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The role of educational technology in developing the cognitive and communicative skills of university students: A Saudi Arabian case

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ABSTRACT

This academic research explores the transformative potential of educational technology platforms, including virtual reality, gamification, and artificial intelligence, in revolutionizing the education sector. Existing literature has indicated that educational technology holds the promise of enhancing cognitive and communicative skills among university students. However, a research gap exists, as previous studies have primarily concentrated on school children, leaving a dearth of empirical evidence in this specific context. To address this gap, our current study conducted a comprehensive survey of 305 university students in Saudi Arabia. Employing quantitative methods, we assessed the impact of educational technology on university students' cognitive and communication skills, yielding noteworthy findings. The results revealed a significant positive influence of educational technology on both cognitive (p-value 0.016) and communication skills (p-value 0.014) among university students in Saudi Arabia. This research significantly contributes to the existing literature by highlighting the importance of educational technology's accessibility and effective utilization in fostering the development of university students' cognitive and communication abilities. Furthermore, it sheds light on the implications of these findings for Saudi Arabia, a nation that has made considerable investments in educational technology and the accreditation of academic programs at its universities. Additionally, the study's outcomes suggest that educational technology can play a crucial role in facilitating the accreditation of academic programs in Saudi Arabian universities through its positive impact on university students' cognitive and communicative capabilities. This insight holds the potential to further advance the educational landscape in the country and beyond, emphasizing the need for continued integration and optimal utilization of educational technology in higher education settings.

1. Introduction

Educational technology is the application of many forms of technological know-how in the classroom. This includes the computer hardware, the programs they run, and the theories and methods used in teaching (Singh and Agarwal, 2011; Singh et al., 2013). As new technologies arise, our living habits, working, playing, making things, and sharing information are constantly evolving. Therefore, it should come as no surprise that progress in educational technology is generating unprecedented prospects for the education sector (Jones, 1991). In the education field, technological advances present new opportunities for stimulating and challenging pupils' minds. Today, increasing numbers of people are interested in and using adaptive technology, such as high-tech collaboration tools, gamification, podcasting, blogging, 3D printing, virtual reality (VR), artificial intelligence (AI), and adaptive learning (Pence, 2019; Steele et al., 2020).

"Digital native" and "net generation" are two of the most prevalent terms for today's "tech-savvy" youngsters (Perkins, 2001). Technology-influenced cognitive and communication abilities and associated educational practices appear to reflect a

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shift in the learning patterns of the students (Singh and Chand, 2012). Students' cognitive skills are the mental abilities to successfully learn their subjects, such as reading, writing, thinking, analyzing, remembering, solving, and comprehending. Digital assessments can determine students' cognitive strengths and weaknesses and assist educators in developing interventions tailored to each student's cognitive profile. Additionally, technology plays a critical role in enhancing students' communication abilities. Students can use educational technology to improve their written and oral communication skills with the guidance of their teachers. Technology has significantly impacted both the quality and quantity of written communication. Students write blogs, maintain social media profiles, and complete classroom assignments online.

The benefit of employing educational technology learning tools is that they enable students to interact with real-world circumstances (Alshammary and Singh, 2017). In addition, students cannot acquire the educational benefits of simulation and imagery by reading or other means (Bradley, 2006). Consequently, the implementation of educational technology can have a substantial impact on the cognitive and communicative skills of pupils (Courts and Tucker, 2012).

The findings of earlier and more recent reviews and meta-analyses show that a relatively small number of studies have investigated the effects of educational technology on developing students' cognitive and communication skills (Valgeirsdottir and Onarheim, 2017). Prior studies have focused mainly on the educational technology's use to develop cognitive and communication skills of school-going and young children (Cecilia et al., 2015; Cofini et al., 2012; Shonkoff and Garner, 2012; Alshammari and Singh, 2021). However, the mechanics and application of educational technology differ between university students and school children. Thus, additional research is required to determine the role of educational technology in developing university students' cognitive and communication skills. This is especially true for Saudi Arabia, as it has been investing tremendous resources to develop its higher education sector (Singh et al., 2022a; 2022b; Alam et al., 2022). Therefore, the current research addresses this research gap by examining educational technology's impact on developing university students' cognitive and communication skills in Saudi Arabia. The current research findings also benefit Saudi universities seeking accreditation from agencies such as the National Center for Academic Accreditation and Evaluation (NCAAA), as the university's role in developing students' cognitive and communication skills is considered critical for accreditation. The objectives of this research are:

- To examine the effect of educational technology on developing university students' cognitive and communication skills.
- To propose mechanisms for developing university students' cognitive and communication abilities.
- To recognize the study's contribution to the literature on educational technology and skill development.

2. Literature review

In the past decade, technological innovations in education have become increasingly prevalent. Smartboards, digital cameras, classroom response systems, document cameras, and LCD or DLP projectors are examples of technological instruments utilized in the education field. Applications and online resources based on educational technology assist current educators in disseminating more advanced knowledge and maintaining academic standards (Elahi and Rehman, 2013). In addition, it provides students with beneficial tools for honing their critical thinking and problem-solving abilities (Neo and Neo, 2009).

Robins et al. (2012) showed that researchers are beginning to focus on educational technology displays to comprehend better how they affect children's cognitive development. Kerawalla and Crook (2002) identified technology availability in the home as a potential indicator of technological competence. The price of devices may affect how frequently individuals use digital tools, but it has a negligible effect on how well they learn to use them. When students are given more flexibility to explore and experiment with digital resources independently, their learning skills improve (Elahi and Rehman, 2013). Cofini et al. (2012) examined the efficacy of digital support for children with limited comprehension. The results demonstrated that technology increased the reading skill of low comprehenders, demonstrating the value of instructional technology in learning. Fuadia (2020) discovered that educational technology affects the learning processes of young children.

Educational technological learning tools' uniqueness is that they enable students to interact with real-world scenarios. Also, students cannot get the learning outcome of simulation and visualization from a book or other sources (Bradley, 2006). Therefore, the use of educational technology captures students' attention and maintains it (Courts and Tucker, 2012). In addition, the classroom's use of educational technology can catalyze students' cognitive skills and sharpen their self-expression (Peffer et al., 2015).

Nebel et al. (2016) asserted that educational technology benefits students not only in terms of entertainment but also in terms of cognitive and communication skill development. Cecilia et al. (2015) observed that children exposed to technology at a young age exhibited enhanced cognitive flexibility and communication skills. Using an innovative digital tool, Shonkoff and Garner (2012) were able to demonstrate improved performance among students with lower reading levels at the start of the study. The findings indicated that

technologies have efficacy and a beneficial effect on the students' learning process. There is evidence that interactive technology improves a child's capacity to acquire and comprehend material while silently reading (Vincenza et al., 2016). Adaptive learning technology can be considered a potent link in the mental development process (Singh and Alshammari, 2021; Singh et al., 2011). According to Vincenza et al. (2016), educational technology can play a vital role in developing school children's cognitive and reading comprehension skills. According to Jiang and Benbasat (2007), an educational technology-driven learning environment entails presenting information via multiple channels, such as auditory and visual, which could play a vital role in developing cognitive and communication skills.

Thus, the literature review shows that:

- Educational technology has the potential to influence students' cognitive and communication development.
- There is a dearth of research examining the impact of educational technology on university students' cognitive and communication skills.

The application of educational technology is contingent upon the availability and utilization of technology (Almaiah et al., 2019). Likewise, student learning is contingent upon the availability of educational technologies. Without educational technology, students can't acquire knowledge and develop the necessary skills (Smith et al., 2018). In addition to the availability of instructional technology, its effective implementation is also a critical factor (Akçayır and Akçayır, 2017). In this study, we posit that educational technology availability and its effective usage are crucial for developing the students' cognitive and communication skills.

The authors describe the conceptual model for this study in Fig. 1 based on a survey of the relevant literature. The model examines the impact of educational technology in developing university students' cognitive and communication skills. The model also introduces one control variable: The age of the students.

The hypotheses of the study are as follows:

H1: Educational technology positively impacts university students' cognitive skills.
H2: Educational technology positively impacts university students' communication skills.

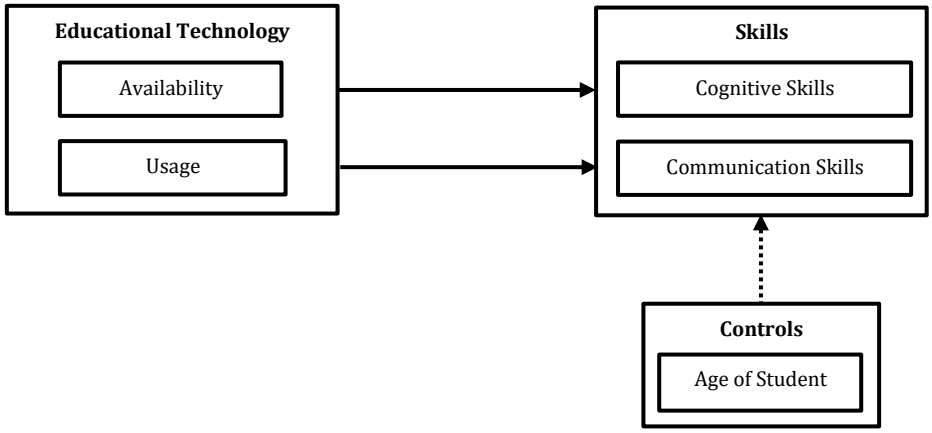

Fig. 1: Conceptual model of the research

3. Methodology

In order to meet the study's aims, a quantitative survey research methodology was utilized. This section explains the data, procedures, variables, empirical model, and analysis method used in this study.

3.1. Data and sampling

The study gathered data using surveys. The surveys have been conducted at the University of Ha'il to determine the effect of educational technology on university students' cognitive and communication abilities. The students studying at the University of Ha'il were the study sample. Responses were collected from 305 students using non-probabilistic sampling. Table 1 depicts the sample features.

Table 1: Sample features

Variable	Type	Number	Percentage
Year	First	79	25.9
	Second	77	25.25
	Third	76	24.92
	Fourth	73	23.93
Age	18-20	164	53.77
	21-23	91	29.84
	24-26	30	9.84
	27-29	15	4.92
	30-32	5	1.64
Gender	Male	151	49.51
	Female	154	50.49

3.2. Procedure and instrument

We developed a questionnaire to conduct the survey for this study. A 5-point Likert scale was developed to collect students' responses on the impact of educational technology on developing their cognitive and communication skills. The Likert scale had ratings of strongly agree (code 5), agree (code

4), neutral (code 3), disagree (code 2), and strongly disagree (code 1). The questionnaire was translated from English to Arabic to increase students' comprehension and response rate. We employed the online mode for distributing questionnaires and collecting responses as it allowed reaching many students and eliminated interview bias (Singh and Alhulail, 2022). Before asking students to complete surveys, the study's goal was explained to them, and they were assured that their responses would be kept confidential and anonymous. The students who gave their informed consent were administered the surveys.

3.3. Variables

Table 2 depicts the variables used in this study and their definitions. The study's dependent variables are the students' cognitive skills (CGS) and communication skills (COS). The independent variables are educational technology availability (ETA) and educational technology usage (ETU). We use age (A) as a control variable since students' cognitive and communication skills may be related to their age.

Table 2: Variables and their definitions

Variable(s)	Definition
	Dependent variables
Cognitive skills	Students' mental abilities to successfully learn their subjects (such as reading, writing, thinking, analyzing, remembering, solving, and comprehending)
Communication skills	Students' written and oral communication skills (manifested in blogs, social media profiles, online assignments, presentations, etc.)
	Independent Variables
Educational technology availability	The availability of educational technology to students (such as blackboard, banners, computers, laptops, software, etc.) (Smith et al., 2018)
Educational technology usage	The students' use of educational technology for their learning (such as assignments, presentations, lab exercises, exams, etc.) (Akçayır and Akçayır, 2017)
	Control Variable
Age	Age of the student

3.4. Empirical model

To examine the impact of educational technology on developing students' cognitive and communication skills, we assess the following empirical models:

$$CGS_t = \beta^0 + \beta^1 ETA_t + \beta^2 ETU_t + \beta^3 A_t + \varepsilon_t \quad (1)$$

$$COS_t = \beta^0 + \beta^1 ETA_t + \beta^2 ETU_t + \beta^3 A_t + \varepsilon_{t^t} \quad (2)$$

where, CGS is cognitive skills, COS is communication skills, ETA is educational technology availability, ETU is educational technology usage, A is Age, and ε is error term.

3.5. Analysis method

The current research employed ordinary least squares (OLS) regression analyses to examine the impact of educational technology on students' cognitive and communication skills. OLS regression analyses estimate coefficients in a linear regression model and minimize error among predicted and real values (Bravo and Godfrey, 2012). Therefore, the current authors employed OLS regression analysis as its usage is consistent with the study goals.

4. Analyses and results

4.1. Descriptive statistics and correlation matrix

Table 3 depicts the descriptive statistics of the variables used in this research. It shows the mean value of cognitive skills at 3.98, communication skills at 3.88, educational technology availability at 4.12, educational technology usage at 3.89, and age at 21.13. The coefficient of variation (CV) estimates the data variability of an individual sample vis-à-vis the population (Eldridge et al., 2006). All the variables used in this study do not have a high CV (Table 3).

Table 3: Descriptive statistics

Variable	Mean	Minimum	Maximum	Standard deviation	Coefficient of variation
Cognitive skills	3.98	1	5	0.65	0.16
Communication skills	3.88	1	5	0.58	0.15
Educational technology availability	4.12	1	5	0.84	0.20
Educational technology usage	3.89	1	5	0.89	0.23
Age	21.13	18	32	3.08	0.15

Table 4 displays the Pearson correlations matrix of the variables used in this study. Multicollinearity issues may arise if there is a high bilateral correlation among the explanatory variables (Ullah et al., 2019). If there is multicollinearity between variables, coefficients will be less precise, and p-values will be unable to accurately predict the importance of independent variables (Shrestha, 2020). Table 4 reveals the absence of strong correlations among explanatory variables. There are a few moderate correlations, such as between age and CGS (0.403) and age and COS (0.406) (Table 4) (McCausland et al., 2021).

Table 4: Correlations matrix

Variable	CGS	COS	ETA	ETU	A
Cognitive skills	1				
Communication skills	0.242	1			
Educational technology availability	0.334	0.197	1		
Educational technology usage	0.263	0.286	0.344	1	
Age	0.403	0.406	0.313	0.358	1

4.2. Multicollinearity and heteroscedasticity analyses

The current study undertook additional analysis to ensure that the data is free from multicollinearity and heteroscedasticity issues (Table 5). Variance inflation factors (VIF) values were assessed to evaluate multicollinearity concerns. There were no multicollinearity concerns as all the VIF values were less than 5 (Table 5) (Hair et al., 2011). Second, Breusch-Pagan and Koenker values were used to evaluate heteroscedasticity concerns. There were no multicollinearity concerns as the p-values for Breusch-Pagan and Koenker test were less than 0.05 (Table 5) (Halunga et al., 2017).

Table 5: VIF and Breusch-Pagan and Koenker values

Variable	VIF values	Breusch-Pagan and Koenker P-values
Cognitive skills	3.563	0.024
Communication skills	3.346	0.028
Educational technology availability	2.975	0.017
Educational technology usage	2.753	0.019
Age	2.357	0.015

4.3. Multivariate regression analysis

Table 6 displays the results of the multivariate regression analysis.

Table 6 model 1 (CGS) depicts an adjusted R2 of 0.592, showing that educational technology availability and effective usage explain 59.2% of the variance. The p-value of the model is 0.016, which is significant at a 0.05 level. This implies that educational technology positively impacts university students' cognitive skills. Therefore, hypothesis H1 is supported. Furthermore, educational technology availability and usage indicate a positive and significant association with cognitive skills. This suggests that both educational technology availability and effective usage are required to develop students' cognitive skills.

Table 6 model 2 (COS) depicts an adjusted R2 of 0.598, showing that educational technology availability and effective usage explain 59.8% of the variance. The p-value of the model is 0.014, which is significant at a 0.05 level. This implies that educational technology positively impacts university students' communication skills. Therefore, hypothesis H2 is supported. Furthermore, educational technology availability and educational technology usage indicate a positive and significant association with communication skills. This suggests that both educational technology availability and effective usage are required to develop students' communication skills.

Table 6: Multivariate regression

Variable	Model 1 (CGS)				Model 2 (COS)			
	Coefficient (B)	Std. error	T-stat	P-value	Coefficient (B)	Std. error	T-stat	P-value
Educational technology availability	4.348**	2.224	2.653	0.008	4.357**	2.256	2.715	0.007
Educational technology usage	4.258**	2.243	2.625	0.009	4.254**	2.248	2.669	0.08
Age	0.862	0.402	1.381	0.168	0.873	0.421	1.395	0.164
R^2	0.568				0.572			
Adjusted R^2	0.592				0.598			
P-Value	0.016*				0.014*			

* and ** signify statistical significance at 0.05 and 0.01 levels

5. Discussion

The results of the study supported the study's first hypothesis. This shows that educational technology positively impacts students' cognitive skills. This result is in accordance with Fuadia (2020), Neo and Neo (2009), and Kerawalla and Crook (2002), which suggested that educational technology hones students' critical thinking, learning, and problem-solving abilities. This result supports Robins et al. (2012), which suggested that educational technology contributes to students' mental development. The study result aligns with Cofini et al. (2012), which asserted that educational technology improves students' reading comprehension. The study results also supported Jiang and Benbasat (2007), Shonkoff and Garner (2012), and Nebel et al. (2016), which indicated that educational technology supports the cognitive development of students. However, most of the prior research has been conducted on school children, whereas this study's results show the vital role of educational technology in developing the cognitive skills of university students. Further, the current study contributes to the literature by depicting that both the availability and effective usage of educational technology are required to develop the student's cognitive skills.

The results of the study supported the study's second hypothesis. This shows that educational technology positively impacts students' communication skills. This result is in accordance

with Bradley (2006) and Courts and Tucker (2012), which suggested that educational technology improves students' communication skills by capturing and maintaining their attention. Furthermore, this result supports Peffer et al. (2015), which suggested that educational technology can catalyze students' cognitive skills and sharpen their self-expression. The study results also supported Jiang and Benbasat (2007), Cecilia et al. (2015), and Nebel et al. (2016), which suggested that educational technology supports the communication abilities of students. However, most of the previous research has been conducted on school children, whereas this study's results show the vital role of educational technology in developing the communication skills of university students. Further, the current study contributes to the literature by depicting that both the availability and effective usage of educational technology are required to develop students' communication skills.

6. Conclusions

The present empirical investigation aimed to explore the effects of integrating educational technology in enhancing the cognitive and communication skills of university students in Saudi Arabia. While prior research has primarily focused on the development of cognitive and communicative abilities among school children, this study centered its attention on university students in the Saudi context. Employing a quantitative research approach, a survey was administered to 305 university students in Saudi Arabia to gather relevant data.

The findings of this study align with existing literature, underscoring the crucial role of educational technology in fostering cognitive and communication skills among university students. The study also makes a noteworthy contribution to the field of educational technology and skill development by emphasizing the significance of both the accessibility and effective utilization of educational technology to promote cognitive and communication competencies.

The implications of this research carry considerable weight for Saudi Arabia, a nation that has invested substantial resources in the advancement of its higher education system. Notably, Saudi universities have devoted significant efforts to attain accreditation for their academic programs. As such, the development of cognitive and communication abilities among university students holds paramount importance for the accreditation process in Saudi Arabia. The results of this study advocate the integration of educational technology as a pivotal factor in cultivating these skills. Consequently, Saudi universities should prioritize efforts to enhance the availability and effective implementation of educational technology to support the growth of cognitive and communication abilities among their students.

This study provides valuable insights into maximizing the potential of educational technology to foster cognitive and communication skills among university students. However, certain limitations are inherent in this study, which offer directions for future research endeavors. Firstly, the data was obtained solely from one public university in Saudi Arabia, warranting the collection of data from multiple institutions to achieve a more comprehensive and diverse sample size. Additionally, comparing the impact of educational technology on cognitive and communicative development across various types of educational institutions, such as universities and colleges, would further enrich the understanding of this topic. Moreover, exploring other Gulf Cooperation Countries (GCC) could provide valuable cross-cultural perspectives on the adoption of educational technology for enhancing university students' cognitive and communication skills, given the cultural similarities with Saudi Arabia. These potential areas for future investigation can enhance the robustness and applicability of the study's findings.

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Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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