Relationship among Perceived Usefulness, Ease of Use, Attitude and Intention to Use Emerging Technology among Undergraduate in South-West Nigeria

Sakiru Sulaimon Keji[1]* iD

[1,2,3] Department of Educational Technology, University of Ilorin, Ilorin, Nigeria

ARTICLE INFO	ABSTRAK
	Alat-alat teknologi yang sedang berkembang adalah alat-alat inovatif dan instruksional yang digunakan untuk melengkapi pengajaran dan pembelajaran tradisional untuk meningkatkan kinerja akademik positif siswa. Meskipun memiliki manfaat pengajaran, namun belum sepenuhnya dimanfaatkan untuk pembelajaran di kalangan mahasiswa sarjana di Nigeria. Oleh karena itu, penelitian ini menganalisis hubungan antara persepsi kegunaan, kemudahan penggunaan, sikap dan niat untuk menggunakan Teknologi Berkembang di kalangan sarjana di Nigeria Barat Daya. Penelitian ini menggunakan desain penelitian kuantitatif jenis survei. Populasinya adalah seluruh mahasiswa sarjana di barat daya, Nigeria dengan sampel sebanyak 1.412 orang yang diambil sampelnya secara sengaja dari 12 universitas Federal dan Negeri di barat daya, Nigeria. Data dikumpulkan melalui pemberian kuesioner yang telah divalidasi dan dirancang oleh peneliti. Persentase dan skor rata-rata digunakan untuk menjawab pertanyaan penelitian, sedangkan uji t independen dan Analisis varians (ANCOVA) digunakan untuk menguji hipotesis pada tingkat signifikansi 0,05. Temuan menunjukkan bahwa tidak ada hubungan yang signifikan antara persepsi kegunaan, kemudahan penggunaan, sikap dan niat mahasiswa untuk menggunakan Teknologi Berkembang di Nigeria Barat Daya. Studi tersebut menyimpulkan bahwa alat-alat Teknologi Berkembang merupakan strategi pembelajaran yang lebih baik bagi semua mahasiswa tingkat sarjana jika diintegrasikan dengan baik dalam pengajaran dan pembelajaran dapat membantu meningkatkan pembelajaran mahasiswa tingkat sarjana. Studi ini merekomendasikan antara lain bahwa mahasiswa sarjana harus diberikan dukungan yang diperlukan dalam penyediaan semua fasilitas yang diperlukan untuk pemanfaatan yang tepat dari teknologi pembelajaran yang sedang berkembang.

ABSTRACT

Emerging technological tools are innovative and instructional tools used to supplement traditional teaching and learning for the enhancement of students' positive academic performance. Despite its instructional benefits, they have not been fully utilized for learning among undergraduates in Nigeria. Hence, the study analyzes the relationship among perceived usefulness, ease of use, attitude and intention to use Emerging Technology among undergraduate in South-west Nigeria. The study adopted quantitative research design of survey type. The population was all undergraduates' students in south-west, Nigeria out of which a sample of 1,412 were purposively sampled from 12 Federal and State universities in South-west, Nigeria. Data were collected through the administration of validated researcher-designed questionnaire. Percentages and mean scores were used to answer the research questions, while independent t-test and Analysis of variance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The findings indicated that there was no significant relationship among undergraduates perceived usefulness, ease of use, attitude and intention to use Emerging Technology in South-west Nigeria. The study concluded that Emerging Technological tools are better learning strategies for all undergraduates if well integrated in teaching and learning can help in improving undergraduates' learning. The study recommended among others that undergraduates should be given the necessary supports on the provision of all needed facilities for proper utilization of the emerging technology for learning.

Corresponding author
E-mail addresses: aladesusigboyega@gmail.com (Sakiru Sulaimon Keji)

1. INTRODUCTION

All over the world, COVID-19 pandemic has brought new ways of doing virtually everything including teaching and learning and business education programmer is not an exception. The year 2020 specifically was a challenging year globally due to COVID-19 which led to changes in teaching and learning with lockdowns of schools and switching from face-to-face teaching and learning to online instructions (Indrayana & Sadikin, 2020; Mukarromah & Wijayanti, 2021). This triggered a lot of action research by various stakeholders and educational experts on new knowledge to inform instructional design, assessment, evaluation and educational policies on emerging technologies in teaching and learning in higher education institutions (Supeni et al., 2019; Yeni & Cagiltay., 2017). New trends in teaching and learning depend on emerging technologies in the new normal brought about by COVID 19 pandemic. Education generally and indeed Educational Technology programme is perceived in most countries as a means of preparing students to acquire practical skills, attitudes, understanding and knowledge relating to occupations in various sectors of the economy and social life (Bhattacharjee & Deb, 2016; Haatainen & Aksela, 2021). According to ILO, UNESCO and World Bank Group, emphases are now on future skills and deskilling particularly learning-to-learn skills (Bhattacharjee & Deb, 2016). This would allow people to adapt to future changes in the labour market through continued and lifelong learning and improving the responsiveness of educational systems to emerging trends. It also requires close cooperation between education, research and industry to allow institutions of higher learning to provide skills training in emerging areas. Furthermore, there is need for a strong emphasis on technologies in teaching and learning to facilitate adaptation to workplaces where manual tasks are being taken over by digital tasks (Arsić & Milovanović, 2016; Martín et al., 2021).

The need to prepare education students to fit into the world of work in the 21st century and beyond requires the acquisition of emerging Technologies in teaching and learning. The emerging technologies focused in this paper include Ubiquitous Computing (UC) which enables computing power anytime, anywhere; Collaboration Technologies (CT) that facilitates the ability to collaborate with anyone in real time; Extended Reality (ER) that drives the ability to digitally simulate reality and to integrate digital and physical worlds into teaching and learning; Artificial Intelligence (AI) enables machines to learn on their own, and interact in a human-like manner in the teaching and learning environment and Blockchain (BC) that use computers with guarantees as to privacy and security (Gunadi et al., 2022; Irwanto et al., 2018; Parno et al., 2022). Previous study explained that the use of technology in every facet of life is also being advanced as an emerging means of teaching and learning especially in the new normal (Widodo et al., 2020).

The adoption of Emerging Technologies in education has been growing for years now, such that their influence has become more apparent. A variety of Emerging Technologies are employed in various ways to foster teaching and learning in higher learning institutions. It is evident that Emerging Technologies and tools are becoming increasingly popular in education, especially higher education (Miranda et al., 2021; Su et al., 2022). For instance, technology such as social networking sites and emerging technologies are most utilized by instructors and students in learning. Similarly, technologies and services such as Microsoft Team, course management systems, Moodle, Waggle and media sharing platforms in addition to SNSs and other Emerging Technologies software are used differently by faculty members and students to support learning directly or indirectly (Batubara, 2017; Morrar et al., 2017).

In fact, professional and instructional use of tools such as LinkedIn, Academia, and ResearchGate is increasingly enhancing learning process. A wide array of educational Emerging Technologies applications, tools and services are available for application in the field of education in order to enhance learning experiences regardless of geographical location (Ali & Frew, 2013; Majid & Salam, 2021). However, the question that stands is how useful and easy to use teaching staff and students perceive these to be. According to previous study perceived usefulness is an individual belief that a technology will make their work better (Elmahdi et al., 2018). On the other hand, other study views perceived usefulness as the degree to which students believe that using technologies will improve their learning performances (Kesavan & Palappallil, 2018; Wen & Walters, 2022). Several studies acknowledge that perceived usefulness is a determining factor of the adoption, integration and continued usage of technologies in teaching and learning activities (J. Jang et al., 2021; Martín et al., 2021). Basically, web-based technologies used in teaching provide faculty members and students with opportunities to collaborate in knowledge creation and sharing.

In this regards, elements of collaboration, communication and participation in knowledge creation and critiquing of ideas given by others are essential factors for the adoption and integration on web-based technologies in teaching and learning. These inform that technologies and tools provide a learning environment in which students can construct their learning experiences and collaborate with

others to generate ideas (Meier, 2021; Meyers et al., 2013). For example, web applications open the door to direct communication among learners and educators. In these aspects, many constructivist theorists affirm that the use of technologies enhances interactions between individuals and the sharing of information between them. Furthermore, supporters of collaborative learning believe that collaborative learning helps students to retain information better than when they work individually (Lampropoulos et al., 2019; Tang et al., 2020). This is attributed to the fact that when Emerging Technologies are used, students and instructors become co-authors or co-developers of ideas and contents.

The perceived, ease of utilization as well as intention to use emerging technology in teaching and learning poses significant challenges and concerns in educational settings. While these technologies offer promising opportunities to enhance the learning experience, they also present several obstacles that need to be addressed for their effective integration. The novelty of this study investigated relationship among perceived usefulness, ease of use, attitude and intention to use emerging technology among undergraduate in south-west Nigeria. The main purpose of this study is to analyze relationship among perceived usefulness, ease of use, attitude and intention to use emerging technology among undergraduate in south-west Nigeria.

2. METHOD

This study is descriptive research using cross-section survey method. The study is descriptive in the sense that the research describes events as they appear without any manipulation (Nassaji, 2015). A researcher-designed questionnaire was used to collect information from the respondents on the Perception of Undergraduates on the utilization of Emerging Technologies for learning in selected Universities in South-West, Nigeria. Survey method was chosen for the study because it enabled the researcher to gather large amount of information on Undergraduates' perception of collaborative tools for learning. The population for the study consists all the university undergraduate students in the South-western States of Nigeria. The instrument for this study was validated by four lecturers from the Department of Educational Technology, one lecturer from the department of computer science, university of Ilorin, Ilorin Nigeria, researchers supervisor's and the researcher's internal-external examiner from the Department of Library and Information Science, University of Ilorin to determine the relevance and suitability of the instrument considering its language clarity to the respondents, content coverage in terms of adequacy and its relevancy to the stated objectives. The suggestion given by these lecturers were used for the modification of the instrument.

The instrument was pilot-tested on 50 undergraduate students at the University of Ilorin. The institution involved in the trial testing was outside the intended sample location for the study. Out of the 50 copies of questionnaire administered for the trial testing, 47 were returned as properly filled and thus were used for the reliability analysis. The analysis of data that was gathered through the questionnaire was done using descriptive and inferential statistics. The frequencies were converted to mean to answer the research questions. Hypothesis was tested using multiple regression analysis. This is because it found out whether there were significant relationships among many variables such as perceived usefulness, perceived ease of use, attitude and intention.

3. RESULT AND DISCUSSION

Result

There is no significant relationship among undergraduates' perceived usefulness, ease of use, attitude and intention to use emerging technologies for learning in south-west Nigeria. To test for relationship between variables of ease of use, attitude and intention on the criterion variables usefulness, the multiple correlation analysis was carried out using the enter method. The results derived from the analysis are shown in Table 1.

Table 2. Model Summary on Perceived Usefulness

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	0.497	0.247	0.245	0.39762	0.247	153.627	3	1408	0.000

From the result in Table 2, the Adjusted R square (0.25) has poor fit. This revealed that the constructed multiple regression model of the independent variables (perceived ease of use, attitude and

intention to use) accounts for 0.25% variance in the dependent variable (useful). The results on the analysis of variance (ANOVA) for the model are as shown in Table 3.

Table 1. ANOVA for Independent Variables on Usefulness

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	72.865	3	24.288	153.627	0.000
	Residual	222.605	1408	0.158		
	Total	**295.471**	**1411**			

The result on the analysis of variance (ANOVA) on independent variable of usefulness was reviewed and presented in Table 3. The results showed that $F_{(3.1408)} = 153.63$, $p = 0.00$. This indicated a statistically significant relationship since the p-value is less than 0.05. The results are as shown in Table 4.

Table 2. Coefficient of Independent Variables on Perceived Usefulness

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	1.326	0.093		14.213	0.000
Perceived ease of use of online collaborative for learning	0.488	0.024	0.482	20.618	0.000
Attitudes towards the use of Emerging Technologies for learning	0.038	0.034	0.039	1.125	0.261
Intention to use Emerging Technologies for learning	0.082	0.029	0.098	2.868	0.004

Base on Table 4, the Independent variable, perceived' ease of use value has the strongest positive influence on usefulness of Emerging Technologies because the Beta (β = .48, .00) shows statistically significant relationship because value was less than 0.05 alpha value. The independent variable, intention to use has strong positive influence on usefulness of Emerging Technologies for learning because the beta (β = .10, .00) shows statistically significant relationship because value was less than 0.05 alpha value. But, the independent variable, attitude to use has low influence on intention to use Emerging Technologies for learning because the Beta (β = .04, .26) shows no statistically significant relationship because value was greater than 0.05 alpha value.

Discussion

The relationship among Undergraduates perceived usefulness, ease of use, attitude and intention to use Emerging Technologies in instruction was examined using research question 5 and hypothesis 1. The result of the regression analysis established a significant relationship between perceived usefulness (dependent variable) and their perceived ease of use, attitude and intention (independent variables). Also, the analysis indicated a significant relationship between perceived ease of use (dependent variable) and their perceived usefulness, attitude and intention (independent variables). Moreover, it was established that there was a significant relationship between the respondents' attitude (dependent variable) and their perceived usefulness, perceived ease of use and their intention (independent variables) to use emerging technologies in instruction. Furthermore, a significant relationship existed between their intention (dependent variable) and their perceived usefulness, perceived ease of use and their attitude (independent variables) towards the use of emerging technologies in instruction.

These findings were in agreement with that of many scholars. Previous study found out that there were significant relationships between perceived ease of use and attitude, perceived ease of use and perceived usefulness, perceived usefulness and intention, perceived usefulness and attitude with attitude and intention (Kumar et al., 2008). These also agreed with the findings also found a significant relationship between intention to use, perceived usefulness, perceived ease of use and attitude (M. Jang et al., 2021; Morrar et al., 2017). However, the findings contradicted who found out that in the context of web-based learning technologies, both usage and perceived usefulness influence continuance intention, whilst perceived ease of use does not (Çoban & Göksu, 2022; Nesbit & Li, 2004). It could therefore be inferred from the findings that there were significant relationships among the variables of perceived usefulness, perceived ease of use, attitude and the intention to use emerging technologies in teaching. All these give way for actual usage. Since they were already found to be in place, the integration of Emerging Technologies in teaching by undergraduates was expected to have a smooth take-off.

It is evident that using emerging technologies tools have been found to help learners understand complex materials and enhance effective transfer of information and concepts learned in one setting to problem-solving processes in other settings (Ali & Frew, 2013; Tuuri & Koskela, 2020). It is also a well-known fact that when users actively participate in their learning, their ability to apply and retain knowledge is higher. On the same note, studies show that today's digital students learn more when they are engaged in meaningful, relevant, and intellectually stimulating schoolwork and that the use of technology is fundamental in such learning (Gomez-del Rio & Rodriguez, 2022). Besides that, it is worth noting that web tools enhance blended learning and create a positive learning environment both for the teaching staff and students, and provide learners with opportunities to create and edit the content accessed (Anjarwati et al., 2018; Hussin et al., 2019).

Along these, the employment of web tools increases self-confidence levels of learners, and enhances the development of critical thinking skills among teachers (Maamuujav et al., 2019; Williams et al., 2009). Exploring perceptions, interests, and use of emerging technologies in education, other study found that participating teaching staff indicated positive perceptions of the pedagogical benefits and importance of emerging technologies for teaching and learning (Reddy et al., 2022). The findings further suggest that teaching staff expressed interest in gaining further skills and understanding the technologies in order to more effectively and seamlessly integrate them in classroom instructions. The findings inform that access to emerging technologies enhances meaningful teaching and learning and fosters readiness for their adoption and integration in classrooms. Previous study examined students' decisions to adopt emerging technologies and found that many students feel that some applications are effective at increasing their satisfaction with a course, improving their learning and writing ability, and increasing students-students and students- faculty interactions (Andyani et al., 2020). Surprisingly, the study further discloses that few students chose to use them in educational contexts.

Previous study noted that faculty's perceptions of the usefulness of emerging technologies are significant predictors of their intention to use the applications in teaching (Fatmawati et al., 2021). Furthermore, web technologies provide students and teaching staff with avenues for publishing their works. Similarly, the usefulness of the technologies exists in form of their enhancement of learning subjects, satisfaction with courses, students' grades, and evaluation of and access to learning materials (Nee et al., 2019). Their ability to change the way of sharing, accessing and interacting with information improves emerging technologies perception. In all, examining the perceived usefulness of emerging technologies is crucial when trying to predict their actual use in teaching and learning activities. Previous study asserts that the perceived usefulness of a technology is a stronger predictor of its use (Morrar et al., 2017). The implication of this study found that perceived ease of use refers to the degree to which an innovation (technology) is perceived to be easy to understand and use. Users of a technology can perceive ease of use of technology when they are exposed to or familiar with it. It is clear that when users perceive ease of use of a technology, they are likely start making use of it. New ideas and innovations that are easier to understand are adopted more rapidly than those that require adopters to develop considerable new skills and understandings. However, this research is limited by its specific region, namely only involving students in southwest Nigeria. The results may not be directly applicable to a broader population or to other geographic locations.

4. CONCLUSION

The study concluded that Emerging Technological tools are better learning strategies for all undergraduates if well integrated in teaching and learning can help in improving undergraduates' learning. The study recommended among others that undergraduates should be given the necessary supports on the provision of all needed facilities for proper utilization of the emerging technology for learning since, there were significant relationships among the variables of perceived usefulness, perceived ease of use, attitude and the intention to use Emerging Technologies in teaching.

5. REFERENCES

Ali, A., & Frew, A. J. (2013). Information and communication technologies for sustainable tourism. In *Information and Communication Technologies for Sustainable Tourism* (Vol. 8). Society of Interdisciplinary Business Research. https://doi.org/10.4324/9780203072592.

Andyani, H., Setyosari, P., Wiyono, B. B., & Djatmika, E. T. (2020). Does Technological Pedagogical Content Knowledge Impact on the Use of ICT In Pedagogy? *International Journal of Emerging Technologies in Learning (IJET)*, *15*(3), 126. https://doi.org/10.3991/ijet.v15i03.11690.

Anjarwati, P. G. P., Sajidan, & Prayitno, B. A. (2018). Problem-Based Learning Module of Environmental

Changes to Enhance Studentsâ€™ Creative Thinking Skill. *Biosaintifika: Journal of Biology & Biology Education*, *10*(2), 313–319. https://doi.org/10.15294/biosaintifika.v10i2.12598.

Arsić, Z., & Milovanović, B. (2016). Importance of computer technology in realization of cultural and educational tasks of preschool institutions. *International Journal of Cognitive Research in Science, Engineering and Education*, *4*(1), 9–16. https://doi.org/10.5937/IJCRSEE1601009A.

Batubara, H. H. (2017). engembangan Situs E-Learning Dengan Moodle Versi 3.1 Sebagai Media Pembelajaran Pada Program Studi Pendidikan Guru Madrasah Ibtidaiyah. *AL-BIDAYAH: Jurnal Pendidikan Dasar Islam*, *9*(1), 1–10. https://doi.org/10.14421/al-bidayah.v9i1.116.

Bhattacharjee, B., & Deb, K. (2016). Role of ICT in 21 st Century's Teacher Education. *International Journal of Education and Information Studies*, *6*(1), 1–6. http://library.oum.edu.my/oumlib/sites/default/files/file_attachments/odl-resources/4353/convergence-ict.pdf.

Çoban, M., & Göksu, İ. (2022). Using virtual reality learning environments to motivate and socialize undergraduates in distance learning. *Participatory Educational Research*, *9*(2). https://doi.org/10.17275/per.22.36.9.2.

Elmahdi, I., Al-Hattami, A., & Fawzi, H. (2018). Using Technology for Formative Assessment to Improve Students' Learning. *Turkish Online Journal of Educational Technology-TOJET*, *17*(2), 182–188. https://eric.ed.gov/?id=EJ1176157.

Fatmawati, F., Andriyani, N., & Ningsih, R. (2021). Digital Literacy: Teachers' Perceptions of Using Google Accounts in the Online Learning Process. *AL-ISHLAH: Jurnal Pendidikan*, *13*(2), 1017–1026. https://doi.org/10.35445/alishlah.v13i2.596.

Gomez-del Rio, T., & Rodriguez, J. (2022). Design and assessment of a project-based learning in a laboratory for integrating knowledge and improving engineering design skills. *Education for Chemical Engineers*, *40*(February), 17–28. https://doi.org/10.1016/j.ece.2022.04.002.

Gunadi, G., Haryono, H., Purwanti, E., Raya, B. R., Pinoh Barat Melawi, T., & Kalimantan, W. (2022). The Analysis of 21 st Century Learning Implementation and Competency Achievement of Junior High School Students in 3T Regions. *Innovative Journal of Curriculum and Educational Technology*, *11*(1), 10–18. https://doi.org/10.15294/IJCET.V11I1.44847.

Haatainen, O., & Aksela, M. (2021). Project-based learning in integrated science education: Active teachers' perceptions and practices. *Lumat*, *9*(1), 149–173. https://doi.org/10.31129/LUMAT.9.1.1392

Hussin, W. N. T. W., Harun, J., & Shukor, N. A. (2019). Online interaction in social learning environment towards critical thinking skill: A framework. *Journal of Technology and Science Education*, *9*(1), 4–12. https://doi.org/10.3926/jotse.544.

Indrayana, B., & Sadikin, A. (2020). Penerapan E-Learning Di Era Revolusi Industri 4.0 Untuk Menekan Penyebaran Covid-19. *Indonesian Journal of Sport Science and Coaching*, *2*(1), 46–55. https://doi.org/10.22437/ijssc.v2i1.9847.

Irwanto, Saputro, A. D., Rohaeti, E., & Prodjosantoso, A. K. (2018). Promoting critical thinking and Problem Solving Skills of Preservice Elementary Teachers through Process-Oriented Guided-Inquiry Learning (POGIL). *International Journal of Instruction*, *11*(4). https://doi.org/10.12973/iji.2018.11449a.

Jang, J., Ko, Y., Shin, W. S., & Han, I. (2021). Augmented Reality and Virtual Reality for Learning: An Examination Using an Extended Technology Acceptance Model. *IEEE Access*, *9*, 6798–6809. https://doi.org/10.1109/ACCESS.2020.3048708

Jang, M., Aavakare, M., Nikou, S., & Kim, S. (2021). The Impact of Literacy on Intention to Use Digital Technology for Learning: A Comparative Study of Korea and Finland. *Telecommunications Policy*, *45*(7). https://doi.org/10.1016/j.telpol.2021.102154.

Kesavan, K. P., & Palappallil, D. S. (2018). Effectiveness of formative assessment in motivating and improving the outcome of summative assessment in pharmacology for medical undergraduates. *Journal of Clinical and Diagnostic Research*, *12*(5), FC08-FC11. https://doi.org/10.7860/JCDR/2018/34533.11527.

Kumar, N., Rose, R. C., & D'Silva, J. L. (2008). Teachers' readiness to use technology in the classroom: An empirical study. *European Journal of Scientific Research*, *21*(4), 603–616. https://www.researchgate.net/profile/Jeffrey-Lawrence-2/publication/239764656.

Lampropoulos, G., Siakas, K., & Anastasiadis, T. (2019). Internet of Things in the Context of Industry 4.0: An Overview. *International Journal of Entrepreneurial Knowledge*, *7*(1), 4–19. https://doi.org/10.2478/ijek-2019-0001.

Maamuujav, U., Krishnan, J., & Collins, P. (2019). The utility of infographics in L2 writing classes: A practical strategy to scaffold writing development. *TESOL Journal*, *September*. https://doi.org/10.1002/tesj.484.

Majid, S. N. A., & Salam, A. R. (2021). A Systematic Review of Augmented Reality Applications in Language Learning. *International Journal of Emerging Technologies in Learning*, *16*(10). https://doi.org/10.3991/ijet.v16i10.17273.

Martín, C. T., Acal, C., Honrani, M. El, & Estrada, Á. C. M. (2021). Impact on the virtual learning environment due to covid-19. *Sustainability (Switzerland)*, *13*(2), 1–16. https://doi.org/10.3390/su13020582.

Meier, E. B. (2021). Designing and using digital platforms for 21st century learning. *Educational Technology Research and Development*, *69*(1), 217–220. https://doi.org/10.1007/s11423-020-09880-4.

Meyers, E. M., Erickson, I., & Small, R. V. (2013). Digital literacy and informal learning environments: An introduction. *Learning, Media and Technology*, *38*(4), 355–367. https://doi.org/10.1080/17439884.2013.783597.

Miranda, J., Navarrete, C., Noguez, J., Molina-Espinosa, J. M., Ramírez-Montoya, M. S., Navarro-Tuch, S. A., Bustamante-Bello, M. R., Rosas-Fernández, J. B., & Molina, A. (2021). The core components of education 4.0 in higher education: Three case studies in engineering education. *Computers and Electrical Engineering*, *93*(February), 1-13. https://doi.org/10.1016/j.compeleceng.2021.107278.

Morrar, R., Arman, H., & Mousa, S. (2017). The fourth industrial revolution (Industry 4.0): A social innovation perspective. *Technology Innovation Management Review*, *7*(11), 12–20. https://timreview.ca/sites/default/files/Issue_PDF/TIMReview_November2017.pdf#page=12.

Mukarromah, U., & Wijayanti, W. (2021). Implementation of the online learning at vocational high school during Covid-19: Between obligations and barriers. *Jurnal Pendidikan Vokasi*, *11*(1). https://doi.org/10.21831/jpv.v11i1.37110.

Nassaji, H. (2015). Qualitative and descriptive research: Data type versus data analysis. *Language Teaching Research*, *19*(2), 129–132. https://doi.org/10.1177/1362168815572747.

Nee, C. C., Yunus, M. M., & Suliman, A. (2019). ICT: An Effective Platform to Promote Writing Skills among Chinese Primary School Pupils. *Arab World English Journal*, *10*(4), 223–237. https://doi.org/10.24093/awej/vol10no4.17.

Nesbit, J. C., & Li, J. (2004). Web-based tools for learning object evaluation. *In International Conference on Education and Information Systems*, 21–25. http://sn4re.note4research.com/sn4re/app/data/dasaw/2553.pdf.

Parno, Nur'aini, D. A., Kusairi, S., & Ali, M. (2022). Impact of The STEM approach with formative assessment in PjBL on students' critical thinking skills. *The 1st International Conference Science Physics and Education 2021 (ICSPE 2021)*, *2165*(1). https://doi.org/10.1088/1742-6596/2165/1/012044.

Reddy, P., Sharma, B., & Chaudhary, K. (2022). Digital literacy: a review in the South Pacific. *Journal of Computing in Higher Education*, *34*(1), 83–108. https://doi.org/10.1007/s12528-021-09280-4.

Su, Y.-S., Cheng, H.-W., & Lai, C.-F. (2022). Study of Virtual Reality Immersive Technology Enhanced Mathematics Geometry Learning. *Frontiers in Psychology*, *13*(February), 1–8. https://doi.org/10.3389/fpsyg.2022.760418.

Supeni, S., Hakim, L., & Jumintono. (2019). Strengthening Character Education of Early Childhood through Javanese Traditional Game Dakon. *International Journal of Recent Technology and Engineering*, *7*(6S2), 243–249. https://www.atlantis-press.com/proceedings/ijcah-20/125947406.

Tang, T., Vezzani, V., & Eriksson, V. (2020). Developing critical thinking, collective creativity skills and problem solving through playful design jams. *Thinking Skills and Creativity*, *37*(May), 100696. https://doi.org/10.1016/j.tsc.2020.100696.

Tuuri, K., & Koskela, O. (2020). Understanding Human–Technology Relations Within Technologization and Appification of Musicality. *Frontiers in Psychology*, *11*(April), 1–14. https://doi.org/10.3389/fpsyg.2020.00416.

Wen, X., & Walters, S. M. (2022). The Impact of Technology on Students' Writing Performances in Elementary Classrooms: A Meta-Analysis. *Computers and Education Open*, *3*, 100082. https://doi.org/10.1016/j.caeo.2022.100082.

Widodo, S. F. A., Wibowo, Y. E., & Wagiran, W. (2020). Online learning readiness during the Covid-19 pandemic. *Journal of Physics: Conference Series*, *1700*(1), 12033. https://doi.org/10.1088/1742-6596/1700/1/012033.

Williams, M. K., Foulger, T. S., & Wetzel, K. (2009). Preparing Preservice Teachers for 21st Century Classrooms: Transforming Attitudes and Behaviors About Innovative Technology. *Journal of Technology and Teacher Education*, *17*(3), 393–418. https://www.learntechlib.org/primary/p/28216/.

Yeni, S., & Cagiltay., K. (2017). A heuristic evaluation to support the instructional and enjoyment aspects of a math game. *Program*, *51*(4), 406–423. https://doi.org/10.1108/ PROG-07-2016-0050.