



Impacts of Digital Technology-Enabled Personalized and Adaptive Learning on Student Learning Performance: A TOE Framework for Saudi Arabia

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Abstract

Digital technology-enabled personalized and adaptive learning has emerged as a critical tool for educational institutions to satisfy the evolving needs of their students, particularly in a dynamic environment like COVID-19. Such learning provides students the necessary guidance and flexibility required in a learner-centered environment, thus improving student performance. The current study leverages the TOE model to develop an institutional-level DT-PAL student learning framework. The framework suggests that digital technology-enabled personalized and adaptive learning can provide the students with the necessary personalization, flexibility, and adaptability to meet their learning needs and enhance their learning performance. The DT-PAL framework also suggests that COVID-19 and national culture complement the relationship between digital technology-enabled personalized and adaptive learning and student performance. The analysis of Saudi national culture on Hofstede cultural dimensions suggests that digital technology-enabled personalized and adaptive learning can foster student creativity, improve teaching-learning methodologies, bridge the gender divide, increase professionalism, improve evaluation methods, and streamline curriculum. The knowledge generated by this study can help Saudi Arabia to meet its digital transformation goals under National Transformation Program. Other countries can use the knowledge generated by this study to transform their education sector and improve the learning performance of their students.

Disciplinary: Management Information Systems, Educational Management, Technology Management

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1 Introduction

The educational sector has undergone a paradigm shift due to advanced technologies. Intelligent devices and technologies contribute to developing an intelligent learning environment (Price, 2015). These digital technologies are facilitating the growth of personalized and adaptive learning. As a result, educators must embrace digital technology to meet their students' evolving needs. The two pillars of the smart learning approach, personalized and adaptive learning, must be thoroughly analyzed. The current research examines how personalized and adaptive learning enabled by digital technology can support the educational sector in a dynamic environment, primarily by enhancing student learning performance in countries such as Saudi Arabia.

Personalized learning is based on a blended learning model that utilizes various approaches and material types to ensure that the learner receives the maximum benefit from the program (Basham et al., 2016). Personalized learning considers each student's unique learning requirements, abilities, interests, and aspirations, resulting in more dynamic and engaging classrooms that promote personal growth and academic performance. Indeed, several case studies demonstrate that integrating digital technology into the classroom to create personalized learning plans results in an average 30% increase in student performance and test scores (SMU Online, 2021).

Adaptive learning is a term that refers to the process of adapting learning to the learner. Digital systems can aid in developing a training program and its tailoring to the appropriate learner in the proper time. The emergence of personalized and adaptive learning is facilitated by technologies such as big data, which generate enormous amounts of data rapidly. Smart devices collect data about learners by tracking their progress, recognizing learning scenarios, and connecting them. Individual students' adaptive learning programs are developed through data analysis to ensure they have the necessary flexibility and that their learning is tailored to their unique characteristics (Dron, 2018).

Smart learning encompasses novel educational contexts in which students' ease of using technology is emphasized for efficient, effective, and convenient learning. Smart learning fosters a learner-centered environment that facilitates effective learning. The approach uses cutting-edge technology to prepare students for a world that is constantly changing and requires adaptability. Smart learning is enabled by various digital technologies that aid learners in effectively absorbing knowledge and skills. These digital technologies include virtual collaboration software and electronic performance support systems (Iqbal & Olariu, 2020).

As previously discussed, digital technologies that enable personalized and adaptive learning can improve student performance significantly. This applies to all countries, but particularly to Saudi Arabia. Saudi Arabia's National Transformation Program (NTP, 2016) aims to assist students and educators in making the transition to digital education. Saudi Arabia's demand for higher education has increased dramatically over the last two decades, owing to the country's rising high

school graduation rate. This increase in enrollment has put pressure on Saudi Arabia's educational institutions, prompting the acceptance of information & communication technologies (ICT) in education. Institutions throughout Saudi Arabia have embraced e-learning as a viable substitute for traditional classroom instruction. However, e-learning does not consider the students' unique needs or their immediate environment. Thus, the current educational environment necessitates a new approach, such as personalized adaptive learning using digital technology-enabled smart learning environments that take individual students' needs into account and tailor programs to their unique needs and desires.

The technology acceptance model (TAM), the diffusion of innovation (DOI), the theory of planned behavior (TPB), the Technology Organization Environment (TOE) framework, and the unified theory of acceptance and use of technology (UTAUT) (Davis, 1989; Tornatzky & Fleischer, 1990; Ajzen, 1991; Rogers, 1995; Venkatesh et al., 2003) are all popular theories in information systems (IS) research. TAM, TBP, and UTAUT apply at the level of individuals, whereas DOI and TOE apply at the level of firms. As we are interested in developing a framework for adopting digital technology-enabled personalized and adaptive learning at the level of the institution, so firm-level theories (DOI and TOE) are pertinent for this research. The TOE framework is regarded as a descendant of the DOI framework. It defines the probability of a particular firm adopting and utilizing innovations comprehensively, considering technological, organizational, and environmental factors. So, this study would utilize the TOE model to build the theoretical framework.

2 COVID-19 and Digital Technology-Enabled Personalized Adaptive Learning

Coronavirus disease of 2019 (COVID-19) has had a devastating effect on education systems worldwide, including Saudi Arabia. The lockdown imposed in nearly every country to ensure social distancing and the closure of face-to-face educational institutions has left no other option but to rely on the digital medium. To ensure that students around the world do not fall behind in their studies, institutions have developed digital mediums for classroom instruction. This extraordinary pandemic situation does not preclude the possibility of future pandemics, and the education sector must adapt accordingly. While digital education has several advantages, it also has some drawbacks, including a lack of hands-on training, a lack of student feedback, limited flexibility, and a lack of a personalized touch. As a result, educational institutions must ensure that digital technologies are appropriately adapted to improve student learning performance (Peng et al., 2019). The smart learning environment can help students learn effectively, particularly during COVID-19, as the force majeure due to COVID-19 propelled digital learning with renewed vigor. Thus, using digital technologies to enable a personalized and adaptive learning approach is the most effective way to address the various issues that students face during COVID-19 and to ensure the overall learning process is effective.

Saudi Arabia's educational sector has seen significant improvement and expansion. One could argue that the country is making a concerted effort to transition to digital education. Saudi universities concentrated their efforts on e-learning, particularly during COVID-19. However, higher education institutions must move toward personalized and adaptive learning enabled by digital technology to survive and succeed globally. Thus, the current research seeks to enrich the literature by developing an institutional-level framework to assist countries such as Saudi Arabia in adopting personalized and adaptive learning using digital technology in dynamic environments such as COVID-19.

3 Technology-Organization-Environment (TOE) Framework

TOE framework is an analytical technique used to investigate adoption at the level of a firm for various IS, information technology (IT) products, and services. It has developed into a widely accepted theoretical framework to evaluate IT adoption (Zhu et al., 2004). The TOE framework identifies the enterprise components that impact technological innovation adoption and implementation. These components are classified into 3 categories: technological, organizational, and environmental. When it comes to technological innovation adoption, use, and value creation, TOE outperforms other adoption models (Oliveira & Martins, 2010). Additionally, it is not industry- or firm-specific (Wen & Chen, 2010). Thus, the TOE framework provides an in-depth examination of consumer technology adoption, technology implementation, technological challenges, impact on activities along the value chain, diffusion of technology within firms the following adoption, and the factors affecting business and innovation adoption.

Prior research has extensively used the TOE framework to analyze various ICT adoptions like websites, electronic commerce & business, B2B e-commerce, social commerce, knowledge management systems (KMS), etc. (Teo et al., 2006; Kuan & Chau, 2001; Chau & Tam, 1997; Pan & Jang, 2008; Oliveira & Martins, 2008; Lee et al., 2009; Oliveira & Martins, 2010; Martins & Oliveira, 2009; Mohtaramzadeh et al., 2017; AlBar & Hoque, 2017; Abed, 2020; Salah et al., 2021). So, TOE is a pertinent framework for developing our study's theoretical model.

The TOE model defines technological context as "all internal and external technologies that may affect the organization," including information technology infrastructure, software, and hardware. The term "organization" refers to the informal & formal linking structures and processes of communication within an organization. Additionally, it refers to the organizational characteristics that may facilitate or obstruct the adoption process. "Environment" refers to an organization's internal and external pressures, such as market competition, regulations, and policies (Hsu et al., 2006).

4 Role of National Culture in Adopting Digital Technology

Hofstede and Bond (1984) pioneered the concept of national cultures by introducing four dimensions: collectivism versus individualism, power distance, masculinity versus femininity, and

avoidance of uncertainty. Individualism entails a loosely coupled social structure, whereas collectivism entails a tightly coupled social structure. Power distance measures how much less powerful people accept and expect unequal power distribution. Femininity represents a consensus-oriented society, whereas masculinity represents a competitive society. Uncertainty avoidance expresses how uncomfortable people are with uncertainty and ambiguity (Hofstede & Bond, 1984).

Later, Hofstede et al. (2010) added two new dimensions - short-term orientation (STO) versus long-term orientation (LTO) and restraint versus indulgence. Long-term-oriented societies adopt a pragmatic approach and encourage modern education. However, short-term-oriented societies maintain traditions and norms. Indulgence embodies a relatively free society that promotes enjoyment of life, whereas restraint embodies a society suppressed and regulated through rigid social norms (Hofstede et al., 2010).

Saudi Arabian national culture ranks near the extremes in all of these dimensions except restraint versus indulgence, where it ranks intermediate (Hofstede, 2017). Thus, national culture is likely to influence how the adoption of digital technologies shapes students' performance in Saudi Arabia.

Table 1: Saudi Arabia Score on Hofstede Cultural Dimensions

Dimensions of Hofstede	Score
People's power distance or disparity	95
Lack of Collectivism (or Individualism)	25
Lack of femininity (or Masculinity)	60
Avoidance of un-certainty	80
Lack of STO (or LTO)	36
Lack of Restraint (or Indulgence)	52

Table 1 portrays that Saudi Arabia has a high-power distance score of 95, underscoring that Saudi society accepts and expects orders from their superiors. This shows that teacher-centered instruction is followed in Saudi educational institutions. This implies a lower value of dialogue-based teaching methods and a lack of active involvement of students in coursework (Singh & Chand, 2012; Singh & Alhulail, 2022). In Saudi Arabia, students usually follow the command structure and the syllabus to achieve higher academic grades (Ramis, 2018), which hinders real learning. This is mainly due to society and culture, language issues, and the education system (Ramis, 2018). Digital technologies enabled a smart learning environment can foster creativity in students, uplift the teaching-learning methodology, and enable knowledge-sharing in a seamless manner (Singh, 2019; Srivastava & Dey, 2018; Singh et al., 2013; Singh & Agarwal, 2011; Singh & Grover, 2011).

Saudi Arabia has a low score of 20 on individualism (Table 1), representing a tightly knit social setup and considered a collectivistic society (Hofstede, 2017). This implies that social factors influence students' performance in Saudi Arabia. Examples include the male students' need to carry their female relatives to schools, hospitals, etc., and female students need to follow social norms (Human Rights Watch, 2016). These social norms are followed in educational institutes like

separate campuses for male and female students, male instructors teaching female students over video conferencing, and usually not interacting with them face-to-face (Alasmari, 2020). At the same time, female instructors usually do not teach male students. Digital technology can provide the flexibility required in a collectivist society like Saudi Arabia to overcome these social barriers. Digital technologies have the potential to close the gender divide in Saudi educational institutions including demographic data, disparities in teaching-learning, content, campus life participation, etc. (Alasmari, 2020). Digital technology can also allow the instructors to give negative feedback to the students privately, which is difficult in a public classroom as collectivist societies don't appreciate it.

Saudi Arabia has a relatively high masculinity score of 60 compared to western countries (Table 1), suggesting a competitive society. The higher masculinity dimension score indicates that success, achievement, and competition drive Saudi society. However, the unemployment problem in Saudi Arabia (Statista, 2021) exaggerates the underlying social issues. The quest for jobs takes precedence over the pursuit of knowledge. Due to extrinsic motivation, students prefer professional courses that could lead to jobs. Digital technology enables this end (Hrastinski, 2021; Singh et al., 2011c; Singh et al., 2011a; Singh et al., 2011b).

Saudi Arabia has a high score of 80 for avoiding uncertainty (Table 1). As per Hofstede et al. (2010), societies that avoid uncertainty have more formal laws that meet their emotional needs and are more likely to adhere to their traditions and norms than to adopt new ones. This implies that Saudi society is orthodox, avoids anxiety, follows the rules and behavior codes, and desires to be busy and engaged. In the education sector, this denotes that there should be a clear pattern, structure, and documentation. Such scenarios encourage education and training systems to define evaluation parameters clearly and document the results precisely. Therefore, Saudi students prefer unambiguous questions and don't prefer analytical and reasoning exams (Ramis, 2018). A well-designed digital technology-based curriculum can provide the structure desired by Saudi students to learn and keep them engaged. In such a scenario, ICT is the silver lining as the adoption of digital technology in Saudi Arabia is high, evident from its high internet penetration and social media usage (Singh, 2017; Pandey et al., 2017; Alshammari & Singh, 2018; Singh & Alshammari, 2020).

Saudi Arabia has a low score of 36 in the long-term orientation (Table 1). This shows that Saudi society values personal stability, time-honored traditions, and norms. A high score in long-term orientation indicates students' inclination to succeed in mathematics and sciences in the educational sector. However, Saudi students generally do not prefer these courses (Ramis, 2018). However, digital technology enables personalized and adaptive learning makes it easier for the youth to follow such courses (Alabdulaziz, 2021). So, monumentalism of courses is not a bar for digital technology as internet use has already high penetration and acceptance in Saudi Arabia (Alhamad & Singh, 2021a; Alhamad & Singh, 2021b; Singh & Alhamad, 2021).

As per Table 1, Saudi Arabia has an intermediate score of 52 in the indulgence dimension. So Saudi society does not portray a clear preference for indulgence or restraint behavior. However, there is a slight tilt towards indulgence. This implies that Saudi students are driven by mild optimism and some restraint in the education sector. They desire a certain amount of flexibility but also a formal structure (Ramis, 2018). Therefore, digital technology-based enabled personalized and adaptive learning can be promoted in educational institutes to cater to the unique needs of Saudi students.

The preceding discussion demonstrates how national culture exerts a moderating effect on the relationship between digital technology and personalized and adaptive learning.

5 Theoretical Framework

Digital learning is a platform that provides important means with an understanding of online learning. Students can be motivated through various mechanisms to adopt digital technology and personalize their learning experience. So, adopting digital technology-based personalized and adaptive learning can enrich the student learning experience and enhance their performance. Environmental forces like COVID-19 and national culture can complement student performance with digital technology-based personalized and adaptive learning.

Based on the TOE framework, we posit the following theoretical framework:

- **Technology:** Technology refers to issues affecting an organization, such as IT infrastructure, software, and hardware. In the current era, digital technology fits this dimension. Digital technology enables a smart learning environment that allows learners to learn efficiently, effectively, and comfortably. Digital technology plays a vital role in personalizing and adapting the learning to the unique needs and wants of the individual learner.
- **Organization:** Organization refers to the intra-organization of informal and formal communication processes and linking structures. Personal and adaptive learning fits the organization dimension well. Digital technology-enabled personalized and adaptive learning can provide the students with the necessary personalization and flexibility to effectively meet their learning needs, which will improve their learning performance.
- **Environment:** In the current study, COVID-19 can be considered as a critical force that has greatly influenced the educational environment of institutions. Also, national culture can be construed as the macro-environment under which an organization operates. These environmental forces (COVID-19 and national culture) can complement the relationship between digital technology-enabled personalized and adaptive learning and student learning performance.

Figure 1 depicts the TOE theoretical framework proposed for this study. We call it the Digital Technology - Personalized and Adaptive Learning (DT-PAL) student learning framework.

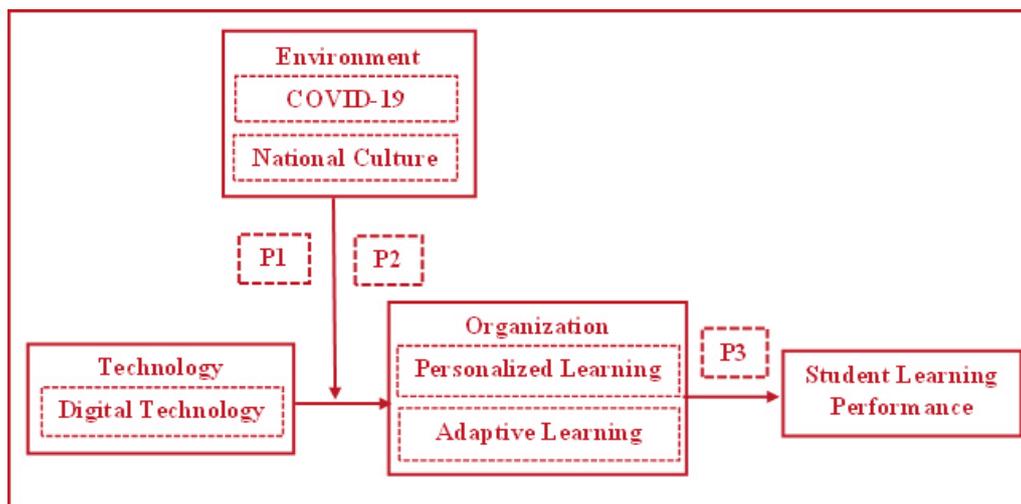


Figure 1: DT-PAL Student Learning Framework.

The DT-PAL student learning framework provides the following significant propositions for Saudi Arabia:

- 1) P1: Digital technology enables personalized and adaptive learning in Saudi higher education institutions.
- 2) P2: The environment in which higher education institutions operate (COVID-19 and national culture) complements the relationship between digital technology and personalized and adaptive learning in Saudi higher education institutions.
- 3) P3: Personalized and adaptive learning enhances student learning performance in Saudi higher education institutions.

6 Conclusion

This study develops a framework depicting the impacts of digital technology-enabled personalized and adaptive learning on student learning performance in Saudi Arabia. This study uses the TOE model to propose a framework for Saudi Arabia's academic institutions. The current study's DT-PAL student learning framework provides significant propositions that can be confirmed through further empirical research. The framework depicts that digital technology enables personalized and adaptive learning in Saudi higher education institutions. Next, COVID-19 and Saudi national culture complement the relationship between digital technology and personalized and adaptive learning in Saudi higher education institutions. Finally, personalized and adaptive learning enhances student learning performance in Saudi higher education institutions.

The study has important practical implications. The study denotes that personalized and adaptive learning provides the students necessary guidance and flexibility to meet their learning needs. During the COVID-19 pandemic, it becomes imminent that digital technology is leveraged to meet the emerging learners' needs. At the same time, Saudi national culture complements its digital transformation efforts.

The analysis of Saudi national culture on Hofstede cultural dimensions suggests important aspects of digital transformation for Saudi Arabia. First, a digitally enabled smart learning environment can foster creativity in Saudi students, improve teaching-learning methodologies, and facilitate seamless knowledge sharing. Second, digital technologies have the potential to close the gender divide in Saudi higher education institutions across a range of dimensions, including demographic data, teaching disparities, content, education opportunities, campus life participation, and mobile learning use. Thirdly, higher education institutions in Saudi Arabia can benefit from increased professionalism because of digital technology. Fourth, digital technology can help higher education and training systems define evaluation parameters and document their findings precisely. Fifth, personalized and adaptive learning enabled by digital technology would make it easier for Saudi students to adhere to a well-organized curriculum. Finally, personalized and adaptive learning enabled by digital technology can address the unique needs of Saudi students.

From this study, digital transformation would play a vital role in percolating the benefits of personalized and adaptive learning to the higher education sector and individual learners.

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