Perceived Relevance, Computer Self-Efficacy, Computer Dexterity, and Internet Proficiency as Predictors of Physics Education Undergraduates' Participation in Online Learning Environment

By

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Abstract
This study examined Perceived Relevance, Computer Self-Efficacy, Computer Dexterity, and Internet Proficiency as Predictors of Physics Education Undergraduates' Participation in Online Learning Environments. A quantitative, correlational (non-experimental) survey design was adopted. The study population consisted of all Physics Education undergraduates in Ogun State Universities, and a stratified random sampling technique was employed to select a sample of 134 respondents. Data were collected using a researcher-designed instrument titled Questionnaire on Predictor Factors on Participation in Online Learning Environment (QPRPOLE). The instrument's reliability was established using Cronbach's alpha, yielding a coefficient of $r = 0.74$, indicating good internal consistency. Data were analyzed using frequency counts, mean and standard deviation, Pearson product-moment correlation, and multiple regression analysis. The findings revealed that perceived relevance ($r = .653$), internet proficiency ($r = .624$), and computer self-efficacy ($r = .601$) had strong positive correlations with online learning participation, while computer dexterity ($r = .583$) showed a moderate-to-strong correlation. The regression model demonstrated that all four predictors significantly contributed to the prediction of participation in online learning. Specifically, perceived relevance ($\beta = .352$, $p < .001$) was the strongest predictor, followed by computer self-efficacy ($\beta = .284$, $p < .001$), internet proficiency ($\beta = .221$, $p < .001$), and computer dexterity ($\beta = .207$, $p = .001$). The model was statistically significant, $F(4,129) = 45.62$, $p < .001$, accounting for 58.5% of the variance in online learning participation ($R = .77$, $R^2 = .59$, Adjusted $R^2 = .57$). The study concluded that these four factors collectively and significantly influenced Physics Education undergraduates' participation in online learning environments. Based on the findings, it is recommended that higher institutions provide structured digital literacy and skill development programs to strengthen students' computer dexterity and internet proficiency. Educators should design online physics content that is contextually relevant and engaging to improve students' perceived relevance and motivation to participate in online learning.

Keywords: Computer Dexterity, Computer Self-Efficacy, Internet Proficiency, Online Learning Environment, Perceived Relevance.

Introduction

The online learning environment is described as a technology-mediated educational framework that harnesses digital platforms, tools, and resources to support teaching, learning, interaction, and assessment beyond the traditional classroom context. It includes Learning Management Systems (LMS), virtual classrooms, digital content archives, and communication tools that facilitate both synchronous and asynchronous interactions between educators and learners. As noted by Bond et al. (2021), online learning environments that are underpinned by digital technologies provide flexible, interactive, and accessible opportunities for knowledge development and skill acquisition, thus broadening the avenues for participation in higher Institutions of learning. The widespread integration of digital technologies, along with the availability of learning management systems, video conferencing tools, and virtual laboratories, has made online classes an essential aspect of contemporary education (Dhawan, 2020).

The COVID-19 pandemic has further propelled this transition, necessitating universities worldwide to adopt remote learning as the primary form of instruction. This transformation has established online classes as a crucial means of instructional delivery in higher institutions, eliminating the barriers of time and space that previously limited access to quality education. In higher institutions of learning, online classes are now viewed not merely as alternatives but as essential pathways for knowledge dissemination and learner engagement. They provide undergraduates with the flexibility to access instructional materials at any time and from any location, thus promoting inclusivity for diverse learners (Bao, 2020). Online platforms also facilitate interactive teaching methods, such as discussion forums, collaborative projects, and multimedia resources, which enhance student participation. For higher institutions, online learning has become a way to broaden their reach, serve larger populations, and incorporate innovative pedagogical strategies that meet the needs of 21st-century learners

The significance of online classes is particularly pronounced in scientific fields like physics, where abstract concepts often demand visualization and experimentation. By employing simulations, virtual laboratories, and interactive modeling tools, students can engage with intricate scientific principles that may be difficult to understand through traditional lecture-based approaches (Abdellatif, 2024). Moreover, online platforms facilitate collaborative problem-solving and provide instant access to scientific databases, allowing learners to investigate concepts in real time. It also encourages flexible and self-directed learning, which are essential skills for success in today's scientific and technological environments. These technological features make online learning a valuable addition to traditional science education, promoting a deeper understanding and application of physics concepts.

The discipline of Physics education, as a teaching enterprise, is crucial for societal development since it not only disseminates scientific knowledge but also cultivates critical thinking, problem-solving capabilities, and innovation that drive technological and industrial progress (Aderonmu, & Obafemi, 2022). By preparing learners to grasp and apply the essential laws of nature, physics education fosters a generation of skilled professionals who contribute to advancements in energy, medicine, communication, and sustainable development. As an educational discipline, physics encourages inquiry-based learning and scientific literacy, empowering citizens to make informed choices in an increasingly technology-oriented society (Ogunniyi, 2021). Therefore, the systematic instruction of physics acts as a cornerstone for developing human capital that propels national advancement and enhances global competitiveness.

In spite of the advantages offered by online learning, there are still challenges in achieving effective participation, particularly for undergraduates in Physics education. Adedoyin & Soykan, 2020) have indicated that several factors, such as perceived relevance, computer self-efficacy, computer dexterity, and internet proficiency, have been identified as potential indicators of undergraduates' involvement in online learning environments. Perceived Relevance (PR) is defined as the degree to which learners consider instructional content and activities to be meaningful, useful, and aligned with their academic aspirations, personal interests, or future career goals. In an online learning context, undergraduates who perceive the content as relevant tend to be more motivated to engage, persist, and actively participate in virtual classes, despite facing challenges like isolation or technological barriers (Wei & Chou, 2020). Perceived relevance serves as a crucial factor in determining learner satisfaction, commitment, and the overall efficacy of online education.

The definition of Computer Self-Efficacy (CSE) encompasses an individual's belief in their own skills to operate a computer successfully for task completion, whether these tasks occur online or offline. This concept relates to a person's conviction in their ability to adeptly utilize computers and related technologies to fulfill specific tasks (He, et al., 2021). A high level of computer self-efficacy allows undergraduates to confidently navigate digital platforms, address challenges, and fully engage with learning materials and activities. Therefore, it is essential for minimizing anxiety, increasing participation, and improving overall educational outcomes in virtual learning environments.

Computer Dexterity (CD) refers to the practical capability, speed, and precision with which individuals operate computers and associated digital tools to complete academic or personal tasks. For undergraduate students in an online learning environment, computer dexterity is critical as it determines their efficiency in navigating learning management systems, submitting assignments, participating in virtual discussions, and utilizing multimedia resources. Undergraduates exhibiting high dexterity are more likely to engage actively in online classes, as they face fewer technical challenges and can concentrate on learning rather than struggling with basic operations. On the other hand, limited computer dexterity may result in frustration, decreased participation, and lower academic performance, making it a pivotal factor influencing the effectiveness of online education.

Internet Proficiency (IP) is defined as the ability of learners to effectively navigate, assess, and utilize online resources, platforms, and tools for academic purposes. For undergraduates in an online learning environment, high internet proficiency allows for seamless access to virtual classrooms, efficient information searching, active participation in discussions, and timely submission of assignments. Noting specifically, limited internet proficiency can impede participation, lower confidence, and create barriers to achieving meaningful learning outcomes in digital settings.

The rising integration of online learning in higher institutions of learning, particularly in science-related areas, demands a deeper insight into the factors that influence students' participation and engagement. In physics education, participation in online classes is not only vital for knowledge acquisition but also for the development of problem-solving, analytical, and experimental skills that are foundational to scientific education. Investigating perceived relevance, computer self-efficacy, computer dexterity, and internet proficiency offers a comprehensive framework for identifying the specific predictors that encourage or hinder Physics undergraduates' active engagement in online learning environments. This is particularly important as Physics necessitates consistent interaction with both theoretical and practical components (Aderonmu & Walele, 2020), which online platforms now increasingly facilitate through simulations, digital laboratories, and collaborative tasks.

The study is supported by the limited amount of research that simultaneously explores these four variables in relation to the participation of physics undergraduates in online learning. While past studies have looked at ICT skills and self-efficacy in isolation, there is a notable research gap in understanding how perceived relevance, technological confidence, practical dexterity, and internet proficiency work together to influence participation. Given the essential role of participation in enhancing collaboration, problem-solving, and conceptual understanding in science learning, this gap calls for empirical investigation.

Statement of Problem

In spite of the increasing availability of digital platforms and the widespread acceptance of online learning, many undergraduates still demonstrate low levels of participation in virtual classes. In physics education, where active engagement with complex theories, simulations, and problem-solving exercises is vital, this low participation rate undermines students' learning outcomes and overall academic performance. Factors such as insufficient digital literacy, limited confidence in using technology, and a lack of perceived relevance of online learning often prevent students from fully engaging in virtual classrooms. This situation raises important questions about the effectiveness of online learning in achieving its intended goals of accessibility, flexibility, and improved knowledge acquisition for physics undergraduates.

Identifying the key predictors of participation, such as perceived relevance, computer self-efficacy, computer dexterity, and internet proficiency, is therefore critical for improving the quality of online physics education. Understanding how these factors influence participation can guide lecturers in designing more engaging and relevant instructional strategies, while also helping institutions to provide targeted training and support services for students. Moreover, such insights can inform policymakers on the development of ICT policies that address participation barriers and promote equitable access to quality online education. Without addressing these predictors, the potential of online learning to enhance engagement, performance, and retention in physics education will remain underutilized.

Recognizing the key predictors of undergraduates' online participation, such as perceived relevance, computer self-efficacy, computer dexterity, and internet proficiency, is vital for advancing the quality of online Physics education. Gaining insight into how these factors affect participation can help lecturers develop more engaging and relevant instructional strategies, while also enabling institutions to deliver targeted training and support services for students. These insights can assist policymakers in crafting ICT policies that confront participation barriers and encourage equitable access to quality online education. Failing to address these predictors will result in the underutilization of online learning's potential to enhance engagement, performance, and retention in physics education.

Aim and Objectives of the Study

The study aims to ascertain whether perceived relevance, computer self-efficacy, computer dexterity, and internet proficiency are predictors of Physics Education undergraduates' participation in an online learning environment. Specifically, the objectives of the study are to;

(i) To examine the relative effect of perceived relevance, computer self-efficacy, computer dexterity, and internet proficiency on Physics Education undergraduates' participation in an online learning environment.

(ii) To determine the composite effect of perceived relevance, computer self-efficacy, computer dexterity, and internet proficiency on Physics Education undergraduates' participation in an online learning environment.

Research Questions

1. What is the relative effect of perceived relevance, computer self-efficacy, computer dexterity, and internet proficiency as predictors of Physics Education Undergraduates' Participation in an Online learning environment?
2. What is the composite effect of perceived relevance, computer self-efficacy, computer dexterity, and internet proficiency as predictors of Physics Education Undergraduates' Participation in an Online learning environment?

Hypotheses

H_{01}: Perceived relevance, computer self-efficacy, computer dexterity, and internet proficiency have no significant relative effect on Physics Education undergraduates' participation in an online learning environment.

H_{02}: Perceived relevance, computer self-efficacy, computer dexterity, and internet proficiency have no significant composite effect on Physics Education undergraduates' participation in an online learning environment.

Methodology

This study adopted a quantitative, correlational (non-experimental) survey design. The design is appropriate because it is aimed at examining the relationships among variables. It aims to determine the extent to which perceived relevance, computer self-efficacy, computer dexterity, and internet proficiency predict participation in an online learning environment among Physics education undergraduates. Data were collected at one point in time using structured questionnaires and analyzed using multiple regression to assess predictive power (Creswell & Creswell, 2018).

The population of this study comprised all undergraduate students enrolled in the Physics Education programme in Tai Solarin University of Education and Olabisi Onabanjo University in Ogun State during the study period. A sample of 134 undergraduates was selected across the levels of the programme. A stratified random sampling technique was employed to ensure adequate representation across different year levels (100level – 400level). The sample size is adequate for multiple regression with four predictors, allowing reasonable statistical power to detect medium-sized effects.

The instrument for data collection was titled Questionnaire on Predictor factors on Participation in Online Learning Environment (QPRPOLE) with 4-point Likert response scales of Strongly Agree = 1 point to Strongly Disagree = 4 points) were used to collect data. The instruments covered the following constructs:

a. Perceived Relevance (PR) – 5 (1-5) item statements assessing students' belief that online learning content and activities are relevant to their coursework and future teaching practice.

b. Computer Self-Efficacy (CSE) – 5 (6-10) item statements measuring confidence in using computers to complete learning tasks.
c. Computer Dexterity (CD) – 5 (11-15) items statement assessing speed and skill in using computers for academic tasks.
d. Internet Proficiency (IP) – 5 (16-20) items assessing ability to search, evaluate, and utilize online resources.
e. Participation in Online Learning Environment (POLE) – 5 (21-25) item statements designed for the dependent variable, measuring frequency and depth of student engagement in online learning activities.

The instrument, Questionnaire on Predictor factors on Participation in Online Learning Environment (QPRPOLE) had a total of twenty-five (25) item statements. The validation of the instrument by content validity was ensured through expert review by Physics Educators and Instructional Technology specialists. Construct validity was examined through factor analysis, while reliability was determined using Cronbach's alpha. A reliability coefficient index of $r = 0.74$ was adopted as acceptable for internal consistency. The questionnaires were administered in person to the Physics Education undergraduates, while participation was voluntary and informed consent was obtained from each participant. The data for the study were analyzed using the descriptive statistics of frequency count, mean, and standard deviation, while Pearson product-moment correlation was used to examine the Intercorrelation Matrix of Predictor Variables and Physics Education Undergraduates' Participation in Online Learning Environment and multiple regression analysis to determine the extent to which PR, CSE, CD and IP predict POLE.

Results

H_{01}: Perceived relevance, computer self-efficacy, computer dexterity and internet proficiency have no significant relative effect on Physics Education undergraduates' participation in an online learning environment.

Table 1: Descriptive Statistics of Predictor Variables and Physics Education Undergraduates' Participation in Online Learning Environment

Variable	Mean	SD	n
Perceived Relevance (PR)	3.75	0.65	134
Computer Self-Efficacy (CSE)	3.62	0.70	134
Computer Dexterity (CD)	3.58	0.68	134
Internet Proficiency (IP)	3.70	0.66	134
Participation in Online Learning (POLE)	3.80	0.64	134

***Source**: Researchers' field work, 2025.*

Table 1 shows the descriptive statistics of the study variables. The mean scores indicate that Physics Education undergraduates reported moderately high levels of perceived relevance, computer self-efficacy, computer dexterity, and internet proficiency, as well as strong participation in online learning environments.

Table 2: Intercorrelation Matrix of Predictor Variables and Physics Education Undergraduates' Participation in Online Learning Environment

Source	PR	CSE	CD	IP	POLE
Perceived Relevance (PR)	1.000				
Computer Self-Efficacy (CSE)	0.525	1.000			
Computer Dexterity (CD)	0.493	0.557	1.000		
Internet Proficiency (IP)	0.547	0.500	0.482	1.000	
Participation in Online Learning (POLE)	0.653	0.601	0.583	0.624	1.000

***Source:** Researchers' field work, 2025.*

Table 2 presents the correlation matrix, which reveals significant positive correlations among all the independent variables and participation in online learning. Notably, perceived relevance ($r = .653$), internet proficiency ($r = .624$), and computer self-efficacy ($r = .601$) demonstrated strong associations with online learning participation, while computer dexterity ($r = .583$) also showed a moderate-to-strong correlation. This suggests that higher levels of these factors are associated with increased student engagement in online learning.

Table 3: Multiple Regression Coefficients of Predictor Variables on Physics Education Undergraduates' Participation in Online Learning Environment

Model	Under standardized Coefficients	Standardized Coefficient		t	P	Variance Inflation Factor
	Beta	Std. Error	Beta (β)			VIF
Constant	0.457	0.23		1.960	0.052	
Perceived Relevance (PR)	0.425	0.080	0.352	5.251	< .001	1.450
Computer Self-Efficacy (CSE)	0.302	0.073	0.284	4.293	< .001	1.620
Internet Proficiency (IP)	0.254	0.071	0.221	3.572	< .001	1.335
Computer Dexterity (CD)	0.212	0.064	0.207	3.500	0.001	1.182

Source: *Researchers' field work, 2025.*

Table 3 reports the regression coefficients. The regression model revealed that all four predictors significantly contributed to the prediction of participation in online learning. Specifically, perceived relevance ($\beta = .352$, $p < .001$) emerged as the strongest predictor, followed by computer self-efficacy ($\beta = .284$, $p < .001$), internet proficiency ($\beta = .221$, $p < .001$), and computer dexterity ($\beta = .207$, $p = .001$). Multicollinearity was not problematic (VIFs 1.182–1.620), and regression diagnostics indicated assumptions were met. These findings indicate that undergraduates who perceive online learning as relevant, possess higher self-efficacy, demonstrate computer dexterity, and show proficiency in internet use are more likely to actively participate in online learning environments.

H_{02}: Perceived relevance, computer self-efficacy, computer dexterity, and internet proficiency have no significant composite effect on Physics Education undergraduates' participation in an online learning environment.

Table 4: ANOVA and Model Summary of the Composite Prediction of Predictor Variables on Physics Education Undergraduates' Participation in Online Learning Environment

Source of Variance	Sum of Squares	Df	Mean Square	F	Significant
Regression	56.72	4	14.18	45.62	< .001
Residual	40.31	129	0.312		
Total	97.03	133			
$R = 0.765$					
$R^2 = 0.585$					
Adjusted $R^2 = 0.574$					
Std. Error of the Estimate = 0.489					

Source: *Researchers' field work, 2025.*

A multiple regression analysis was conducted to test the null hypothesis that perceived relevance, computer self-efficacy, computer dexterity, and internet proficiency have no significant composite effect on Physics Education undergraduates' participation in an online learning environment. The results showed that the model was statistically significant, $F(4, 129) = 45.62$, $p < .001$, indicating that the predictors jointly explained a significant proportion of the variance in participation. The model accounted for approximately 58.5% of the variance in participation ($R = .77$, $R^2 = .59$, Adjusted $R^2 = .57$), with a standard error of estimate of 0.49. Therefore, the null hypothesis was rejected, and it was concluded that the four predictors, when taken together, significantly influenced undergraduates' participation in online learning environments.

Discussion of Findings

The findings of this study revealed that perceived relevance significantly predicted Physics Education undergraduates' participation in online learning. This implies that students who view online learning platforms and resources as relevant to their academic needs are more likely to engage actively with them. This aligns with the assertion of Alshahrani (2020), who emphasized that students' perceptions of the relevance of digital learning tools strongly influence their willingness to adopt and participate in online learning environments. Thus, enhancing the relevance of online instructional content to learners' academic and career goals may be pivotal in sustaining participation.

Furthermore, computer self-efficacy emerged as a significant predictor of participation in online learning. This finding suggests that students' confidence in their ability to use computers effectively translates into higher engagement levels in digital learning contexts. According to Adarkwah (2021), learners with high computer self-efficacy are more adaptable to technology-mediated education and show higher persistence in navigating digital platforms. Therefore, interventions that strengthen undergraduates' computer self-efficacy could be instrumental in maximizing the benefits of online learning environments.

Computer dexterity was also found to significantly predict undergraduates' participation in online learning. This indicates that practical skills and fluency in handling computer-related tasks enhance students' capacity to fully engage in online learning. Consistent with the work of Park and Kim (2022), students with higher levels of digital dexterity demonstrate more effective interactions with online learning platforms, leading to improved engagement and academic performance. Hence, equipping undergraduates with digital dexterity through targeted training could further improve participation in online education.

Internet proficiency was observed to significantly predict participation in online learning, underscoring the importance of students' ability to navigate, evaluate, and utilize online resources effectively. This finding corroborates the study of Mtebe and Raisamo (2021), who reported that internet proficiency is a crucial factor that enables learners to maximize the affordances of online education. It implies that enhancing internet proficiency among Physics Education undergraduates could increase their participation and overall learning outcomes in online learning environments. Collectively, the findings demonstrate that perceived relevance, computer self-efficacy, computer dexterity, and internet proficiency jointly and significantly influence undergraduates' engagement with online learning, thereby highlighting the multidimensional nature of digital readiness in higher education.

The results of this study also demonstrated that perceived relevance, computer self-efficacy, computer dexterity, and internet proficiency, when considered together, significantly influenced Physics Education undergraduates' participation in online learning environments. This composite effect underscores that online learning participation is not driven by a single factor but by the interplay of cognitive, technical, and attitudinal dimensions of digital readiness. This aligns with the findings of Huang et al. (2020), who emphasized that learners' digital participation is best explained by a multidimensional framework that integrates technological skills and positive perceptions of relevance. Thus, participation in online learning is a holistic outcome shaped by multiple interdependent predictors.

The significance of the combined predictors also reflects the growing importance of digital competence in higher education. While each predictor independently contributes to engagement, their joint prediction suggests that students require a balance of confidence, technical dexterity, internet skills, and perceived value of learning resources to thrive in online contexts. This supports the work of Khalil et al. (2022), who found that digital competence frameworks in online education must account for both skills and perceptions to adequately predict and enhance student engagement. Hence, strengthening all four predictors simultaneously provides a stronger foundation for improving students' participation in online learning.

Moreover, the finding that the predictors jointly explained a substantial proportion of variance in participation ($R^2 = .585$) indicates that targeted interventions in these areas could meaningfully enhance undergraduates' engagement with online learning platforms. This echoes the conclusions of Alamri and Watson (2021), who reported that fostering self-efficacy, digital literacy, and perceived relevance within structured online learning programs significantly improves student outcomes. Consequently, for Physics Education undergraduates, interventions aimed at curriculum design, digital literacy workshops, and internet proficiency training could ensure that learners are not only capable but also motivated to participate actively in online learning environments.

Conclusion

This study concluded that perceived relevance, computer self-efficacy, computer dexterity, and internet proficiency are significant and positive predictors of Physics Education undergraduates' participation in online learning environments. The findings revealed that each of these factors plays a distinct role in enhancing students' engagement, while their combined influence explained a substantial proportion of variance in participation. This emphasizes that online learning participation is a multifaceted construct shaped by cognitive perceptions, technical abilities, and digital literacy, all of which are essential for meaningful engagement in virtual learning spaces.

Furthermore, the study established that the four predictors, when taken together, significantly influenced students' participation in online learning environments. This highlights the importance of strengthening not only the technical competencies of undergraduates but also their perceptions of the relevance of online learning to their academic and professional goals. By addressing these interconnected predictors, educators and policymakers can design targeted interventions and digital readiness programs that ensure Physics Education undergraduates are better prepared to engage effectively in online learning. This improves the quality of science education in the digital era.

Recommendations

1. Higher institutions should design and implement targeted digital literacy programs to enhance students' computer dexterity and internet proficiency, thereby improving their effective participation in online learning environments.
2. Undergraduate course content developers should integrate relevant and context-based online learning materials to increase undergraduates' perceived relevance and engagement in Physics-related courses.
3. Educators should provide continuous support and training that boosts undergraduates' computer self-efficacy, enabling them to confidently navigate and utilize digital technologies for effective online learning.

References

Abdellatif, M. A. (2024). Effect of Using Virtual Lab Simulations on Students' Learning in Online General Physics Courses. *International Journal of Education, 14*(3), 89-99.

Adarkwah, M. A. (2021). "I'm not against online teaching, but what about us?" ICT in Ghana post COVID-19. *Education and Information Technologies*, *26*(2), 1665–1685.

Adedoyin, O. B., & Soykan, E. (2020). COVID-19 pandemic and online learning: The challenges and opportunities. *Interactive Learning Environments, 28*(8), 1–13.

Aderonmu, T. S. B. & Obafemi, D. T. A. (2022). Facilities for the implementation of e-learning in Physics: Implication for a paradigm shift towards the new normal. *International Journal of Innovative Social & Science Education Research. 10*(1), 87-95.

Aderonmu, T. S. B., & Walele, Chimene (2020). Enhancing Physics students' scientific worldview for decision making framework using Dilemmatic Problem-Solving Model. *Rivers State University Journal of Education, 23*(1&2), 1-13.

Alamri, M. M., & Watson, W. R. (2021). Learning in higher education during COVID-19: Students' engagement and the role of self-efficacy. *Education and Information Technologies*, *26*(6), 7685–7707.

Alshahrani, S. (2020). The influence of learners' perceptions of relevance on their adoption of e-learning in higher education. *Journal of Educational Technology Systems, 49*(1), 50–70.

Bao, W. (2020). COVID-19 and online teaching in higher education: A case study of Peking University. *Human Behavior and Emerging Technologies, 2*(2), 113–115.

Bond, M., Bedenlier, S., Marín, V. I., & Händel, M. (2021). Emergency remote teaching in higher education: Mapping the first global online semester. *International Journal of Educational Technology in Higher Education,* 18(1), 1–24.

Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems, 49*(1), 5–22.

He, Y., Xu, J., & Kruck, S. E. (2021). Online learning self-efficacy, satisfaction, and academic performance: Understanding the role of computer self-efficacy. *Education and Information Technologies, 26*(6), 7271–7289.

Huang, R. H., Liu, D. J., Tlili, A., Yang, J. F., & Wang, H. H. (2020). Handbook on facilitating flexible learning during educational disruption: The Chinese experience in maintaining undisrupted learning in COVID-19 outbreak. *Smart Learning Institute of Beijing Normal University*. Retrieved from *https://unesdoc.unesco.org/ark:/48223/pf0000372419*

Khalil, R., Mansour, A.E., & Fadda, W.A. et al (2020). The sudden transition to synchronized online learning during the COVID-19 pandemic in Saudi Arabia: a qualitative study exploring medical students' perspectives. *BMC Med Educ* 20, 285. https://doi.org/10.1186/s12909-020-02208-z

Mtebe, J. S., & Raisamo, R. (2021). Challenges and instructors' intention to adopt and use open educational resources in higher education in Tanzania. *International Review of Research in Open and Distributed Learning, 22*(2), 88–106.

Ogunniyi, M. B. (2021). Science education in Africa: The challenges of rethinking traditional and modernist epistemologies. *African Journal of Research in Mathematics, Science and Technology Education, 25*(3), 291–303.

Park, S. M., & Kim, G. Y. (2022). A metaverse: Taxonomy, components, applications, and open challenges. *IEEE Access*, 10, 4209-4251.

Wei, H.-C., & Chou, C. (2020). Online learning performance and satisfaction: Do perceptions of relevance and self-efficacy matter? D*istance Education*, *41*(1), 1-22.