Critical Review on the Impact of ICT Among Undergraduate Students

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ABSTRACT

Speedy scientific and technological growths, particularly in the area of information and communication technology (ICT), are generating novel conditions in learning and it imposes a transformation in a modernized society. ICT is helpful in converting varied sectors like banking, transportation, education, manufacturing, health, employment, and so on. Its amalgamation with the learning system has brought up an innovative renovation by offering a flexible environment of education. This survey makes a critical analysis of about 65 papers regarding the impact of ICT on undergraduate students. More particularly, varied performance measures that are contributed in diverse articles are analyzed. In addition, a comprehensive study is made regarding the maximal performances in each contribution. Lastly, the survey extends with the determination of varied research challenges, which might be productive for the analysts to endorse enhanced upcoming works on the impact of ICT among undergraduate students.

1. INTRODUCTION

Technology has paved the way for several amendments in several school trainings. Teachers were the most important troupes in the introduction of these amendments in daily classroom practices. So as to aid lecturer's usage of technology, training on educational technology has turned out to be essential (Kim, 2012; Adesemowo et al. 2017; Patiar et al. 2017). Nevertheless, this causes demands in recognizing the constraints, which influence the implementation of technology and the creation of practicable solutions for integrating sustainable technologies into education practices. Speedy scientific and technological growths, particularly in the area of ICT, are generating new stipulations in teaching and inflict a transformation on the role of conventional schools in response to novel human requirements and demands of modernized society (Woreta et al. 2013; Nketiah-Amponsah et al. 2017; Charles and Issifu, 2015).

 "ICT is defined as Technological devices (hardware and software) that allow editing, producing, storing, exchange and transmitting data between different information systems that have common protocols (Couceiro et al. 2013; Odunola and Tella, 2020). These applications, which integrate

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computer media, telecommunications and networks, enable both interpersonal (person-to-person) and multidirectional (one-to-many or many-to-many) communication and collaboration (Bankole and Nasir, 2020; McGill et al. 2014). These tools play a substantive role in the generation, exchange, diffusion, management and access to knowledge". ICT is turning out to be ever more relevant and significant in every area of societal life, predominantly in education.

The gaps among research and practices complicate the appliance of useful and insightful educational research in everyday education practice. Even though every attempt was made to recognize both inhibiting and contributing factors of technology usage, educators are often opposed and reluctant to adopt technology in their classrooms, and their overall ability to make effectual usage of technology is less. By the way, numerous obstructions were recognized as to "why little impact has been made on the use of ICTs in higher education teaching and learning in some institutions" (Trushell et al. 2013; Goktas and Demirel, 2012).

The major contribution of this review is given below.

1. Analyzed 68 research publications to conduct a review on the effect of ICT on undergraduate students.
2. Offers a thorough analysis of the different approaches used in each paper under examination.
3. Evaluates the performance metrics in every article that has been reviewed.

The structure of this paper is as follows: Section 2 lists relevant ICT-related studies completed by undergraduate students. It is preferable for section 3 to include a thorough analysis of a range of approaches. In Section 4, the performance metrics evaluation is depicted. In addition, Section 5 describes the challenges, and Section 6 presents the conclusion.

2. LITERATURE REVIEW

2.1 Related Works

Vega-Hernández et al. 2018 conducted a quantitative analysis using a REATIC questionnaire to find out how undergraduate students from "The University of Salamanca" in five skill areas used and perceived the role of ICT in their education. Islam et al. 2019 have developed the TAG model and examined teachers' gratification and adoption of ICT for research and teaching purposes in Malaysian institutions. Further, the researchers were examined using the 3-phase SEM. Kang and Park, 2017 have presented a global ITTP, which seemed to combine learning with ICT with specified ODA in Korea.

Tam et al. 2020 have provided experiential facts that supported the efficacy of a STEM learning program for endorsing student improvement and minimizing gender stereotypes in ICT. The findings demonstrate that the created work significantly increased ICT self-efficacy and reduced perceived ICT deployment challenges. A 2019 study by Dubey and Tiwari examined the perceived value of soft skills and the gaps that still exist for newcomers to the ICT industry. When analyzing the background effects, practitioners reacted to a similarity in the perceived significance of soft skills, regardless of experiences. Giavrimis, 2020 have focused on undergraduate's views as social acts towards ICT, via conflict hypothetical schemes. The researchers' important discoveries were revealed by their findings, which were examined through the "integration" of ICT.

Zhang et al. 2017 analyzed the effect of DA on undergraduate educational performances. Primarily, the research focuses on DA, which depends on post-and pretest assessment. Second, the TML-oriented evaluation was modelled as the evaluation system includes undergraduates who received assistance directly in the TML environment. Reyes et al. 2017 have proposed a 3-cluster configuration of teachers, which required empirical substantiation. The findings and implications that carried out ICT intensive courses were also examined, particularly in association with teaching

practices. Verma et al. 2019 have focused on the forecast of 2 most important constraints namely, educational benefits and usability by means of 4 classifiers such as SVM, KNN and DISC. Further, this work revealed that the upcoming awareness level for learning benefits was moderate or very high in Hungary and India.

Sar and Misra, 2020 have determined the elements that affect higher education's use of technology, the results of having easy access to ICT resources, and the ability of users to integrate ICT sources into the teaching and learning process. Cid et al. 2020 have presented a field experimentation, wherein students attained face-to-face and higher quality sessions united with ICTs, which required fostering healthy behaviour. Slechtova, 2015 have contributed to the present debate on ICT in high education role and usage. The outcomes may support further examination into the issues related to the subject and have provided valuable data for instructors and teachers who wish to make their courses more valuable to undergraduates. Nookhong and Wannapiroon, 2015) aimed to develop collaborative learning by means of "case-based learning via cloud technology and social media". This demonstrates that the adopted lesson plan has increased teaching effectiveness and has the potential to promote ICT literacy and problem-solving abilities.

Li, 2012 have analysed ICT–oriented learning problems from undergraduates of diverse schools on the Linyi campus. The study provided an ICT approach that CRHEI authorities have to consider for properly integrating ICT in their institution. Trushell et al. 2013 have described an illuminative analysis, which featured a survey mechanism that included 66 undergraduates of social science and Education. From the results, no noteworthy variations were found to capably report with the chosen software via age. Goktas and Demirel, 2012 explored the effect of deploying blogs on potential educators' perceived ICT perceptions and competencies in blog-improved ICT courses. The conclusion indicated that the majority of the contestants considered blogs to be a significant device that transformed their ICT awareness in an optimistic way and adapted them to ICT.

Sedek et al. 2012 have identified the levels and types of universal technologies used amongst undergraduates from Malaysian technological universities. In fact, this represented "how undergraduates at higher learning in Malaysia use ubiquitous technology and the level of use of ubiquitous technology". Techataweewan and Prasertsin, 2018 have employed digital literacy markers for Thai undergraduates by means of mixed research techniques. The intention was to recognize the real description, indicators, and factors of digital education in Thailand. Ivanković et al. 2013 have determined the ICT literacy level, which was carried out amongst 807 undergraduates. The primary part was associated with individual characteristics of students, and the subsequent part included a test. The percentages of the precise responses amongst the students range up to 99.01%.

Chen and Wu, 2020 have analyzed the information collected from the questionnaire by means of the "partial-least-squares structural equation modelling multivariate data analysis" technique. The outcomes pointed out that perceived efficacy mainly influenced students' behavioural intent to utilize via attitude toward use. Hu et al. 2018 have considered ICT as multi-level constructs and scrutinized their associations with learner's reading, technical literacy, and math. The conclusion pointed out that nationalized ICT skills have more constructive effects on student educational performances. Boa et al. 2018 have adopted 2 phases associated with 2 research goals: 1) assessing 371 business undergraduates at "Naresuan University International College" regarding their critical assessment skills. Thus, the determination stage of their crucial thinking was observed and an instructional model was developed followed by substantiation by 5 experts.

In de-Marcos, et al. 2017 have reported data regarding the learning performances of undergraduates by means of 4 diverse motivating tools: "an educational game, a gamified plugin, a social networking website and a gamified social networking website". The data included variables of 4 post-test scores, 4 pre-test scores and a last assessment. Pheeraphan, 2013 have analyzed the impact of the amalgamation of ICT in classrooms for improving 21st-century education skills. The findings indicate that integrating ICT into the classroom has greatly improved graduate and undergraduate students' 21st-century learning abilities. The goal of Xu and Du's 2019 study was

to identify the parallels and differences in graduate and undergraduate students' satisfaction with DLs. Individual differentiations of users, namely; user experience, frequency of usage and age, had a noteworthy impact on students with DLs.

Papastergiou et al. 2011 evaluated the efficiency of multimedia blogging, regarding the achievement of skills of specified basketball knowledge and self-efficacy in ICT. Contribution in the blogging actions encompassed an optimistic impact on the self-efficacy of students. Edgar et al. 2012 sought to consider required ICT assignments in specific undergraduate agricultural courses at a land-grant university throughout a ten-year period. It is necessary to expand the quantity and complexity of ICT in undergraduate agricultural courses. Charles and Issifu (2015) looked at secondary school pupils' perceptions and use of ICT. The analysis showed that students were using ICT less frequently to support their learning. The results of the exam indicate that students had higher expectations for accomplishment, perceived value, and perceived cost.

Kokkinos and Antoniadou, 2019 have investigated the relationship among numerous contextual and individual variables and CB/ CV amongst "Greek University undergraduates", depending on the GAM scheme. Results have shown that contestants who deployed the Internet more often achieved high CB. Niyigena et al. 2018 applied computer attitude level and proposed a forecasting scheme depending on the MLR scheme to find out the major factors that affected computer attitude for the execution of ICT-oriented learning environments. Ramos and de Andrade, 2016 intended to examine the insight of educators, who taught visually damaged undergraduates in secondary school and middle school educations. It was determined that the biggest barrier preventing instructors from truly integrating ICT into undergraduate education was a lack of specialized training.

Papastergiou, 2011 have aimed at designing and implementing 2 project-oriented optional courses on ICT in learning for undergraduates of the sport science and PE sector. Further, the instructor's experiences and students' responses were investigated in this work. Adetimirin, 2012 conducted an experiment the usage and accessibility of ICT and the ICT literacy skills of undergraduate students in 7 Nigerian institutions. Further, the 3 most important factors that have an impact on the undergraduate's ICT literacy were recognized as unbalanced power supply, insufficient ICT and restricted time of ICT usage. Ekenze et al. 2017 have evaluated the skills and usage of medical students' Internet equipment and their outlook on the appliance of such equipment in surgical learning. The study analyzed the application, utility, and knowledge of Internet equipment in surgical learning by means of a "5-point Likert scale".

Woyo et al. 2020 have analysed the factors, which had an impact on how well ICT policies were implemented in Namibia's high school experiential learning environment. Certain challenges from the previous analysis were reconfirmed since they were examined from a diverse perspective. Woreta et al. 2013 have assessed the utilization and knowledge of ICT amongst health and medicine science students and its related factors in "Gondar College of Medicine and Health Sciences, University of Gondar". The results have shown that students' skills were insufficient and exploitation of ICT was poorer. Nketiah-Amponsah et al. 2017 have analyzed students' skills with the usage of certain elected ICT applications and devices and their educational performances. In addition, the usage of e-mails exerted positive effects on academic performances, whereas the iPad had unconstructive effects on educational performances.

Selwyn, 2007 conducted an examination of 406 college students, ages 18 to 39, to discover if younger adults were still primarily viewing different components of ICT in terms that were gendered. Overall, the findings demonstrated how gender preconceptions continue to advance and be used as a framework for ICT references. The use of a computer game to teach ICT principles to sports science and physical education students was examined by Couceiro et al. (2013). Moreover, the game prototypes had a noteworthy constructive effect on undergraduate skills concerning the input concepts, interplay, output and their program, and it aided specific students to prevail over their misapprehensions. Verhoeven et al. 2016 have constructed a novel instrument for measuring the self-awareness of ICT use (53 items) and ICT skills (49 items). This allowed the discovery of certain

patterns for ICT use and ICT skills. Both hypotheses were examined amongst bachelor's students, by means of some significant contextual variables.

Heiman et al. 2017 have analyzed students' accessibility and knowledge of ICTs and analyzed students' view of ICTs deployed by lecturers training in a conventional postsecondary learning institution (Canada) and distance-based learning (Israel). The findings showed that Israeli undergraduates were more accessible, used ICTs more frequently, and contributed to increasing ICT utilization by university instructors. A study by Agyei and Voogt (2011) investigated the feasibility of using ICT for math tutoring at Ghana's higher education institutions. The preliminary outcomes have shown that Ghana maths teachers have not integrated ICT into their maths educations. Adesemowo et al. 2016 have illustrated the experiences with introducing e-assessment to first-year undergraduate ICT network courses for a larger population at a South African institution. Here, the research was found to be helpful to administrators, students, lecturers and teaching instructors, since it provided key opinions as guidelines for deploying e-assessment as a platform for active education.

Barnard and Mostert, 2015 have investigated the value of merging 2 technical interferences, "tutorial screencasts and online quizzes", to enhance the learning experience of students in courses on student management accounting. Oluwasusi (2014) has examined the characteristics that impact how undeveloped students at tertiary institutions in the South Western Zone of Nigeria utilize ICT. Students were mainly masculine and were registered in student programs. ANOVA has shown a noteworthy variation in the ICT utilization level of students. Hossain and Sormunen, 2019 have assessed the self-estimated task-specific and overall ICT skills of LIS undergraduates in Bangladesh. The findings showed that pupils thought they had good general computer and internet skills.

Sheard et al. 2010 analyzed students' commitment in 1st year of undergraduate ICT level at an Australian institution. The study delved into conclusions regarding the alleged deficiency in student involvement and proposed strategies to enhance the degree of student dedication. Mohamedhoesein (2017) investigated how second-year Netherlands University students interacted with technology and how that connected to their feeling of identity and combination. The overall findings demonstrated that the use of cutting-edge communication technologies improved student-teacher interaction and minority students' persistence in higher education. The educational difficulties faced by undergraduates in African rural universities have been examined by Uleanya, 2020. The results of the studies have indicated that more attention has to be paid to the high caliber of academic instruction provided in prosperous African countries.

Odunola and Tella, 2020 have investigated the relationship between undergraduates' perceptions of OPACs' utility and their utilization of them in South West Nigerian institutions. The results of the investigation indicate that university undergraduates' use of OPAC was influenced by their perception of its value. Undergraduates' perceptions of using electronic resources in "the Kwara State University library" were examined by Bankole and Nasir in 2020. The results of the investigation showed that students thought the "Kwara State University library"'s electronic resources were insufficient. In McGill et al. 2014 have explored the ways, wherein, the ICT industries believed it has contributed to ICT research and education in institutions. The paper made suggestions for how industry and universities acted to fortify linkages.

Ifinedo et al. 2018 have explored the functions or impacts of external support and usability variables (such as pleasure, perceived efficacy, and perceived ease of use) on undergraduate students' usage outcomes of "Moodle in a blended learning environment". Hu and McGrath, 2011 have described an analysis of ICT-associated teacher improvement in the framework of a "national reform of College English teaching in China". The discoveries pointed out that restricted pedagogic expertise and ICT skills were obstructions to the usage of ICT in English language teachings. Eyo, 2014 have analyzed digital partition in the exploitation of ICT in counsellor learning at Nigeria University. A direct delivery method was deployed for collecting data by means of t-test, standard deviation and mean.

Kim, 2012 has explored ways of utilizing ICT in pre-service tutor education to enhance and facilitate the creation of learning and teaching metaphors. Adesemowo et al. 2017 have developed a

cloze questionnaire type to "mimic real-life" scenarios. Further, a correlation coefficient (Pearson) rate was observed among text-oriented and skills assessment of students. Patiar et al. 2017 have examined students' experience with a novel VFT of hotels. Undergraduates taking a "Food and Beverage Management course" contributed to this analysis. Students appeared to be more energetic than inactive learners, and the VFT surroundings aided in the progression of basic business graduate skills. Muriithi et al. 2016 have focused the condition of ICT uses by educational staff in a certain South African nursing training college. In spite of advancements in ICT usage in global nursing education, demands existed to deploy it in elected educational institutions. Gonen et al. 2016 have established "how ICTs are being used to support collaborative research in Kenya", and identified parameters in ICT ecosystems, which contributed to their usage and adoption. This work identified 4 foremost constructs, which affected the implementation of technologies "performance expectancy, effort expectancy, facilitating conditions and social influence".

Capel et al. 2017 promoted a novel teaching strategy for undergraduate PDC courses that deployed code patterns. Assessment of the academic performances of students using this technique has exposed better enhancement in the grades of students. Tiainen and Berki, 2019 have focused on the educational field through a gender-aware analysis of ICT academics. In addition, this work continued earlier gender-focused conversations of Higher Education Studies by offering an organizational viewpoint. Valentín et al. 2013 have analyzed the association among diverse uses of ICTs and the education results. It further examined the association between learning policies and the usage of ICT. Duţă and Martínez-Rivera, 2015 emphasized the significance of deploying novel technology in university education that was noteworthy for teachers' feasibility for implementing into teaching as the technique of suggestion for combined works for developing the required skills.

(Yıldırım and Şanlı 2023) focused on the internal consistency reliability, factor structure, criterion validity, and predictive validity of the Turkish version of the CIS in order to investigate its psychometric qualities in university students for the first time. A cross-sectional research design was used to collect data from 486 students enrolled in a public institution in Turkey. Using an online survey, participants answered the CIS and Kessler Psychological Distress Scale-6. (Jabbour et al. 2023) conducted questionnaire-based cross-sectional study set out to find out how Lebanese university students perceived the influence of social media during the COVID-19 epidemic and how much false information affected respondents' decisions about vaccinations and mental health.A total of 440 students participated and answered questions about social media trust, the "general health questionnaire index" (GHQ-12), and "attitude towards vaccination" in an online survey.According to our data, there was a low prevalence of mental health illnesses among university students in Lebanon. (Hassan et al. 2023) investigated the correlation between self-concept and internet addiction, gender, and the collaborative connection among Kwara State University, Malete undergraduate students. Using practical sampling approaches, four hundred university undergraduates were chosen from among the participants in their various departments at the university. The report makes several recommendations, including that school counselors and legislators hold conferences, seminars, and workshops to teach kids on the need of having a realistic and impartial self-evaluation and self-concept.
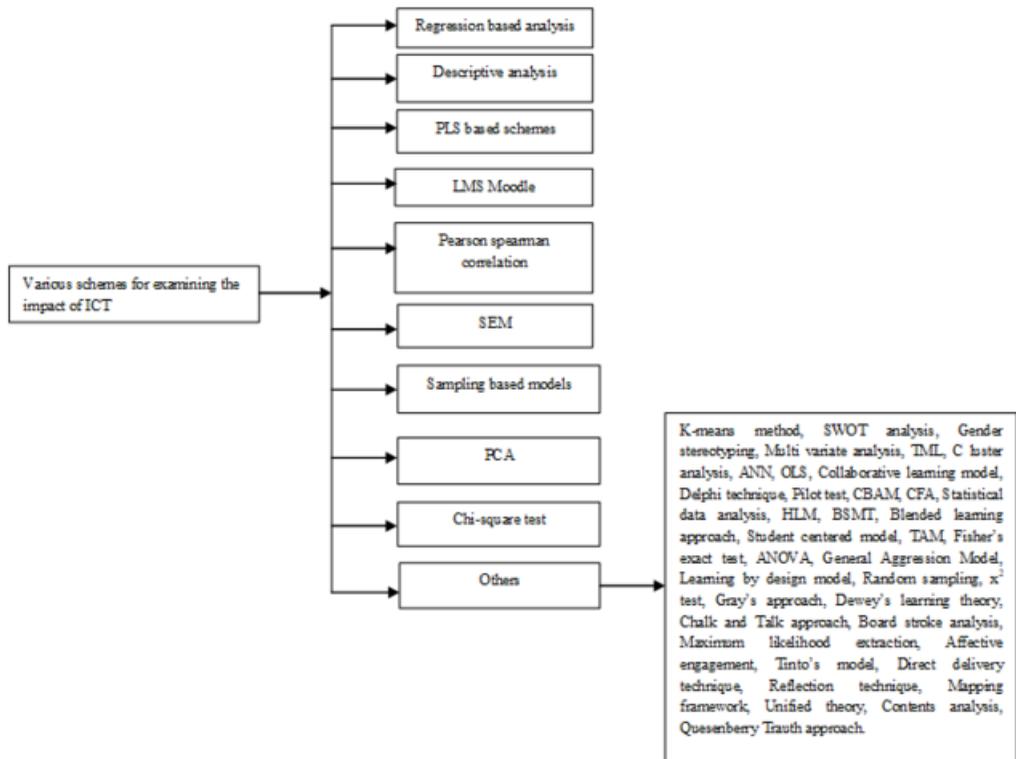
3. WIDE-RANGING REVIEW OF ADOPTED MODELS

3.1 Review of Adopted Techniques

The many contributions related to ICT are quantified by performance measures. This section discusses the review of the techniques used in each work, with an illustration provided in Fig. 1. It was observed from the review that regression-based analysis was applied. (Niyigena et al. 2018; Woyo et al. 2020; Woreta et al. 2013; Valentín et al. 2013). In addition, Descriptive analysis based methods were adopted in (Ramos and de Andrade, 2016; Nketiah-Amponsah et al. 2017; Couceiro

et al. 2013; Odunola and Tella, 2020; Duţă and Martínez-Rivera, 2015) and PLS-based schemes were used in (Chen and Wu, 2020) and (Ifinedo et al. 2018). Furthermore, LMS Moodle-based methods were exploited in (Slechtova, 2015) and (Adesemowo et al. 2016). Moreover, the Pearson Spearman correlation was adopted in (Sar and Misra, 2020; Trushell et al. 2013; Oluwasusi, 2014; Adesemowo et al. 2017; Puckree et al. 2015; Capel et al. 2017). Moreover, SEM was developed by (Islam et al. 2019) and Sampling-based models were deployed (Uleanya, 2020; Bankole and Nasir, 2020; Hu and McGrath, 2011) respectively. PCA was adopted by (Dubey and Tiwari, 2019; Papastergiou et al. 2011) and Chi-square test was adopted by (Heiman et al. 2017; McGill et al. 2014). Moreover, other methods such as K-means, SWOT analysis, Gender stereotyping, Multivariate analysis, TML, Cluster analysis and ANN were deployed in (Vega-Hernández et al. 2018), (Kang and Park, 2017), (Tam et al. 2020), (Giavrimis, 2020; Zhang et al. 2017), (Reyes et al. 2017) and (Verma et al. 2019) respectively. Also, OLS, collaborative learning model, Delphi technique, pilot test, CBAM, CFA, Statistical data analysis, HLM, BSMT were deployed in (Cid et al. 2020), (Nookhong and Wannapiroon, 2015), (Li, 2012), (Goktas and Demirel, 2012; Sedek et al. 2012), (Techataweewan and Prasertsin, 2018), (Ivanković et al. 2013), (Hu et al. 2018) and (Boa et al. 2018). In addition, the blended learning approach, student-centred model, TAM, Fisher's exact test, ANOVA, General Aggression Model, learning-by-design' model, Random sampling, x^2 test, Gray's approach and Dewey's learning theory were deployed in (de-Marcos, et al. 2017; Pheeraphan, 2013; Xu and Du, 2019; Papastergiou et al. 2011; Charles and Issifu, 2015; Kokkinos and Antoniadou, 2019; Papastergiou, 2011; Adetimirin, 2012; Ekenze et al. 2017; Selwyn, 2007; Verhoeven et al. 2016) correspondingly. Chalk and Talk" approach, broad stroke analysis, maximum likelihood extraction, affective engagement, Tinto's model, direct delivery technique, reflection technique, mapping framework, Unified Theory, Contents analysis and Quesenberry–Trauth approach were

Figure 1. Pictorial representation of various models adopted for examining the impact of ICT among undergraduate students

deployed in (Agyei and Voogt, 2011; Barnard and Mostert, 2015; Hossain and Sormunen, 2019; Sheard et al. 2010; Mohamedhoesein, 2017; Eyo, 2014; Kim, 2012; Patiar et al. 2017; Muriithi et al. 2016; Gonen et al. 2016; Tiainen and Berki, 2019) correspondingly.

4. COMPREHENSIVE REVIEW OF VARIED PERFORMANCE METRICS

4.1 Analysis of Performance Metrics

Table 1 shows the performance indicators measured in several contributions pertaining to undergraduates' use of ICT. From Table 1, it is observed that (Vega-Hernández et al. 2018; Tam et al. 2020; Dubey and Tiwari, 2019; Giavrimis, 2020; Zhang et al. 2017; Reyes et al. 2017; Cid et al. 2020; Nookhong and Wannapiroon, 2015; Goktas and Demirel, 2012; Sedek et al. 2012; Chen and Wu, 2020; Boa et al. 2018; Pheeraphan, 2013; Xu and Du, 2019; Papastergiou et al. 2011; Edgar et al. 2012; Charles and Issifu, 2015; Papastergiou, 2011; Adetimirin, 2012; Woyo et al. 2020; Nketiah-Amponsah et al. 2017; Selwyn, 2007; Couceiro et al. 2013; Heiman et al. 2017; Agyei and Voogt, 2011; Barnard and Mostert, 2015; Oluwasusi, 2014; Hossain and Sormunen, 2019; Mohamedhoesein, 2017; Odunola and Tella, 2020; McGill et al. 2014; Ifinedo et al. 2018; Eyo, 2014; Adesemowo et al. 2017; Puckree et al. 2015; Muriithi et al. 2016; Gonen et al. 2016) and (Valentín et al. 2013) made analysis on mean and (Vega-Hernández et al. 2018; Verma et al. 2019; Hu et al. 2018) has done analysis on error. A performance research under standard deviation has been made in 32 publications, while effect size analysis has been examined in 3 studies, accounting for roughly 4.62% of the assessed works. Similarly, the Path coefficients, overall score, ICT access, median, accuracy and Cronbach α have contributed about 1.54% (1 paper), 1.54% (1 paper), 1.54% (1 paper), 1.54% (1 paper) and 12.31% (8 papers). Further, correlation, reliability, ability gap and frequency of internet usage have been obtained in 6.15% (4 papers), 6.15% (4 papers), 1.54% (1 paper) and 1.54% (1 paper). Moreover, the RMSEA, significance level, t value, response rate, variance and frequency have acquired about 3.08% (3 papers), 7.69% (5 papers), 3.08% (2 papers), 12.31% (8 papers), 3.08% (3 papers) and 6.15% (4 paper) of the entire contribution correspondingly. Furthermore, RMR, GFI, accurate response, p value, CAS score, training in hours, AOR, higher positive response, mean participation rate and minimum score, have contributed about 1.54% of the total contribution. The indicators such as maximum score, dropout rate, confidence level, and % agreement have been analyzed for over 1.54% of the total contributions.

4.2 Analysis of Maximal Performances

Table 2 displays the highest performances obtained in the assessed works. According to the review, the standard deviation investigated by (Reyes et al. (2017) has a minimum value of 0.221%, while the mean examined by (Reyes et al. (2017) has reached a value of 1.05. Furthermore, the effect Size investigated by (Reyes et al. (2017) has a value of 0.66, while the error assessed by (Verma et al. 2019) has a minimum value of 1.5. Similrly, Path coefficients, Overall score, ICT access, Cronbach α, Median, accuracy and correlation have attained the values of 0.2 (≥0.080), 100, 40%, 0.91, 2, 98.5 and 1.000 and it has been examined in (Islam et al. 2019; Kang and Park, 2017; Kang and Park, 2017; Heiman et al. 2017; Giavrimis, 2020; Verma et al. 2019) and (Sar and Misra, 2020) correspondingly. The measures such as ability gap, frequency of internet usage, reliability, RMSEA and RMR have attained optimal values of 2.86, 18.6%, 0.901, 0.0127 and 0.00658 and they have been analysed (Li, 2012; Trushell et al. 2013; Sedek et al. 2012; Techataweewan and Prasertsin, 2018) and (Techataweewan and Prasertsin, 2018) respectively. Also, GFI, accurate response, significance level, t value, p value, CAS score, response rate, variance, AOR and higher positive response were exploited in (Techataweewan and Prasertsin, 2018; Ivanković et al. 2013; Chen and Wu, 2020; Hu et al. 2018; Chen and Wu, 2020; Niyigena et al. 2018; Adetimirin, 2012; Valentín et al. 2013; Woreta et al. 2013) and (Adesemowo et al. 2016), and they have obtained superior rates of 0.996, 99.01%, 5%, 74.73, 0.304, 74.19, 100%, 16.6%, 2.7 and 59% correspondingly. Also, mean participation rate,

Table 1. Review of different performance metrics for the impact of ICT among undergraduate students

Measures	Citations
Mean	(Vega-Hernández et al. 2018; Tam et al. 2020; Dubey and Tiwari, 2019; Giavrimis, 2020; Zhang et al. 2017; Reyes et al. 2017; Cid et al. 2020; Nookhong and Wannapiroon, 2015; Goktas and Demirel, 2012; Sedek et al. 2012; Chen and Wu, 2020; Boa et al. 2018; Pheeraphan, 2013; Xu and Du, 2019; Papastergiou et al. 2011; Edgar et al. 2012; Charles and Issifu, 2015; Papastergiou, 2011; Adetimirin, 2012; Woyo et al. 2020; Nketiah-Amponsah et al. 2017; Selwyn, 2007; Couceiro et al. 2013; Heiman et al. 2017; Agyei and Voogt, 2011; Barnard and Mostert, 2015; Oluwasusi, 2014; Hossain and Sormunen, 2019; Mohamedhoesein, 2017; Odunola and Tella, 2020; McGill et al. 2014; Ifinedo et al. 2018; Eyo, 2014; Adesemowo et al. 2017; Puckree et al. 2015; Muriithi et al. 2016; Gonen et al. 2016; Valentín et al. 2013)
Standard Deviation	(Tam et al. 2020; Dubey and Tiwari, 2019; Giavrimis, 2020; Zhang et al. 2017; Reyes et al. 2017; Cid et al. 2020; Nookhong and Wannapiroon, 2015; Goktas and Demirel, 2012; Sedek et al. 2012; Chen and Wu, 2020; Boa et al. 2018; Pheeraphan, 2013; Papastergiou et al. 2011; Edgar et al. 2012; Charles and Issifu, 2015; Papastergiou, 2011; Adetimirin, 2012; Nketiah-Amponsah et al. 2017; Selwyn, 2007; Couceiro et al. 2013; Heiman et al. 2017; Agyei and Voogt, 2011; Hossain and Sormunen, 2019; Mohamedhoesein, 2017; Odunola and Tella, 2020; McGill et al. 2014; Ifinedo et al. 2018; Eyo, 2014; Puckree et al. 2015; Gonen et al. 2016; Capel et al. 2017; Valentín et al. 2013)
Error	(Vega-Hernández et al. 2018; Verma et al. 2019; Hu et al. 2018)
Effect Size	(Islam et al. 2019; Reyes et al. 2017; Pheeraphan, 2013)
Path coefficients	(Islam et al. 2019)
Overall score	(Kang and Park, 2017)
ICT access	(Kang and Park, 2017)
Cronbach α	(Dubey and Tiwari, 2019; Charles and Issifu, 2015; Nketiah-Amponsah et al. 2017; Verhoeven et al. 2016; Heiman et al. 2017; Agyei and Voogt, 2011; Mohamedhoesein, 2017; Eyo, 2014)
Median	(Giavrimis, 2020)
Accuracy	(Verma et al. 2019)
Correlation	(Sar and Misra, 2020; Trushell et al. 2013; Woyo et al. 2020; Adesemowo et al. 2017)
Ability gap	(Li, 2012)
Frequency of Internet Usage	(Goktas and Demirel, 2012)
Reliability	(Sedek et al. 2012; Bankole and Nasir, 2020; Ifinedo et al. 2018; Eyo, 2014)
Miscellaneous measures	
RMSEA	(Techataweewan and Prasertsin, 2018; Kokkinos and Antoniadou, 2019)
RMR	(Techataweewan and Prasertsin, 2018)
GFI	(Techataweewan and Prasertsin, 2018)
accurate response	(Ivanković et al. 2013)
significance level	(Chen and Wu, 2020; Pheeraphan, 2013; Odunola and Tella, 2020; Eyo, 2014; Valentín et al. 2013)
t value	(Chen and Wu, 2020; Hu et al. 2018)
p-value	(Chen and Wu, 2020)
CAS score	(Niyigena et al. 2018)
Training in hours	(Ramos and de Andrade, 2016)
Response rate	(Adetimirin, 2012; Ekenze et al. 2017; Woreta et al. 2013; Sheard et al. 2010; Mohamedhoesein, 2017; Odunola and Tella, 2020; Bankole and Nasir, 2020; Puckree et al. 2015)
Variance	(Woyo et al. 2020; Selwyn, 2007; Valentín et al. 2013)

Table 1. Continued

Measures	Citations
AOR	(Woreta et al. 2013)
Higher positive response	(Adesemowo et al. 2016)
Mean participation rate	(Barnard and Mostert, 2015)
Minimum score	(Oluwasusi, 2014)
Maximum score	(Oluwasusi, 2014)
Frequency	(Mohamedhoesein, 2017; Odunola and Tella, 2020; Bankole and Nasir, 2020; Hu and McGrath, 2011)
Drop out rate	(Uleanya, 2020)
Confidence level	(Odunola and Tella, 2020)
% Agreement	(McGill et al. 2014)

minimum score, maximum score, frequency, drop-out rate, confidence level and % agreement analysed in (Oluwasusi, 2014; Oluwasusi, 2014; Mohamedhoesein, 2017; Uleanya, 2020; Odunola and Tella, 2020) and (McGill et al. 2014) have accomplished better values of 86%, 72, 126, 136, 40%, 95% and 65.9% correspondingly.

4.3 Analysis of Cronbach Alpha

Table 3 displays the analysis of Cronbach alpha for various research works. When observing the below Table 3, the values of Cronbach alpha varies differently for every research (Richa Singh et al. 2019, Buabeng-Andoh et al. 2015, Nketiah-Amponsah et al. 2017, Verhoeven et al. 2016, Heiman et al. 2017, Agyei et al. 2011, Nasser Mohamedhoesein et al. 2017, Mfon Eyo *et al.* 2014). Here, a maximum rate of 0.93 is achieved by (Richa Singh et al. 2019) and the lowest rate of 0.31 is achieved by (Verhoeven et al. 2016). Also, the rest of the research like (Buabeng-Andoh et al. 2015, Nketiah-Amponsah et al. 2017, Heiman et al. 2017, Agyei et al. 2011, Nasser Mohamedhoesein et al. 2017, Mfon Eyo *et al.* 2014) have obtained Cronbach alpha rates of 0.83, 0.763, 0.91, 0.82, 0.71, 0.80 respectively. From this evaluation, the performance of various types of research is analyzed to show the impact of ICT on undergraduates.

4.4 Analysis of Response Rate

Table 4 displays the analysis of the response rate for various research works. When observing the below Table 4, the values of response rate vary differently for every research (Adetimirin et al. 2012, Ekenze et al. 2017, Woreta et al. 2013, Judy Sheard et al. 2010, Nasser Mohamedhoesein et al. 2017, Oluwole Akanmu et al. 2020, Qudus Ajibola et al. 2020, T. Puckree et al. 2015). Here, a maximum rate of 97.8% is achieved by (Woreta et al. 2013) and the lowest rate of 44% is achieved by (Judy Sheard et al. 2010). Also, the rest of the research like (Adetimirin et al. 2012, Ekenze et al. 2017, Nasser Mohamedhoesein et al. 2017, Oluwole Akanmu et al. 2020, Qudus Ajibola et al. 2020, T. Puckree et al. 2015) have obtained response rates of 87.0%, 78%, 61%, 87.3%, 90.1%, and 81.5% respectively. From this evaluation, the performance of various types of research is analyzed to show the impact of ICT on undergraduates.

Table 2. Maximum performance attained in the reviewed works

Sl. no	Citation	Performance metrics	Maximal performances
1	(Reyes et al. 2017)	Mean	1.05
2	(Reyes et al. 2017)	Standard Deviation	0.221
3	(Verma et al. 2019)	Error	1.5
4	(Reyes et al. 2017)	Effect Size	0.66
5	(Islam et al. 2019)	Path coefficients	0.2 (≥0.080)
6	(Kang and Park, 2017)	Overall score	100
7	(Kang and Park, 2017)	ICT access	40%
8	(Heiman et al. 2017)	Cronbach α	0.91
9	(Giavrimis, 2020)	Median	2
10	(Verma et al. 2019)	Accuracy	98.5
11	(Sar and Misra, 2020)	Correlation	1.000
12	(Li, 2012)	Ability gap	2.86
13	(Goktas and Demirel, 2012)	Frequency of Internet Usage	18.6%
14	(Sedek et al. 2012)	Reliability	0.901
15	(Techataweewan and Prasertsin, 2018)	RMSEA	0.0127
16	(Techataweewan and Prasertsin, 2018)	RMR	0.00658
17	(Techataweewan and Prasertsin, 2018)	GFI	0.996
18	(Ivanković et al. 2013)	accurate response	99.01%
19	(Chen and Wu, 2020)	significance level	5%
20	(Hu et al. 2018)	t value	74.73
21	(Chen and Wu, 2020)	p-value	0.304
22	(Niyigena et al. 2018)	CAS score	74.19
23	(Ramos and de Andrade, 2016)	Training in hours	7%
24	(Adetimirin, 2012)	Response rate	100%
25	(Valentín et al. 2013)	Variance	16.6%
26	(Woreta et al. 2013)	AOR	2.7
27	(Adesemowo et al. 2016)	Higher positive response	59%
28	(Barnard and Mostert, 2015)	Mean participation rate	86%
29	(Oluwasusi, 2014)	Minimum score	72
30	(Oluwasusi, 2014)	Maximum score	126
31	(Mohamedhoesein, 2017)	Frequency	136
32	(Uleanya, 2020)	Drop out rate	40%
33	(Odunola and Tella, 2020)	Confidence level	95%
34	(McGill et al. 2014)	% Agreement	65.9%

5. RESEARCH GAPS AND CHALLENGES

- Teachers require specified professional advancement opportunities to increase their capability to utilize ICT for decisive learning evaluations, individualized instructions, accessing online

Table 3. Analysis of Cronbach alpha

Citations	Cronbach alpha
(Richa Singh et al. 2019)	0.931
(Buabeng-Andoh et al. 2015)	.83
(Nketiah-Amponsah et al. 2017)	0.763
(Verhoeven et al. 2016)	0.329
(Heiman et al. 2017)	.91
(Agyei et al. 2011)	0.82
(Nasser Mohamedhoesein et al. 2017)	.717
(Mfon Eyo et al. 2014)	0.80

Table 4. Analysis of response rate

Citations	Response rate
(Adetimirin et al. 2012)	87%
(Ekenze et al. 2017)	78%
(Woreta et al. 2013)	97.8%
(Judy Sheard et al. 2010)	44%
Nasser (Mohamedhoesein et al. 2017)	61%
(Oluwole Akanmu et al. 2020)	87.3%
(Qudus Ajibola et al. 2020)	90.1%
(T. Puckree et al. 2015)	81.5%

sources, and developing student collaboration and interaction.
- These educations in ICT have to definitely impact teachers' common attitude towards ICT in the classroom; however, it must also offer specified management on ICT learning and teaching within every discipline (Barnard and Mostert, 2015).
- To aid teachers since they vary their training, it is also necessary for supervisors, educational managers, decision-makers and teacher educators, to be skilled in ICT usage (Puckree et al. 2015; Gonen et al. 2016).
- To ensure the funds made in ICT profited undergraduates, supplementary conditions should be met. Policies in schools require offering schools with minimal satisfactory infrastructures for ICT, together with affordable and stable internet connection and secure metrics namely; site blockers and filters.
- Policies of teachers require fundamental discipline-specified usages, ICT usage in educational settings, and ICT literacy skills. Successful execution of ICT necessitates the incorporation of ICT in the set of courses (Verhoeven et al. 2016; Vega-Hernández et al. 2018).
- Lastly, digital contents require to be expanded in the local language and it should reveal local cultures. Thus, ongoing organizational, human, and technical support on the above-mentioned issues is required to ensure access and effectual usage of ICTs.

6. CONCLUSION

An extensive overview of the effects of ICT on undergraduates has been provided by this publication. Reviewing a variety of works, their performances were presented. Additionally, this survey examines the different ICT-based system performances. In conclusion,

- About 68 research publications have been analyzed for this work, which also provides an explanation of the remarkable analysis of the impact of ICT among undergraduates.
- The review has examined the various performance metrics utilized in every researches.
- Additionally, the best performances in each piece were examined and succinctly summarized.
- Lastly, a variety of research topics have been presented in this work that may encourage analysts to look into the impact of ICT among undergraduates further.

These findings will be combined with those expected from the literature review on mobile-based ICT skills to provide a comprehensive set of ICT capabilities for students pursuing higher education. Future studies could be considering the mediator role to find the causeeffects of results and carry out the survey in more universities. Likewise, it is possible to conduct the study at private and public universities regarding the students' perception of knowledge sharing in ICT.

CONFLICTS OF INTEREST

FUNDING STATEMENT

REFERENCES

Adesemowo, A. K., Johannes, H., Goldstone, S & Terblanche, K. (2016). The experience of introducing secure e-assessment in a South African university first-year foundational ICT networking course. *Africa Education Review, 13*(1), 67-86.

Adesemowo, A. K., Oyedele, Y & Oyedele, O. (2017). Text-based sustainable assessment: A case of first-year information and communication technology networking students. *Studies in Educational Evaluation, 55*, 1-8.

Adetimirin, A. E. (2012). ICT literacy among undergraduates in Nigerian universities. *Education and Information Technologies, 17*(4), 381-397.

Agyei, D. D & Voogt, J. (2011). ICT use in the teaching of mathematics: Implications for professional development of pre-service teachers in Ghana. *Education and information technologies, 16*(4), 423-439.

Bankole, Q. A & Nasir, Z. (2020). Empirical Analysis of Undergraduate Students' Perception in the Use of Electronic Sources in Kwara State University Library. *International Information & Library Review, 53*(2), 131-141.

Barnard, K. J & Mostert, M. (2015). Exploring student perceptions and experiences of ICT-enhanced formative assessment in an undergraduate management accounting course. *South African Journal of Accounting Research, 29*(2), 132-150.

Boa, E. A., Wattanatorn, A & Tagong, K. (2018). The development and validation of the Blended Socratic Method of Teaching (BSMT): An instructional model to enhance critical thinking skills of undergraduate business students. *Kasetsart Journal of Social Sciences, 39*(1), 81-89.

Capel, M. I., Tomeu, A. J & Salguero, A. G. (2017). Teaching concurrent and parallel programming by patterns: An interactive ICT approach. *Journal of Parallel and Distributed Computing, 105*, 42-52.

Charles, B. A & Issifu, Y. (2015). Innovation in education: Students' perceptions of implementing ICT in learning in second-cycle institutions in Ghana. *Procedia-Social and Behavioral Sciences, 197*, 1512-1519.

Chen, C. L & Wu, C. C. (2020). Students' behavioural intention to use and achievements in ICT-Integrated mathematics remedial instruction: A case study of a calculus course. *Computers & Education, 145*, 103740.

de-Marcos, L., García-López, E & García-Cabot, A. (2017). Dataset on the learning performance of ECDL digital skills of undergraduate students for comparing educational gaming, gamification and social networking. *Data in brief, 11*, 155-158.

Dubey, R. S & Tiwari, V. (2019). Operationalisation of soft skill attributes and determining the existing gap in novice ICT professionals. *International Journal of Information Management, 50*, 375-386.

Duţă, N & Martínez-Rivera, O. (2015). Between theory and practice: the importance of ICT in Higher Education as a tool for collaborative learning. *Procedia-Social and Behavioral Sciences, 180*, 1466-1473.

Edgar, L. D., Johnson, D. M & Cox, C. (2012). A 10-year assessment of information and communication technology tasks required in undergraduate agriculture courses. *Computers & Education, 59*(2), 741-749.

Ekenze, S. O., Okafor, C. I., Ekenze, O. S., Nwosu, J. N & Ezepue, U. F. (2017). The value of Internet tools in undergraduate surgical education: the perspective of medical students in a developing country. *World journal of surgery, 41*(3), 672-680.

Eyo, M. (2014). Digital divide in the utilization of Information and Communication Technology (ICT) in counsellor education in Nigerian Universities. *Africa Education Review, 11*(2), 91-102.

Giavrimis, P. (2020). Sociological Approaches to ICT Integration in Primary School Through Students' Views. *SN Computer Science, 1*(5), 1-10.

Goktas, Y & Demirel, T. (2012). Blog-enhanced ICT courses: Examining their effects on prospective teachers' ICT competencies and perceptions. *Computers & Education, 58*(3), 908-917.

Gonen, A., Sharon, D & Lev-Ari, L. (2016). Integrating Information Technology's competencies into academic nursing education–An action study. *Cogent Education, 3*(1), 1193109.

Hassan, A. A., Abdulkareem, H. B., & Suleiman, A. (2023). Self-concept as predictors of internet addiction among undergraduate students of Kwara State University, Nigeria. *ASEAN Journal of Educational Research and Technology, 3*(1), 1-8.

Heiman, T., Fichten, C. S., Olenik-Shemesh, D., Keshet, N. S & Jorgensen, M. (2017). Access and perceived ICT usability among students with disabilities attending higher education institutions. *Education and Information Technologies, 22*(6), 2727-2740.

Hossain, M. A & Sormunen, E. (2019). ICT skills of Library and Information Science (LIS) students in Bangladesh. *International Information & Library Review, 51*(4), 285-299.

Hu, Z & McGrath, I. (2011). Innovation in higher education in China: Are teachers ready to integrate ICT in English language teaching? *Technology, pedagogy and education, 20*(1), 41-59.

Hu, X., Gong, Y., Lai, C & Leung, F. K. (2018). The relationship between ICT and student literacy in mathematics, reading, and science across 44 countries: A multilevel analysis. *Computers & Education, 125*, 1-13.

Ifinedo, P., Pyke, J & Anwar, A. (2018). Business undergraduates' perceived use outcomes of Moodle in a blended learning environment: The roles of usability factors and external support. *Telematics and Informatics, 35*(1), 93-102.

Islam, A. A., Mok, M. M. C., Gu, X., Spector, J & Hai-Leng, C. (2019). ICT in higher education: An exploration of practices in Malaysian universities. *Ieee Access, 7*, 16892-16908.

Ivanković, A., Špiranec, S & Miljko, D. (2013). ICT literacy among the students of the Faculty of Philosophy, University of Mostar. *Procedia-Social and Behavioral Sciences, 93*, 684-688.

Jabbour, D., Masri, J. E., Nawfal, R., Malaeb, D., & Salameh, P. (2023). Social media medical misinformation: impact on mental health and vaccination decision among university students. *Irish Journal of Medical Science (1971-), 192*(1), 291-301.

Kang, D & Park, M. J. (2017). Competitive prospects of graduate programs on the integration of ICT superiority, higher education, and international aid. *Telematics and Informatics, 34*(8), 1625-1637.

Kim, M. S. (2012).Cultural–historical activity theory perspectives on constructing ICT-mediated metaphors of teaching and learning. *European Journal of Teacher Education, 35*(4), 435-448.

Kokkinos, C. M & Antoniadou, N. (2019). Cyberbullying and cyber-victimization among undergraduate student teachers through the lens of the General Aggression Model. *Computers in Human Behavior, 98*, 59-68.

Li, Y. (2012). Development strategy for the requirement of ICT in the learning of comprehensive regional higher education institutes: Comparing undergraduates belonging to different schools. *Procedia Environmental Sciences, 12*, 1005-1009.

McGill, T., Koppi, T. & Armarego, J. (2014). ICT industry involvement with ICT education and research in universities: Industry perceptions. *Innovation in teaching and learning in information and computer sciences*, 1-18.

Muriithi, P., Horner, D. & Pemberton, L. (2016). Factors contributing to adoption and use of information and communication technologies within research collaborations in Kenya. *Information Technology for Development, 22*(sup1), 84-100.

Nketiah-Amponsah, E., Asamoah, M. K., Allassani, W & Aziale, L. K. (2017). Examining students' experience with the use of some selected ICT devices and applications for learning and their effect on academic performance. *Journal of Computers in Education, 4*(4), 441-460.

Nookhong, J & Wannapiroon, P. (2015). Development of collaborative learning using case-based learning via cloud technology and social media for enhancing problem-solving skills and ICT literacy among undergradute students. *Procedia-Social and Behavioral Sciences, 174*, 2096-2101.

Odunola, O. A & Tella, A. (2020). Perceived usefulness as a correlate of undergraduate students' patronage of online public access catalogue in South-West Nigeria. *Cataloging & Classification Quarterly, 58*(5), 520-532.

Oluwasusi, J. O. (2014). Determinants of ICT utilization among agricultural students of tertiary institutions in South Western Nigeria. *Journal of Agricultural & Food Information, 15*(2), 121-135.

Papastergiou, M. (2011). Physical education and sport science undergraduate students as multimedia and web developers: Moving from the user's to the creator's perspective. *Education and Information Technologies, 16*(3), 281-299.

Papastergiou, M., Gerodimos, V & Antoniou, P. (2011). Multimedia blogging in physical education: Effects on student knowledge and ICT self-efficacy. *Computers & Education, 57*(3), 1998-2010.

Patiar, A., Kensbock, S., Ma, E & Cox, R. (2017). Information and communication technology–Enabled innovation: Application of the virtual field trip in hospitality education. *Journal of Hospitality & Tourism Education, 29*(3), 129-140.

Pheeraphan, N. (2013). Enhancement of the 21st century skills for Thai higher education by integration of ICT in the classroom. *Procedia-Social and Behavioral Sciences, 103*, 365-373.

Puckree, T., Maharaj, S & Mshunquane, N. (2015). Status of usage of information communications technology by academic staff at a selected nursing training institution in South Africa. *International Journal of Educational Sciences, 8*(3), 511-519.

Ramos, S. I. M & de Andrade, A. M. V. (2016). ICT in Portuguese reference schools for the education of blind and partially sighted students. *Education and Information Technologies, 21*(3), 625-641.

Reyes Jr, V. C., Reading, C., Doyle, H & Gregory, S. (2017). Integrating ICT into teacher education programs from a TPACK perspective: Exploring perceptions of university lecturers. *Computers & Education, 115*, 1-19.

Sar, A & Misra, S. N. (2020). An empirical study to examine the components of technology-enabled distance education affecting students' perception. *Materials Today: Proceedings*.

Selwyn, N. (2007). Hi-tech= guy-tech? An exploration of undergraduate students' gendered perceptions of information and communication technologies. *Sex roles, 56*(7), 525-536.

Sheard, J., Carbone, A. & Hurst, A. J. (2010). Student engagement in the first year of an ICT degree: staff and student perceptions. *Computer Science Education, 20*(1), 1-16.

Slechtova, P. (2015). Attitudes of undergraduate students to the use of ICT in education. *Procedia-Social and Behavioral Sciences, 171*, 1128-1134.

Tam, H. L., Chan, A. Y. F & Lai, O. L. H. (2020). Gender stereotyping and STEM education: Girls' empowerment through effective ICT training in Hong Kong. *Children and Youth Services Review, 119*, 105624.

Tiainen, T & Berki, E. (2019). The re-production process of gender bias: a case of ICT professors through recruitment in a gender-neutral country. *Studies in Higher Education, 44*(1), 170-184.

Trushell, J., Byrne, K & Hassan, N. (2013). ICT facilitated access to information and undergraduates' cheating behaviours. *Computers & Education, 63*, 151-159.

Uleanya, C. (2020). Rural undergraduate university students' learning challenges in Africa: a case study of Nigeria and South Africa. *African Identities*, 1-29.

Vega-Hernández, M. C., Patino-Alonso, M. C & Galindo-Villardón, M. P. (2018). Multivariate characterization of university students using the ICT for learning. *Computers & Education, 121*, 124-130.

Verhoeven, J. C., Heerwegh, D & De Wit, K. (2016). ICT learning experience and research orientation as predictors of ICT skills and the ICT use of university students. *Education and Information Technologies, 21*(1), 71-103.

Verma, C., Stoffová, V & Illés, Z. (2019). Prediction of students' awareness level towards ICT and mobile technology in Indian and Hungarian University for the real-time: preliminary results. *Heliyon, 5*(6), e01806.

Woreta, S. A., Kebede, Y & Zegeye, D. T. (2013). Knowledge and utilization of information communication technology (ICT) among health science students at the University of Gondar, North Western Ethiopia. *BMC medical informatics and decision making, 13*(1), 1-7.

Woyo, E., Rukanda, G. D & Nyamapanda, Z. (2020). ICT policy implementation in higher education institutions in Namibia: A survey of students' perceptions. *Education and Information Technologies, 25*(5), 3705-3722.

Xu, F & Du, J. T. (2019). Examining differences and similarities between graduate and undergraduate students' user satisfaction with digital libraries. *The Journal of Academic Librarianship, 45*(6), 102072.

Yıldırım, M., & Şanlı, M. E. (2023). Psychometric properties of the Turkish version of the COVID-19 Impact Scale in university students. *Journal of School and Educational Psychology, 3*(1), 22-33.

Zhang, R. C., Lai, H. M., Cheng, P. W & Chen, C. P. (2017). Longitudinal effect of a computer-based graduated prompting assessment on students' academic performance. *Computers & Education, 110*, 181-194.

APPENDIX

Acronym	Description
AOR	Adjusted Odd Ratio
CB	Cyber-Bullying
CV	Cyber-Victimization
CFA	Confirmatory Factor Analysis
DLs	Digital Libraries
DISC	Discriminant
GAM	General Aggression Model
HLM	Hierarchical Linear Models
ICT	Information and Communication Technology
ITTP	Information And Telecommunication Technology Program
KNN	K-Nearest Neighbour
LIS	Library And Information Science
MLR	Multiple Linear Regression
OPACs	Online Public Access Catalogs
OLS	Ordinary Least Squares
PE	Physical Education
PDC	Parallel and Distributed Programming
PCA	Principal Component Analysis
PLS	Partial Least Squares
RMR	Root Mean Square Residual
RMSEA	Root Mean Square Of Error Approximation
SVM	Support Vector Machine
SEM	Structural Equation Modelling
TAG	Technology Adoption and Gratification
TML	Technology-Mediated Learning
TAM	Technology Acceptance Model
VFT	Virtual Field Trip