Mobile Learning Revolution: Harnessing the Potential of Smartphones in the Learning Process

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Article Information:	ABSTRACT
	Utilizing smartphone-based mobile learning in the learning process will provide the latest innovative alternatives to the learning process. Today's students tend to experience distractions in their learning process. Not infrequently the learning system that applies in a school makes students bored and not enthusiastic about learning. This could have been because the school did not make any changes in the existing education system. Where the effect of the incident will cause students to feel bored and bored in the learning process. In this era of the mobile revolution, it will create various advances in the field of technology that can be used to support the learning process. The purpose of this research is to find out the potential utilization of smartphones as a form of mobile learning revolution in the learning process. Through research on the Mobile Learning Revolution: Utilizing the Potential of Smartphones in the Learning Process, researchers hope that by utilizing the potential of smartphones as a manifestation of the mobile learning revolution in the learning process, it can facilitate the learning process itself. The method used in this research is a quantitative method. The researcher conducted a survey using the Google form which consisted of 15 statements related to the research title. Researchers found that the use of the potential of smartphones in the era of the mobile learning revolution had a major impact on the learning process. The existence of a smartphone in the learning process greatly facilitates the implementation of the teaching and learning process in schools. The limitations of this study are that researchers only conduct research in schools and researchers do not conduct research directly at schools but share survey links on Google forms containing statements about the Mobile Learning Revolution: Utilizing the Potential of Smartphones in the Learning Process.

Keywords: *Learning Process, Mobile Learning, Utilizing Smartphone* |

INTRODUCTION

The education sector is moving more and more significantly every day(Ting et al., 2020). This is the impact of developments in information and communication technology(Javaid et al., 2020). Teachers can take advantage of this progress to develop learning materials to be more diverse and interesting for students(Scherer et al., 2019). This effort is a form of effort to develop the learning process with the aim of making the learning system varied and interesting so that students can participate more in learning and also provide a more enjoyable learning experience than before.(Chick et al., 2020). Integrating media into the learning process can be an instrument to overcome the problems that teachers inherently face when teaching and communicating effectively and the limitations associated with limited learning schedules.(Al-Fraihat et al., 2020). Innovating learning facilities in the world of education is very important nowadays. One form of effort used in the process of improving education is by utilizing information technology or what is called e-learning.

E-learning has many branches, one of which is mobile learning. Mobile learning is a medium that uses smartphones or smart phones(Sarker, 2021). The emergence of technology as a means in the learning process, especially in the use of e-learning or mobile learning, is marked as the emergence of the fifth world revolution in the world of education(Aledhari et al., 2020). Mobile learning relates to gaining knowledge and skills in using a laptop, while e-learning acts as a tool that allows individuals to access information from many different places.(Craik et al., 2019). Utilization of e-learning provides convenience in the learning process related to online learning programs, important features such as wide accessibility, interactive and complete support functionality for the learning process(Pang et al., 2022). Learning. Using smartphone-based mobile learning is one option for providing learning facilities that can be accessed anytime and anywhere by students and teachers.

Using mobile learning will make the learning process easier. Students can learn without space and time limitations(Budd et al., 2020). Mobile learning can be defined as an educational approach that integrates the development of mobile technology with mobile devices. Using a smartphone has become a learning tool for students and teachers(Praveen Kumar et al., 2019). Using mobile learning as a learning medium will improve the learning process and provide comfort and benefits(Almarzooq et al., 2020). In this era of mobile learning revolution, it allows students and teachers to access learning materials easily anywhere and without time constraints(Min et al., 2019). Unlimited accessibility to learning resources encourages the development of student autonomy, because students are no longer constrained by space and time limitations. By entering mobile learning, it provides a form of involvement of information technology in the educational process, this will increase access to learning resources, which makes it possible for students to access learning materials anywhere and at any time.(Aceto et

al., 2019). The benefits of using mobile learning media are: increased accessibility to different materials so that learning becomes more interesting. Incentive use of mobile learning provides space to create favorable conditions for the learning process in the classroom and outside the classroom.

Review of Literature

1. Mobile learning revolution

Revolution contains the meaning of change, where change here takes place quickly and is related to the basic things of life(Niknam et al., 2020). Revolutions can occur in various fields, one of which is in the field of education. The mobile learning revolution is a form of change that is occurring in the field of education by using technology(Kang et al., 2020). This mobile learning revolution uses technology and mobile devices such as smartphones and cellphones. Mobile learning is also referred to as learning that uses information and communication technology as a model(Zhao et al., 2019). The learning concept using mobile learning offers advantages in the availability of teaching materials that are easily accessible at any time and visualizing the material to make it more interesting and interactive. M-learning has the potential to attract students' attention and foster enthusiasm and encourage students to play a serious role in the learning process(Smutny & Schreiberova, 2020). The subjects taught by teachers can be communicated effectively and can be mastered by students. Also, learning with mobile learning brings many benefits such as encouraging students to learn independently. Utilizing mobile learning with the use of smartphones will greatly facilitate students in the learning process.

2. Smartphones

Smartphones have now become an integral part of student life. Regarding the benefits, it is necessary to know and understand that this smartphone will create a learning process that allows students to learn with whatever media is most comfortable for them.(Capponi et al., 2019). Some of the benefits that can be felt by students and teachers related to the use of smartphones in the educational process are: first, smartphones can be taken anywhere so they can be accessed anywhere and anytime.(Martins et al., 2019). This makes learning resources\such as easily accessible content, independent of time and place. So students can access their learning without interruption. With the use of smartphones learning will be available literally at the student's fingertips(De Vos et al., 2019). Second, the smartphone's capabilities as a communication tool make it a great social interaction tool that can increase collaboration between students and teachers, parents and the wider school community.(Bottani & Vignali, 2019). With smartphones, social interaction is enhanced and the school community remains connected at all times. The learning process using the benefits of smartphones allows for various interactive media that can be tailored to individual student needs(Villa-Henriksen et al., 2020). This aspect of learning with mobile learning gives students the opportunity to take control of

their learning and develop a sense of ownership. Having choices gives students the option to study in the environment they feel most comfortable and thus enhances the overall learning journey.

3. Learning process

Teaching and learning are two things that cannot be separated(Vamathevan et al., 2019). Learning and learning are similar but not the same. Learning is a process or individual effort to achieve changes in behavior, in the form of knowledge, skills, attitudes and positive values and experiences from different material studied.(Oztemel & Gursev, 2020). Apart from that, the concept of learning is also understood as a series of psychological activities carried out by individuals which make their behavior different before and after learning. That's because there is intelligence or new knowledge. Meanwhile, the term learning comes from the word "teach" which means instructions given to others so that they know(Yuan et al., 2020). The word then begins with "pe" and ends with "an" so that it becomes a learning word. Thus, the concept of learning is an action, effort, and way of teaching carried out by educators in order to transmit knowledge. Furthermore, learning is understood as a process of student interaction with educational and learning resources in the learning environment(Bhat et al., 2019). Thus, based on this understanding, it is known that learning is a process of gaining knowledge to experience changes from before. In fact, learning is a process between learners and learning resources. So it can be concluded that the difference between studying and teaching is that learning will be successful if students actively lead the learning process by interacting with learning resources. In fact, learning is a system that helps students learn and interact with learning resources.

There are several previous research opinions regarding research on the Mobile Learning Revolution: Utilizing the Potential of Smartphones in the Learning Process. First by(Arsyad & Lestari, 2020), with the research title The Effectiveness of Using Android-based Mobile Learning Media on Student Learning Outcomes at IKIP Budi Utomo Malang and obtained research results. From the results of the Kolmogorov-Smirnov test using SPSS 14 software, it showed that the research subjects were normally distributed and based on the results of the paired sample t test, values were obtained sig is $0.000 > 0.05$. Meanwhile tcount = -12.692 and for ttable at the significance level α = 5% (0.05) with degrees of freedom (df) n-1 or 45-1 = 44. Two-sided test results (significance = 0.025) were obtained for ttable = 2.01537 with a significance level of 0.025. Get the results -tcount < -t table (-12.692 < -2.01537) then H0 is rejected and Ha is accepted. Therefore, the use of Android-based mobile learning multimedia material on the history of the European industrial revolution can improve student learning outcomes in the History and Sociology study program at IKIP Budi Utomo Malang. Second(Ardiansyah & Nana, 2020), with the research title The Role of Mobile Learning as an Innovation in Improving Student Learning Outcomes in School Learning and obtained research results showing that learning via

mobile devices (Android-based multimedia applications) on student learning outcomes in learning can be a solution to problems encountered in the teaching and learning process in class. Learning through learning in the form of Android-based applications can enable students to participate in class and even access it from home or anywhere. Therefore, educators and students need to be prepared to welcome the technological advances of this century. Third by(Warsita, 2018), with the research title Mobile Learning as an Effective and Innovative Learning Model and obtained research results. The potential and prospects for the development of mobile learning in the future are still very open to face the trend of an increasingly dynamic and mobile society, as well as demands for quality and diverse educational needs. The learning concept should encourage the creation of an effective and creative learning environment so that it encourages students and teachers to learn.

Research conducted by previous researchers is different from current research. Meanwhile, the study conducted by researchers was entitled Mobile Learning Revolution: Utilizing the Potential of Smartphones in the Learning Process. Researchers found that using smartphones in the era of the mobile learning revolution in the learning process had a profound effect on the learning process. Mobile learning (m-learning) is a learning model that applies developments in mobile technology and mobile devices such as smartphones which are used as learning media. Mobile learning is developed in multimedia format, presenting text, images, audio and minimizing video and animation due to the limited size of the content so that it is easily accessed via smartphones, mobile phones and tablets which makes learning material interesting and easy to understand. Mobile learning is an alternative learning model that does not depend on place and time.

RESEARCH METHOD

Research methods are the methods or techniques used by researchers in conducting research. Research methods can also be said to be methods or processes specifically used to solve problems presented in research(Zou et al., 2020). Research methods can be understood as guidelines and references in the process of conducting research. Quantitative methods are research methods that use lots of numbers. Starting from the data collection process to its interpretation(L. Mishra et al., 2020). Meanwhile, the research method is to study all the facts thoroughly and carefully. Quantitative research is a type of research that is systematic, planned and structured. Many people think that quantitative methods are traditional methods. Because quantitative methods have been used for a long time to become a tradition in research(Fang et al., 2019). Quantitative research is widely used in the fields of psychology, economics, demography, sociology, marketing, health, community and many more. Less commonly used in anthropology and history, the study of mathematical sciences such as physics is also included in quantitative research although the use of these terms varies according to context.

Research methods using quantitative research methods have their own

characteristics. Among them, quantitative methods examine research with two variables and then measure their effect. Quantification also considers the effect between two variables(P. Mishra et al., 2019). Quantification also uses samples that are already represented in the population. The nature of this quantitative research is objective and concise. In general, quantitative research uses survey methods to collect data from large populations. The survey was carried out by distributing questionnaires to respondents in the form of statements. Apart from surveys, there are various methods such as empirical methods and content analysis(Liang et al., 2019). An experiment is a study that attempts to determine the influence between variables under controlled conditions. The purpose of content analysis is to see the content of variables under certain conditions. A questionnaire is a data collection technique or commonly known as a research tool or quantitative research tool. Quantitative research data collection techniques can also be carried out through observation, interviews, documentation, or literature review. It all depends on the needs of each researcher.

RESULTS AND DISCUSSION

The use of smartphones in the learning process is one form of the mobile learning revolution in education. Technological advances, which are growing more rapidly and moving significantly, of course make the learning process easier. The learning process will be better than before, if we use today's technology. It cannot be denied that the learning process really needs technology to create innovation and new breakthroughs in learning. The existence of technology has given birth to various kinds of learning methods which are supported by sophisticated and innovative facilities. Technology is developing both in the field of information and in the field of communication. These two fields are really needed in the learning process. One form of progress in information technology in the field of education is the emergence of the e-learning learning system, which then gave birth to the mobile learning system.

The learning process using mobile learning is a learning process that uses mobile devices such as smartphones and cell phones. Smartphones themselves, as is known, not only help in the field of education but also in various other fields such as business and economics. Using smartphones in the learning process makes it very easy for students to access learning resources in the form of online content which can be accessed anywhere and at any time. Moreover, a smartphone is a tool that can be carried anywhere because of its small design, making it easier for students. The conveniences provided by smartphones in the learning process are numerous, including ease of accessing learning content, ease of a place for carrying out the teaching and learning process that can be adjusted to suit the teacher's and student's time and ease of adjusting learning to suit the abilities of each student.

With today's increasingly advanced technological developments, it has certainly led to the emergence of various alternatives for teachers to help students' learning process. The technology that is currently in great demand among the general public is smartphone-based mobile learning. Learning materials can be developed on mobile devices using smartphones, because smartphones can be taken anywhere. In addition, students also have the opportunity

to

can easily interpret words, increase understanding, obtain a lot of information, present data, create student motivation and interest in learning so that students not only listen to the teacher's explanation but also through learning media. Apart from that, students can also make more observations and proofs. Developing a learning process using smartphone-based mobile learning can of course meet the objectives and criteria for learning content, adapt learning to student characteristics, effectiveness in terms of time and learning comfort used by students.

The characteristic of using smartphones or mobile learning as a tool in the learning process is that it has a very flexible learning model. Apart from that, using smartphones in the learning process allows students to be able to access learning materials, tutorials and information about learning anytime and anywhere. Smartphone-based mobile learning is an alternative way to develop the learning process through learning media which can be used as a learning supplement to train students to learn individually. Mobile learning itself has its own function for the learning process, including: first, as an additional supplement in the learning process, because as a complement it can be understood as follows:
students have the freedom to choose and use their cellphone to access learning materials or use it as a learning support. Second, as a complement to learning, Mobile learning can be seen as a complement, because it can be used as an assessment tool, provide enrichment and reinforcement and can be used to repeat (recall) learning that has been carried out even without the help and support of teachers or parents. Third, as a replacement or substitute for learning, learning with smartphone-based mobile learning can replace understanding and students can freely choose the learning model they want.

The use of smartphones in the learning process has had many positive impacts in the world of education. Among the positive impacts that smartphones have in the learning process is that they make it easier for students and teachers to communicate even though they are separated by distance and time, this of course also makes the distance learning process easier. Apart from that, the use of smartphones in the learning process also makes it easier for students to obtain information related to the entire learning process, both in accessing materials and alternative learning resources. On a smartphone, a student can also access learning content. Smartphones are also a means of verbal and written communication, can store messages, and are very convenient to use as a communication tool because they can be taken anywhere. And the most important thing related to the use of smartphone-based mobile learning in the learning process is the birth of various kinds of learning media that support the learning process. The learning process will also develop and be more sophisticated if you use mobile learning.

Figure 1. Illustration of the use of smartphones in the learning process

Based on the picture above, it can be concluded that the use of smartphones in the learning process is really needed. Smartphones provide applications that contain a lot of learning content as well as other applications that can be used for online classes such as clashroom. It cannot be denied that the use of smartphones has now become commonplace among both adults and children. Increasingly sophisticated smartphones seem to have become a necessity for society. Not only used for work, this smartphone can also be useful for studying. As objects that can access all information from anywhere in the world, smartphones can be useful learning tools and help enrich students' learning experiences. However, the use of smartphones in learning can also pose a threat if they are not used wisely and in accordance with learning objectives.

This smartphone, which has many model variants, can help students find information more easily and quickly, and can help them complete school assignments and understand confusing material. Smartphones can easily access the Internet, which contains all the necessary information as well as additional explanations on certain topics, helping teachers to provide better explanations and students to be more knowledgeable. But that's not the only benefit of smartphones which have many advantages, they definitely have negative impacts if misused, and not only in a globalized world. This also has a big influence in the world of education, if the SmartPhone can quickly access educational information, then the SmartPhone can also quickly access information that has negative content. This situation can be dangerous for students at an age that is considered especially vulnerable to negative things. However, smartphones can have a positive impact if used correctly. This means that there must be strict teacher supervision to monitor students when learning to use smartphones at school. If this is successfully done, it will prove that the use of smartphones is not only used for business purposes, but can also advance the world of education.

Researchers collected data about students' perspectives and responses to the Mobile Learning Revolution: Utilizing the Potential of Smartphones in the Learning Process, namely through distributing questionnaire links to students. The aim of distributing this questionnaire is to obtain results and also to find out whether the use of smartphones in the era of the learning revolution can make the learning process easier for students and teachers. The questionnaire given by researchers to students contains 15 statements covering the Mobile Learning Revolution: Utilizing the Potential of Smartphones in the Learning Process. The questionnaire was created using Google Form. Apart from that, researchers also need to pay attention to aspects of the relevance of the statements given, also related to the accuracy of the statements with the title of the research. The response from students who filled out the questionnaire was very positive regarding the Mobile Learning Revolution: Utilizing the Potential of Smartphones in the Learning Process. The data that the researchers obtained then summarized them in one table, as below:

NO	Statement	SS	S	RR	T.S	STS
1	I feel with utilizationsmartphones in the era of the mobile learning revolution, the learning process will make it easier for teachers and students	60%	40%			
2	I feel with utilizationsmartphones in the era of the mobile learning revolution, the learning process will be more effective and efficient	33.3%	50%	16.7%		
3	I feel that I feel with utilizationsmartphones in the era of the mobile learning revolution means students will be more active in the learning process	40%	60%			
4	I feel with utilizationsmartphones in the era of the mobile learning revolution, the learning process will take place flexibly	66.7%	33.3%			
5	I feel with utilizationsmartphones in the era of the mobile learning revolution in the learning process must be followedby every educational institution	55%	45%			
6	I feel with utilizationsmartphones in the era of the mobile learning revolution in the learning process can bemake it easier for teachers to teach	50%	50%			

7	In my opinion I feel with utilizationsmartphones in the era of the mobile learning revolutionvery suitable to be applied in the educational process	60%	40%			
8	I feel with utilizationSmartphones in the era of the mobile learning revolution in the learning process have a positive impact	50%	50%			
9	I feel with utilizationsmartphones in the era of the mobile learning revolution in the learning processas a form of educational transformation	50%	50%			
10	I feel with utilizationsmartphones in the era of the mobile learning revolution then the learning process thenThe learning system will be more advanced than before	30%	50%%	20%		
11	I feel with utilizationsmartphones in the era of the mobile learning revolution in the learning processthe process of finding information and communicating becomes easier	55%	45 %			
12	I feel with utilizationsmartphones in the era of the mobile learning revolution, the learning processSmartphones have many benefits in their use	60%	40%			
13	I feel with utilizationsmartphone in the era of the mobile learning revolution, the learning process will be more enjoyable	55%	45%			
14	I feel with utilizationsmartphones in the era of the mobile learning revolution in the learning processcan change the way students learn	50%	50%			
15	I feel with utilizationsmartphones in the era of the mobile learning revolution, the learning process is nottakes up a lot of time and takes up learning space	33.3%	50%	16.7%		

Figure 1: Table of filling out questionnaires by students

Information :

SS = Strongly Agree

S = Agree

RR = Undecided

TS = Disagree

STS = Strongly Disagree

The table above is a table of assessment results from the questionnaire given to students. Feedback or responses given by students are needed to provide an assessment of the role of information and communication technology in educational transformation whether it is optimal or not. In this statement there are 5 assessment categories, namelyStrongly Agree (SS), Agree (S), Undecided (RR), Disagree (TS), Strongly Disagree (STS). Based on this table, the first highest assessment result was 66.7% with the assessment category strongly agree. The second assessment was 60% with the assessment category strongly agree. The use of smartphones in the learning process makes things easier for teachers and students during PBM. Although there are still some negative effects in its implementation. By utilizing smartphones in the era of the mobile learning revolution in the learning process, learning becomes more individual and flexible. Students feel a sense of being actively involved in the learning process.

Next, the researcher will describe the results of filling out the questionnaire. For the first statement, I feel that by using smartphones in the era of the mobile learning revolution, the learning process will make it easier for teachers and students to get responses in the strongly agree category of 60% and the agree category of 40%. For the second statement, I feel that by using smartphones in the era of the mobile learning revolution, the learning process will be more effective and efficient, getting responses in the strongly agree category of 33.3% and the agree category of 50% and the unsure category of 16.7%. For the third statement, I feel that with the use of smartphones in the era of the mobile learning revolution, students will be more active in the learning process, getting responses in the strongly agree category of 40% and the agree category of 60%. For the fourth statement, I feel that with the use of smartphones in the era of the mobile learning revolution, the learning process will take place flexibly, obtaining responses in the strongly agree category of 66.7% and the agree category of 33.3%. For the fifth statement, I feel that the use of smartphones in the era of the mobile learning revolution in the learning process must be followed by every educational institution, getting responses in the strongly agree category of 55% and the agree category of 45%.

Furthermore, for the sixth statement, I feel that using smartphones in the era of the mobile learning revolution in the learning process can make it easier for teachers to teach, getting responses in the strongly agree category of 50% and the agree category of 50%. For the seventh statement, in my opinion, I feel that the use of smartphones in the era of the mobile learning revolution is very suitable to be applied in the educational process, getting responses in the strongly agree category, 60% and the agree category, 40%. For the eighth statement, I feel that the use of smartphones in the era of the mobile learning revolution in the learning process has had a positive impact, getting responses

in the strongly agree category of 50% and the agree category of 50%. For the ninth statement, I feel that the use of smartphones in the era of the mobile learning revolution in the learning process as a form of educational transformation received responses in the strongly agree category of 50% and the agree category of 50%. For the tenth statement, I feel that with the use of smartphones in the era of the mobile learning revolution, the learning process and learning system will be more advanced than before, getting responses in the strongly agree category of 30% and the agree category of 50% and the unsure category of 20%.

Furthermore, for the eleventh statement, I feel that with the use of smartphones in the era of the mobile learning revolution in the learning process, the process of finding information and communicating has become easier to obtain responses with a strongly agree category of 55% and an agree category of 45%. For the twelfth statement, I feel that with the use of smartphones in the era of the mobile learning revolution, the smartphone learning process has many benefits in its use, getting responses in the strongly agree category of 60% and the agree category of 40%. For the thirteenth statement, I feel that by using smartphones in the era of the mobile learning revolution, the learning process will be more enjoyable, getting responses in the strongly agree category of 55% and the agree category of 45%. For the fourteenth statement, I feel that using smartphones in the era of the mobile learning revolution in the learning process can change the way students learn, getting responses in the strongly agree category of 50% and the agree category of 50%. For the fifteenth statement, I feel that with the use of smartphones in the era of the mobile learning revolution, the learning process does not take up a lot of time and takes up learning space, getting responses in the strongly agree category, 33.3% and the agree category, 50%, and the unsure category, 16.7%.

CONCLUSION

Based on the results and discussion above, it can be concluded that I feel that by using smartphones in the era of the mobile learning revolution, the learning process will make it easier for teachers and students. M-Learning or Mobile Learning is learning using a tool as a source of information that can be used whenever possible for students to achieve effective learning. The advantage of using mobile learning in learning is that it makes the teaching and learning process easier inside or outside the classroom, it can attract students' attention, and at the same time it can foster students' enthusiasm and motivation in learning so that the material presented can be conveyed well and can be understood by students, besides that, there are other benefits. The advantage of using mobile learning is that it can help students towards independent learning. The use of smartphones as a form of mobile learning revolution in the learning process has had many positive impacts in the world of education. Among the positive impacts that smartphones have in the learning process is that they make it easier for students and teachers to communicate even though they are separated by distance and time, this of course also makes the distance learning process easier. Apart from that, the use of

smartphones in the learning process also makes it easier for students to obtain information related to the entire learning process, both in accessing materials and alternative learning resources. On a smartphone, a student can also access learning content.

REFERENCES

Aceto, G., Ciuonzo, D., Montieri, A., & Pescape, A. (2019). Mobile Encrypted Traffic Classification Using Deep Learning: Experimental Evaluation, Lessons Learned, and Challenges. IEEE Transactions on Network and Service Management, 16(2), 445–458. https://doi.org/10.1109/TNSM.2019.2899085

Aledhari, M., Razzak, R., Parizi, R.M., & Saeed, F. (2020). Federated Learning: A Survey on Enabling Technologies, Protocols, and Applications. IEEE Access, 8, 140699–140725. https://doi.org/10.1109/ACCESS.2020.3013541

Al-Fraihat, D., Joy, M., Masa'deh, R., & Sinclair, J. (2020). Evaluating E-learning systems success: An empirical study. Computers in Human Behavior, 102, 67–86. https://doi.org/10.1016/j.chb.2019.08.004

Almarzooq, Z.I., Lopes, M., & Kochar, A. (2020). Virtual Learning During the COVID-19 Pandemic. Journal of the American College of Cardiology, 75(20), 2635–2638. https://doi.org/10.1016/j.jacc.2020.04.015

Ardiansyah, Abd. A., & Nana, N. (2020). The Role of Mobile Learning as an Innovation in Improving Student Learning Outcomes in School Learning. Indonesian Journal Of Educational Research and Review, 3(1), 47. https://doi.org/10.23887/ijerr.v3i1.24245

Arsyad, MN, & Lestari, DEG (2020). Effectiveness of Using Android-based Mobile Learning Media on Student Learning Outcomes at IKIP Budi Utomo Malang. AGASTYA: JOURNAL OF HISTORY AND ITS STUDY, 10(1), 89. https://doi.org/10.25273/ajsp.v10i1.5072

Bhat, G., Danelljan, M., Van Gool, L., & Timofte, R. (2019). Learning Discriminative Model Prediction for Tracking. 2019 IEEE/CVF International Conference on Computer Vision (ICCV), 6181–6190. https://doi.org/10.1109/ICCV.2019.00628

Bottani, E., & Vignali, G. (2019). Augmented reality technology in the manufacturing industry: A review of the last decade. IISE Transactions, 51(3), 284–310. https://doi.org/10.1080/24725854.2018.1493244

Budd, J., Miller, BS, Manning, EM, Lampos, V., Zhuang, M., Edelstein, M., Rees, G., Emery, VC, Stevens, MM, Keegan, N., Short, MJ, Pillay, D., Manley, E., Cox, I. J., Heymann, D., Johnson, A. M., & McKendry, R. A. (2020). Digital technologies in the public-health response to COVID-19. Nature Medicine, 26(8), 1183–1192. https://doi.org/10.1038/s41591-020-1011-4

Capponi, A., Fiandrino, C., Kantarci, B., Foschini, L., Kliazovich, D., & Bouvry, P. (2019). A Survey on Mobile Crowdsensing Systems: Challenges, Solutions, and Opportunities. IEEE Communications Surveys & Tutorials, 21(3), 2419–2465. https://doi.org/10.1109/COMST.2019.2914030

Chick, RC, Clifton, GT, Peace, KM, Propper, BW, Hale, DF, Alseidi, AA, & Vreeland, TJ (2020). Using Technology to Maintain the Education of Residents During the COVID-19 Pandemic. Journal of Surgical Education, 77(4), 729–732. https://doi.org/10.1016/j.jsurg.2020.03.018

Craik, A., He, Y., & Contreras-Vidal, J. L. (2019). Deep learning for electroencephalogram (EEG) classification tasks: A review. Journal of Neural Engineering, 16(3), 031001. https://doi.org/10.1088/1741-2552/ab0ab5

De Vos, B.D., Berendsen, F.F., Viergever, M.A., Sokooti, H., Staring, M., & Išgum, I. (2019). A deep learning framework for unsupervised affine and deformable image registration. Medical Image Analysis, 52, 128–143. https://doi.org/10.1016/j.media.2018.11.010

Fang, C., Li, J., Zhang, M., Zhang, Y., Yang, F., Lee, J.Z., Lee, M.-H., Alvarado, J., Schroeder, M.A., Yang, Y. , Lu, B., Williams, N., Ceja, M., Yang, L., Cai, M., Gu, J., Xu, K., Wang, X., & Meng, Y.S. (2019). Quantifying inactive lithium in lithium metal batteries. Nature, 572(7770), 511–515. https://doi.org/10.1038/s41586-019-1481-z

Javaid, M., Haleem, A., Vaishya, R., Bahl, S., Suman, R., & Vaish, A. (2020). Industry 4.0 technologies and their applications in fighting COVID-19 pandemic. Diabetes & Metabolic Syndrome: Clinical Research & Reviews, 14(4), 419–422. https://doi.org/10.1016/j.dsx.2020.04.032

Kang, J., Xiong, Z., Niyato, D., Zou, Y., Zhang, Y., & Guizani, M. (2020). Reliable Federated Learning for Mobile Networks. IEEE Wireless Communications, 27(2), 72–80. https://doi.org/10.1109/MWC.001.1900119

Liang, C., Amelung, W., Lehmann, J., & Kästner, M. (2019). Quantitative assessment of microbial necromass contribution to soil organic matter. Global Change Biology, 25(11), 3578–3590. https://doi.org/10.1111/gcb.14781

Martins, J., Costa, C., Oliveira, T., Gonçalves, R., & Branco, F. (2019). How smartphone advertising influences consumers' purchase intention. Journal of Business Research, 94, 378–387. https://doi.org/10.1016/j.jbusres.2017.12.047

Min, M., Xiao, L., Chen, Y., Cheng, P., Wu, D., & Zhuang, W. (2019). Learning-Based Computation Offloading for IoT Devices With Energy Harvesting. IEEE Transactions on Vehicular Technology, 68(2), 1930–1941. https://doi.org/10.1109/TVT.2018.2890685

Mishra, L., Gupta, T., & Shree, A. (2020). Online teaching-learning in higher education during the lockdown period of COVID-19 pandemic. International Journal of Educational Research Open, 1, 100012. https://doi.org/10.1016/j.ijedro.2020.100012

Mishra, P., Pandey, C., Singh, U., Gupta, A., Sahu, C., & Keshri, A. (2019). Descriptive statistics and normality tests for statistical data. Annals of Cardiac Anaesthesia, 22(1), 67. https://doi.org/10.4103/aca.ACA_157_18

Niknam, S., Dhillon, H.S., & Reed, J.H. (2020). Federated Learning for Wireless Communications: Motivation, Opportunities, and Challenges. IEEE Communications Magazine, 58(6), 46–51. https://doi.org/10.1109/MCOM.001.1900461

Oztemel, E., & Gursev, S. (2020). Literature review of Industry 4.0 and related technologies. Journal of Intelligent Manufacturing, 31(1), 127–182. https://doi.org/10.1007/s10845-018-1433-8

Pang, G., Shen, C., Cao, L., & Hengel, AVD (2022). Deep Learning for Anomaly Detection: A Review. ACM Computing Surveys, 54(2), 1–38. https://doi.org/10.1145/3439950

Praveen Kumar, D., Amgoth, T., & Annavarapu, CSR (2019). Machine learning algorithms for wireless sensor networks: A survey. Information Fusion, 49, 1–25. https://doi.org/10.1016/j.inffus.2018.09.013

Sarker, I. H. (2021). Machine Learning: Algorithms, Real-World Applications and Research Directions. SN Computer Science, 2(3), 160. https://doi.org/10.1007/s42979-021-00592-x

Scherer, R., Siddiq, F., & Tondeur, J. (2019). The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. Computers & Education, 128, 13–35. https://doi.org/10.1016/j.compedu.2018.09.009

Smutny, P., & Schreiberova, P. (2020). Chatbots for learning: A review of educational chatbots for the Facebook Messenger. Computers & Education, 151, 103862. https://doi.org/10.1016/j.compedu.2020.103862

Ting, DSW, Carin, L., Dzau, V., & Wong, T.Y. (2020). Digital technology and COVID-19. Nature Medicine, 26(4), 459–461. https://doi.org/10.1038/s41591-020-0824-5

Vamathevan, J., Clark, D., Czodrowski, P., Dunham, I., Ferran, E., Lee, G., Li, B., Madabhushi, A., Shah, P., Spitzer, M., & Zhao, S. (2019). Applications of machine learning in drug discovery and development. Nature Reviews Drug Discovery, 18(6), 463–477. https://doi.org/10.1038/s41573-019-0024-5

Villa-Henriksen, A., Edwards, G.T.C., Pesonen, L.A., Green, O., & Sørensen, CAG (2020). Internet of Things in arable farming: Implementation, applications, challenges and potential. Biosystems Engineering, 191, 60–84. https://doi.org/10.1016/j.biosystemseng.2019.12.013

Warsita, B. (2018). MOBILE LEARNING AS AN EFFECTIVE AND INNOVATIVE LEARNING MODEL. Technodic Journal, 062–073. https://doi.org/10.32550/teknodik.v14i1.452

Yuan, Q., Shen, H., Li, T., Li, Z., Li, S., Jiang, Y., Xu, H., Tan, W., Yang, Q., Wang, J., Gao, J., & Zhang, L. (2020). Deep learning in environmental remote sensing: Achievements and challenges. Remote Sensing of Environment, 241, 111716. https://doi.org/10.1016/j.rse.2020.111716

Zhao, N., Liang, Y.-C., Niyato, D., Pei, Y., Wu, M., & Jiang, Y. (2019). Deep Reinforcement Learning for User Association and Resource Allocation in Heterogeneous Cellular Networks. IEEE Transactions on Wireless Communications, 18(11), 5141–5152. https://doi.org/10.1109/TWC.2019.2933417

Zou, H., Guo, L., Xue, H., Zhang, Y., Shen, X., Liu, X., Wang, P., He, X., Dai, G., Jiang, P., Zheng, H., Zhang, B., Xu, C., & Wang, Z. L. (2020). Quantifying and understanding the triboelectric series of inorganic non-metallic materials. Nature Communications, 11(1), 2093. https://doi.org/10.1038/s41467-020-15926-1