and motivation, and become a solution to several problem factors in the learning mentioned earlier (Davis et al., 2018; Khalid, 2011; Law et al., 2019; Roll, 2021). In addition, this interactive multimedia can be used for learning during the Corona Virus *Disease* (Covid-19) pandemic as it happens today because interactive multimedia supports independent learning.

Some previous researchers who conduct research on interactive multimedia by utilizing technological developments state that interactive multimedia is able to attract interest and make it easier for students to understand the material (Meyer et al., 2019). It can be used as a source of independent learning, and is practical for use in learning (Hobbs et al., 2013; Hobbs & Friesem, 2019). Based on some of the research results, it can be said that

interactive multimedia can be used effectively and efficiently to achieve learning objectives. Based on this consideration, this research tried to develop learning media in the form of shallow foundation interactive multimedia for support capacity materials on S1 PTB UNJ.

2. METHODS

This research is included Research and Development (RnD), with the approach of addie development model. The instrument used in this study is a non-test instrument in the form of a questionnaire, in which respondents are given a set of questions or statements to answer. Then the data measurement will be done using The Likert Scale with a range of very less good, less good, enough, good, and very good. Addie model R&D design is shown in Figure 1.

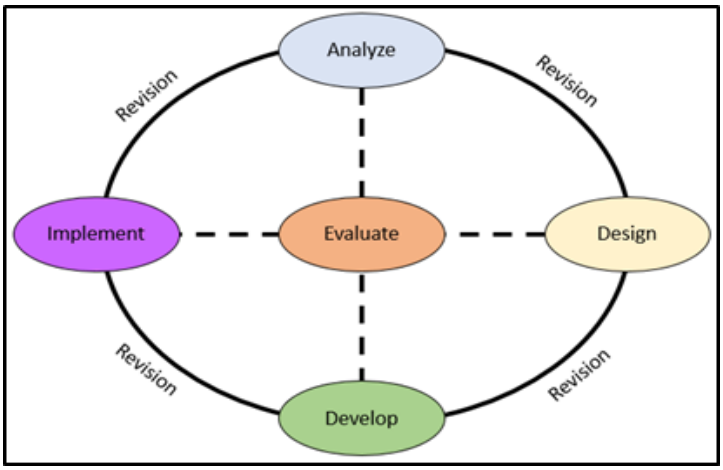

Figure 1. ADDIE model R&D design

Here is an explanation of the ADDIE development model used in this study: (1) *Analysis,* at this stage, is conducted analysis in the form of literature studies and needs analysis. (2) *Design,* conducting initial product planning, developed media specificity as well as appropriate testing methods. (3) *Develop,* develop products or produce finished products which is the realization of the product design that has been made and due diligence by material experts and media experts. (4) *Implement,* the product that has been developed is applied by conducting limited trials with students. (5) *Evaluate,* which is the last stage performed by assessing the products that have been developed and making revisions or improvements based on input from material experts and media experts. In this study, there are two instruments, namely media expert instruments and material expert instruments. The instrument is used to determine the level of feasibility and effectiveness of interactive multimedia products developed. Here's a grid of instruments for material experts and media as shown in Table 1.

Table 1. Validation Instrument Grid By Material Experts

No.	Aspects	indicator	sum grain
1	Learning Materials	1. Conformity of materials with learning objectives 2. Material clarity 3. Material sequence clutter 4. Suitability of problem examples 5. Accuracy of the concept presented	5

No.	Aspects	indicator	sum grain
2	Language & Communication	1. Clarity of the language used 2. Communicative use of language	2
3	Learning Presentation	1. Suitability of the image to the content of the material 2. Suitability of video or animation with material content 3. Ability to respond to commands 4. Ability to provide feedback on learning outcomes	4
4	Aspects of Learning Media	1. Conformity of media with the content of the material 2. Type selection compatibility 3. Suitability of font size selection 4. Clarity of media usage instructions	4
Total Number of Instrument Items			**15**

Table 1, is a table of validation instruments by material experts consisting of 4 aspects, namely learning materials, language and communication, presentation of learning, and aspects of learning media with a total of 15 questions.

Table 2. Validation Instrument Grid By Media Experts

No.	Aspects	indicator	Number of Items
1	Media View	1. Interactive multimedia design 2. Typeface compatibility 3. Font size compatibility 4. Color selection compatibility 5. Image quality 6. Audio quality 7. Video/animation quality 8. Interesting learning media	8
2	Programming	1. Clarity of media usage instructions 2. Accuracy of the use of symbols for navigation 3. *Menu/link* control capabilities 4. Page navigation capabilities 5. Feedback or feedback capabilities 6. Ability to be used anywhere at any time 7. Required memory capacity 8. Media smoothness	8
Total Number of Instrument Items			**16**

Table 2 is a table of validation instruments by media experts consisting of 2 aspects, namely media display and programming with a total of 16 questions. Data collection techniques for assessment by 2 media experts, and 2 material experts in this study used questionnaire data collection techniques with the Likert Scale as a measurement scale that has a range of very poor, less good, enough, good, and very good. Likert scale is shown in table 3.

Table 3. Likert Scale

Valuation	Scale Value
Very Poor	1
Less Good	2
enough	3
good	4
Excellent	5

(Source : Sugiyono, 2015)

This study uses quantitative descriptive analysis techniques and qualitative descriptive. Data validation test results by material experts and media experts will be processed by quantitative data analysis techniques that result in the percentage of product feasibility. While qualitative data analysis techniques are used to process data in the form of advice or input from media experts and material experts. After the experts gave the assessment, the researchers calculated the validation of the contents using a formula from the Aikens's formula. Aiken'V validity values with indexes less than or equal to 0.4 are said to be less valid, indexes 0.4-0.8 are said to be valid, and indexes over 0.8 are very valid (Miller et al., 2009).

3. RESULTS AND DISCUSSION

Result

Interactive multimedia development is validated by 2 material experts who are experts in the field of Foundation Engineering and 2 media experts who are experts in the field of learning media. The limited trial was conducted by 20 respondents of students of building engineering education program of UNJ class of 2016 and 2017. The dissemination of questionnaires for validation by media experts, material experts, as well as limited trials is conducted through Google Form. The *analysis* stage is carried out by collecting various information from literature studies which are then strengthened by the analysis of needs by disseminating questionnaires to students who have taken shallow foundation support capacity materials in the Course of Foundation Engineering I. Literature studies and analysis of such needs are conducted to find out information related to classroom learning, media used, effectiveness of the use of media used, and learning media needed to be developed.

After conducting the analysis stage, the *design* (planning) stage or initial planning of the product is carried out. At this stage, it is determined the design of the learning media be developed. Determined the media elements used as well as the interactive level applied so as to produce an initial draft of interactive multimedia and produce design specifications such as (1) determine the specifications of the media to be created ie themes, navigation functions, types of text used, animations, videos, and interactions or feedback used. (2) create a learning structure that is the purpose of learning, material content, sample questions, and evaluation of learning. The interactive learning media to be developed is designed using *Microsoft PowerPoint*, which is equipped with the *iSpring Suite plug-in* so that educators can edit learning media if there are errors in a particular subject or add a discussion. At the stage of developing (developing) product design that has been produced realized in real form and produce development products in the form of interactive multimedia then validated by material experts and media experts. The learning media developed will be published in the form of web *(HTML5)* which can be accessed through a computer/laptop with *search engines* such as Opera *Internet Browser, Google Chrome, and Internet Explorer.* The implementation stage (implementation) carried out in implementing the design is a limited trial activity for students of the Building Engineering Education Study Program Class of 2016 and 2017 as

many as 20 students. The evaluation stage contains activities to make product improvements based on assessments and suggestions and inputs that have been given by material experts and media experts based on the development stage. Product feasibility is done through product assessment or validation by several competent experts in their fields, namely material experts, and media experts. The validation results by media experts are shown in Table 4.

Table 4. Media Expert Validation Results

No.	Indicator	Percent	V_{score}	category
1	Interactive Multimedia Design	80%	0,75	proper
2	Typeface compatibility	80%	0,75	proper
3	Font size compatibility	80%	0,75	proper
4	Color selection compatibility	70%	0,63	proper
5	Image quality	80%	0,75	proper
6	Audio quality	80%	0,75	proper
7	Video/animation quality	80%	0,75	proper
8	Interesting learning media	80%	0,75	proper
9	Clarity of media usage instructions	80%	0,75	proper
10	Accuracy of the use of symbols for navigation	80%	0,75	proper
11	*Menu/link* control capabilities	80%	0,75	proper
12	Page navigation capabilities	80%	0,75	proper
13	Feedback or feedback capabilities	90%	0,8	Very Decent
14	Ability to use anywhere and anytime	80%	0,75	proper
15	Required memory capacity	70%	0,63	proper
16	Media smoothness	80%	0,75	proper
	Average	**79,4%**	**0,74**	**proper**

Based on table 4, validation results media experts showed an average score belonging to the category "Eligible" with 79.4% and based on the formula Aikens's obtained an average of 0.74 and greater than 0.5. This shows that there is a consistency in the assessment given by experts. Therefore, this interactive multimedia deserves to be used as a learning medium in shallow foundation support capacity materials. The validation results by media experts are shown in table 5.

Table 5. Material Expert Validation Results

No.	indicator	Percent	V_{score}	category
1	Conformity of materials with learning objectives	90%	0,88	Very Decent
2	Material clarity	80%	0,75	proper
3	Material sequence clutter	80%	0,75	proper
4	Suitability of problem examples	80%	0,63	proper
5	Accuracy of the concept presented	80%	0,75	proper
6	Clarity of the language used	80%	0,75	proper
7	Communicative use of language	70%	0,63	proper
8	Suitability of the image to the content of the material	90%	0,88	Very Decent
9	Video/animation compatibility with material content	90%	0,88	Very Decent
10	Ability to respond to commands	80%	0,75	proper
11	Ability to provide feedback on learning outcomes	80%	0,75	proper
12	Conformity of media with the content of the	80%	0,75	proper

No.	indicator	Percent	V_{score}	category
	material			
13	Type selection compatibility	70%	0,63	proper
14	Suitability of font size selection	70%	0,63	proper
15	Clarity of media usage instructions	90%	0,88	Very Decent
	Average	**80,7%**	**0,75**	**proper**

In table 5, validation results material experts showed an average score belonging to the category "Eligible" with 80.7%, and based on the formula Aikens's obtained an average of 0.75 and greater than 0.5. This shows that there is a consistency in the assessment given by experts. Therefore, this interactive multimedia deserves to be used as a learning medium in shallow foundation support capacity materials. Product revisions are done based on suggestions and inputs from material experts and media experts at the validation stage. Suggestions and input from media experts and material experts, namely change the font type used, increase the font size, color the icon, the back sound is adjusted so that it is not too large, on pages that are too full should be separated, increase the size of images and videos, fix typography on the product and use easy-to-understand language. The final design based on revisions from the input of material experts and media experts is shown in figure 2, figure 3, figure 4, and figure 5.

Figure 2. Learning Media Home View and Main Menu View

Figure 3. How To View Instructions for Use and Display of Learning Objectives

Figure 4. Learning Materials View and Learning Practice/Evaluation View

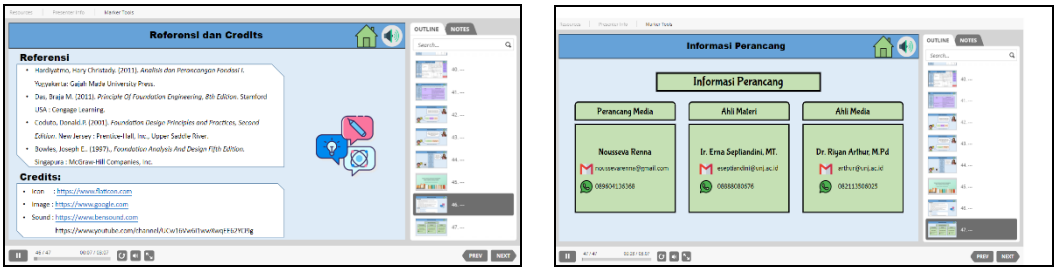

Figure 5. Reference-Credits and Designer Information Display

Based on the limited trial, the average pretest score was 54.5 and the post-test average score was 79.75 in the limited trial. Based on the data analysis, there is an increase in the value of the average pretest result of 54.5 and the average post-test result of 79.75. So it can be concluded there is an increase in the average value of 46.3%.

Discussion

Interactive multimedia development on shallow foundation support capacity materials in Building Engineering Education UNJ is made by research and development methods using ADDIE model with 5 stages, namely *analysis, design, development, implementation, and evaluation.* Interactive learning media developed following the characteristics of interactive multimedia so that it contains more than one type of media and is interactive. The elements in the interactive learning media developed consist of several media elements, namely text, images, sound, animation, video, and interactivity properties in line (Arthur et al., 2019; Surjono, 2017). Interactive levels in this interactive learning media in the form of video or audio navigation, page navigation, menu or link controls, animation controls, hypermaps, Responses, and Feedback. This development medium is created using *Microsoft PowerPoint* software equipped with the *iSpring Suite* plug-in and published on the web (*HTML5*).

Interactive learning media developed has several advantages and disadvantages. The advantages of this interactive learning media include the design of learning media that is more interesting, there are supporting audio and video in some materials, there is a learning evaluation, easy to use anywhere and anytime, does not require special applications because it utilizes search engines such as Opera Internet Browser, Google Chrome, and Internet Explorer and train students to do learning independently. In addition, this developed learning media supports self-learning outside the classroom so that it is suitable for use during the current COVID-19 pandemic. Interactive learning media developed can be used on gadgets such as laptops or computers. This advantage is in line with the opinions of other researchers which present several advantages of interactive multimedia (Rajendra & Sudana, 2017).

The disadvantages of interactive learning media that have been developed include the level of interactivity used does not include drag and drop, simulation controls, and game controls. Supporting videos are only on a few discussions and a large enough media capacity, and development is only done on shallow foundation support capacity materials. In addition, because of the limitations of the software used to cause a discussion forum cannot be created that the results can be directly accepted by lecturers, but this can be overcome by creating a class group through an application on a smartphone such as WhatsApp so that students can discuss in the group. Based on these advantages and disadvantages are expected to be used as a reference for further development, so interactive learning media will be developed next into a better interactive learning media than the interactive learning media developed today.

Interactive learning media assessment is carried out through validation by two material experts and two media experts who are competent in their respective fields. The average validation result for material experts is 80.7% and validation for media experts is 80.7% and falls into the eligible category. In addition, the assessment given by the validator

tends to be consistent so that the multimedia interactive is declared appropriate and suitable for use in the learning process of the Shallow Foundation Supporting Capacity material both in terms of material and media appearance.

Some validators said that this multimedia interactive did not need to be revised because it had instructions for use that were very clear and easy to understand, the images and animations used helped improve user understanding, as well as responses and feedback on learning evaluations, were good because they were given the correct answers and discussion of how to finish it. This is in line with the opinion regarding the general criteria for selecting learning media, namely: the availability of technology, conformity with the interests, needs, and students' conditions (Santika et al., 2020; Satrianawati, 2018; Sobry & Sa'i, 2020). In line with several researchers who conducted research on interactive multimedia, the results of interactive multimedia products in this study had several media elements, namely text, images, sound, animation, video, and the nature of interactivity (Surjono's opinion, 2017). Generally, the videos contained in development learning media are videos sourced from Youtube, but in this study, the videos contained were original videos from personal development. In addition, interactive learning media that will be developed are designed using *Microsoft PowerPoint* which is equipped with the *iSpring Suite* plug-in so that educators can edit learning media if there are errors in certain topics or add to the discussion. The interactive learning media design developed is an original design and has never been made for any learning media. The purpose of this research is to produce a product in the form of Interactive Multimedia on the material shallow foundation support capacity in accordance with the research objectives. In line with relevant research, the results of interactive multimedia products in this study utilize technological developments, effectively, and efficiently. Several studies on the development of interactive learning media usually use software other than Microsoft PowerPoint, which means that some lecturers are less familiar with their use, making it difficult to edit the learning media to add and reduce the desired discussion.

The difference between this study and previous research is that in this study the researcher took advantage of several features of Microsoft PowerPoint that could be used as an interactive medium in the learning of Foundation Engineering-I courses on shallow foundation supporting capacity, with the iSpring Suite plug-in to provide convenience the user to add or remove the desired material. The novelty value of this interactive media is in the form of a video that is presented as an original video from personal development, the design developed is an original design that has never been made by previous researchers, and there is a learning evaluation feature that is useful as a measuring tool for students' ability to understand the material presented contained in the interactive learning media. The impact given by the use of developed interactive learning media is to make it easier for students to understand the material presented by the lecturer, besides that it can increase student learning motivation on Shallow Foundation Supporting Capacity materials, and build discussion forums between students and lecturers about the material that has been presented in learning media the interactive. The limited trial was conducted by 20 students of Building Engineering Education Study Program class of 2016 and 2017 who have taken Foundation Engineering courses I. *Pre-test* and *post-test* are provided through Google *Form* and interactive multimedia is developed and disseminated through Google *Drive.* Obtained an average *pretest* score of 54.5 and a *posttest* average score of 79.75 on limited trials. The results of the increase from pretest score of 54.5 to posttest 79.75 showed that interactive multimedia was assessed to improve students' understanding and knowledge in shallow foundation support capacity material.

4. CONCLUSION

Interactive multimedia can be used as a facility and variety of media in studying the materials of Shallow Foundation Support Capacity and can improve student learning outcomes because this interactive multimedia is effective, efficient, and follows technological developments. This research is still limited to learning materials of Shallow Foundation Support Capacity and can be accessed through a computer/laptop with *search engines* such as Opera *Internet Browser, Google Chrome, and Internet Explorer.* The suggestions that can be given, namely adding interactive multimedia development to other materials, testing the effectiveness of the product on a larger scale, and developing interactive multimedia that can be accessed via *smartphone*.

5. ACKNOWLEDGMENTS

The Authors declared no potential conflicts of interest with respect to the research authorship and publication of this article

6. REFERENCES

Akinosho, T. D., Oyedele, L. O., Bilal, M., Ajayi, A. O., Delgado, M. D., Akinade, O. O., & Ahmed, A. A. (2020). Deep learning in the construction industry: A review of present status and future innovations. *Journal of Building Engineering*, *32*, 101827. https://doi.org/10.1016/j.jobe.2020.101827.

Arthur, R., Anisah, A., Wijayanti, I., & Sidik, J. (2021). Occupational Health and Safety Animated Learning Videos: Validity and Feasibility. *JPI (Jurnal Pendidikan Indonesia)*, *10*(1), 1. https://doi.org/10.23887/jpi-undiksha.v10i1.25192.

Arthur, R., Dwi, R. N., & Lenggogeni, L. (2020). E-Module of Cost Estimating Course in Building Construction Vocational Undergraduate Program Faculty of Engineering Universitas Negeri Jakarta. *Jurnal Ilmu Pendidikan*, *25*(2), 88. https://doi.org/10.17977/um048v25i2p88-96.

Arthur, R., Sekartaji, G. T., Maulana, A., & Dewi, L. K. (2019). Pengembangan Media Video Presentasi Pada Mata Kuliah Hidrologi Universitas Negeri Jakarta. *Kwangsan: Jurnal Teknologi Pendidikan*, *07*(02), 170–183. https://doi.org/10.31800/jtp.kw.v7n2.p170--183.

Bayyurt, Y., Erçetin, G., & Karataş, N. B. (2014). The Stages in Mobile-Assisted Language Learning Material Development. In *International Conference on Mobile and Contextual Learning* (pp. 339–350). Springer, Cham. https://doi.org/10.1007/978-3-319-13416-1_33.

Bayyurt, Y., & Karataş, N. B. (2011). Needs-Analysis: The First Step in Content Development for Mobile Learning. In *Boğaziçi Üniversitesi Eğitim Dergisi* (Vol. 28, Issue 1, pp. 13–21). https://dergipark.org.tr/en/pub/buje/issue/3833/327952.

Beverborg, A. O. G., Sleegers, P. J. C., & Van Veen, K. (2015). Promoting VET teachers' individual and social learning activities: The empowering and purposeful role of transformational leadership, interdependence, and self-efficacy. *Empirical Research in Vocational Education and Training*, *7*(1), 1–20. https://doi.org/10.1186/s40461-015-0018-4.

Coetzer, A., Susomrith, P., & Ampofo, E. T. (2020). Opportunities to participate in formal and informal vocational learning activities and work-related outcomes in small professional services businesses. *Journal of Vocational …*. https://doi.org/10.1080/13636820.2019.1584637.

Davis, D., Chen, G., Hauff, C., & Houben, G. J. (2018). Activating learning at scale: A review of innovations in online learning strategies. *Computers and Education*, *125*(June), 327–344. https://doi.org/10.1016/j.compedu.2018.05.019.

Emami, M. R., Bazzocchi, M. C. F., & Hakima, H. (2020). Engineering design pedagogy: a performance analysis. In *International Journal of Technology and Design Education* (Vol. 30, Issue 3). Springer Netherlands. https://doi.org/10.1007/s10798-019-09515-7.

Encheva, M., Zlatkova, P., Tammaro, A. M., & Brenner, M. (2019). Information Behavior of Humanities Students in Bulgaria, Italy and Sweden: Planning a Game-Based Learning Approach for Avoiding Fake Content. In *Communications in Computer and Information Science* (Vol. 989). https://doi.org/10.1007/978-3-030-13472-3_28.

Fernandez, R. C., García, S. R., & Aurelio Chao Fernandez. (2017). Online Interactive Storytelling as a Strategy for Learning Music and for Integrating Pupils with Hearing Disorders into Early Childhood Education (ECE). *Procedia - Social and Behavioral Sciences*, *237*, 17–22. https://doi.org/10.1016/j.sbspro.2017.02.005.

Gong, P. (2020). Safety risk evaluations of deep foundation construction schemes based on imbalanced data sets. *Journal of Civil Engineering and Management*, *26*(4), 380–395. https://doi.org/10.3846/jcem.2020.12321.

Hite, R. L., Jones, M. G., Childers, G. M., Ennes, M., Chesnutt, K., Pereyra, M., & Cayton, E. (2019). Investigating Potential Relationships Between Adolescents' Cognitive Development and Perceptions of Presence in 3-D, Haptic-Enabled, Virtual Reality Science Instruction. *Journal of Science Education and Technology*, *28*(3), 265–284. https://doi.org/10.1007/s10956-018-9764-y.

Hobbs, R., Donnelly, K., Friesem, J., & Moen, M. (2013). Learning to Engage: How Positive Attitudes about the News, Media Literacy, and Video Production Contribute to Adolescent Civic Engagement. In *Educational Media International* (Vol. 50, Issue 4, pp. 231–246). Routledge. https://doi.org/10.1080/09523987.2013.862364.

Hobbs, R., & Friesem, Y. (2019). The creativity of imitation in remake videos. *E-Learning and Digital Media*, *16*(4), 328–347. https://doi.org/10.1177/2042753019835556.

Ivanovic, M., Milicevic, A. K., Aleksic, V., Bratic, B., & Mandic, M. (2018). Experiences and perspectives of Technology-enhanced learning and teaching in higher education - Serbian case. *Procedia Computer Science*, *126*, 1351–1359. https://doi.org/10.1016/j.procS.2018.08.086.

Khalid, M. S. (2011). ICT in Education: Secondary Technical Vocational Education and Training Institute Centered Diffusion of Innovation in Rural Bangladesh. In *International Technology, Education and Development Conference* (pp. 1126–1134). International Association of Technology, Education and Development (IATED). https://vbn.aau.dk/en/publications/ict-in-education-secondary-technical-vocational-education-and-tra.

Law, K. M. Y., Geng, S., & Li, T. (2019). Student enrollment, motivation and learning performance in a blended learning environment: The mediating effects of social, teaching, and cognitive presence. *Computers and Education*, *136*, 1–12. https://doi.org/10.1016/j.compedu.2019.02.021.

Lee, A. Y. L. (2016). Media education in the School 2.0 era: Teaching media literacy through laptop computers and iPads. *Global Media and China*, *1*(4), 435–449. https://doi.org/10.1177/2059436416667129.

Liu, L. (2020). Study on foundation pit construction cost prediction based on the stacked denoising autoencoder. *Mathematical Problems in Engineering*, *2020*. https://doi.org/10.1155/2020/8824388.

McKenzie, A. R. (2009). Unique considerations for assessing the learning media of students who are deaf-blind. *Journal of Visual Impairment and Blindness*, *103*(4), 241–245. https://doi.org/10.1177/0145482x0910300408.

Meyer, O. A., Omdahl, M. K., & Makransky, G. (2019). Investigating the effect of pre-training when learning through immersive virtual reality and video: A media and methods experiment. *Computers and Education*, *140*(December 2018), 103603. https://doi.org/10.1016/j.compedu.2019.103603.

Miller, M. D., Linn, R. L., & Gronlund, N. E. (2009). *Measurement and Assessment in Teaching*. Pearson Education.

Nurtanto, M., Sofyan, H., & Pardjono, P. (2020). E-Learning Based AutoCAD 3D Interactive Multimedia on Vocational Education (VE) Learning. *Journal of Engineering Education*. https://doi.org/10.16920/jeet/2021/v34i4/155014.

Peña-Ayala, A., & Cárdenas-Robledo, L. A. (2019). A cybernetic method to regulate learning through learning strategies: A proactive and reactive mechanism applied in U–Learning settings. *Computers in Human Behavior*, *98*, 196–209. https://doi.org/10.1016/j.chb.2019.03.036.

Polter, M., & Scherer, R. (2017). Towards an Adaptive Civil Engineering Computation Framework. *Creative Construction Conference 2017*, *196*(June), 45–51. https://doi.org/10.1016/j.proeng.2017.07.171.

Rajendra, I. M., & Sudana, I. M. (2017). The Influence of Interactive Multimedia Technology to Enhance Achievement Students on Practice Skills in Mechanical Technology. *Journal of Physics*, *953*, 1–5. https://doi.org/10.1088/1742-6596/953/1/012104.

Reyna, J., Hanham, J., & Meier, P. (2017). A taxonomy of digital media types for Learner-Generated Digital Media assignments. *E-Learning and Digital Media*, *14*(6), 309–322. https://doi.org/10.1177/2042753017752973.

Roll, M. J. J. (2021). Multidisciplinary digital competencies of pre-service vocational teachers. In *Empirical Research in Vocational Education and Training* (Vol. 13, Issue 1, pp. 1–25). SpringerOpen. https://doi.org/10.1186/S40461-021-00112-4.

Santika, D. A., Mulyana, E. H., & Nur, L. (2020). Pengembangan Media Pembelajaran Model STEM pada Konsep Terapung Melayang Tenggelam untuk Memfasilitasi Keterampilan Saintifik Anak Usia Dini. *Jurnal Paud Agapedia*, *4*(1), 171–184. https://doi.org/10.17509/jpa.v4i1.27207.

Satrianawati. (2018). *Media dan Sumber Belajar*. Deepublish.

Sobry, M., & Sa'i, M. (2020). Penguatan Kompetensi Guru Melalui Pemanfaatan Media Sederhana Dan Modern. *El-Tsaqafah : Jurnal Jurusan PBA*, *19*(1), 97–118. https://doi.org/10.20414/tsaqafah.v19i1.2347.

Sugiyono. (2015). *Metode Penelitian Pendidikan (Pendekatan Kuantitatif, Kualitatif, dan R&D)*. ALFABETA.

Suraweera, S. A. D. H. N., Yatigammana, M. R. K. N., Jayantha, R. U. H., Pathiranage, D. M., Pasaual, M. K. De, Priyankara, C., & Wijeyarathne, P. G. (2018). Transforming Sri Lankan Education with Interactive Multimedia Technology: The Journey to E-Lankapura. In *2018 National Information Technology Conference (NITC)*. IEEE. https://doi.org/10.1109/NITC.2018.8550079.

Surjono, H. D. (2017). *Multimedia Pembelajaran Interaktif*. UNY Press.

Suyitno, S., Purwoko, R. Y., Widiyono, Y., Jatmoko, D., & Nurtanto, M. (2020). Development of Learning Media for Automotive Charging System Based on Macromedia Flash Vocational School. *Universal Journal of Educational Research*, *8*, 64–71. https://doi.org/10.13189/ujer.2020.082308.

Tiarasari, A. T., Sukarno, S., & Sarwanto, S. (2018). Interactive Multimedia Use to Increase Learning Interest. *Social, Humanities, and Educational Studies (SHEs): Conference Series*, *1*(1), 38–47. https://doi.org/10.20961/shes.v1i1.23540.

Vagg, T., Balta, J. Y., Bolger, A., & Lone, M. (2020). Multimedia in Education: What do the Students Think? *Health Professions Education*, *6*(3), 325–333. https://doi.org/doi.org/10.1016/j.hpe.2020.04.011.

Zaneldin, E., Ahmed, W., & El-Ariss, B. (2019). Video-based e-learning for an undergraduate engineering course. *E-Learning and Digital Media*, *16*(6), 475–496. https://doi.org/10.1177/2042753019870938.