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High school science teachers' acceptance of using distance education in the light of UTAUT

Ehab Gouda Tolba [1*], Nasser Helmy Youssef [1]

[1] Curricula and Instruction Department, College of Education, Imam Abdulrahman Bin Faisal University, Dammam, SAUDI ARABIA

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Abstract

This research aimed at developing hypotheses based on the unified theory of acceptance and use of technology (UTAUT) model and adopting a proposed model that considers the basic structures (performance expectancy, effort expectancy, social influence, and facilitating conditions) as it represents the technology features "distance education (DE)", which are independent variables that affect the dependent variables (behavioral intention (BI) to use DE), taking into consideration the moderating factors (gender, experience, and technological self-efficiency). The research adopted a tool to reveal science teachers' acceptance of using DE in the light of UTAUT, 120 teachers responded online to the tool. The results indicated that the teachers' acceptance of DE was high. It is possible to predict that teachers have BI to use DE, that gender has no effect on BI, and there are differences between the research model variables due to the teaching experience favoring teachers with less teaching experience.

Keywords: UTAUT, use of technology, use of distance education, science teachers, high school

INTRODUCTION

Distance Education and Science Education Movement

The future contains a package of important technological changes accompanied by new educational scenarios, where applying information and communication technology (ICT) and integrating it into teaching practices play an important role in enhancing teaching and learning, especially in complex science topics. This will provide innovations to construct an artificial learning environment such as simulation and virtual teaching and learning, employing a variety of technological tools that are used for communication and creativity, its integration with the teaching process may lead to expanding and intensifying the quality of teaching and learning in science. These new educational scenarios can accelerate, enrich, and deepen skills, and motivate students towards knowledge collection, selection, analysis, organization, expansion, transformation, presentation, and engagement in the learning process. This also leads to advanced individual education that meets the educational needs, provides a high level of flexibility to learn in your own time and place, promotes cooperation, inquiry, and discovery, and creates a new learning culture focused on the learner (Babateen, 2011).

These tremendous changes in the educational environment involve using ICT to improve teaching and learning, and the focus of including ICT in pedagogy means improving the learning process, motivating learners, and creating an open and flexible new learning environment.

The science, technology, society, and environmental education movement have a long history of reforming science education and embracing a wide range of theories about the intersection between science, technology, and society. The main challenge in providing distance science curricula is to provide the learner with a real and meaningful experience (Harsha, 2017).

The National Research Council (NRC, 1996) indicates that science is a systematic study of the structure and behavior of the material world and the natural phenomena to discover its principles and laws in the light of the two dimensions: **products and process**. The **products** because it includes a part of organized scientific knowledge represented in knowing and understanding scientific concepts, principles, laws, and

✉ egtolba@iau.edu.sa **(*Correspondence)** ✉ nyoussef@iau.edu.sa

Contribution to the literature

- It developed the hypotheses based on the unified theory of acceptance and use of technology (UTAUT) model that PE, EE SI, and FC determine science teachers' behavioral intention (BI) to adopt and use DE in science teaching.
- It highlighted the importance of high school science teachers' acceptance of using distance education (DE).
- It can help the developer of teacher preparation and professional development programs to improve the use DE in science teaching of in-service and prospective science teachers when building those programs.
- It can help future researchers to develop the hypotheses based on the UTAUT model.

theories that cover in their broad form the relationships between ideas in the natural and social sciences, mathematics, and technology, and represent a combination of insight related to science and skills related to inquiry, critical thinking, problem-solving and decision-making. The **process** because it includes a set of scientific processes such as observation, classification, measurement, experimentation, questioning, hypothesizing, controlling variables, and interpreting data that can be employed to access this knowledge, using tools for data collection, analyzing, and interpreting these data, suggesting answers, explanations, and predictions. This also includes identifying assumptions, using logical thinking, using alternative explanations, and transferring findings.

At the same time, the National Science Teachers Association (NSTA) supports and encourages the importance of using e-learning experiences for science students during distance teaching. NSTA (2016) defines e-learning as an effective learning process created by combining digitally presented content with supporting learning services. E-learning is not only limited to DE via the Internet, where the learner and teacher are separated according to place and time, but it contains a set of experiences such as a planned and effective use of collaborative and interactive digital tools and resources, remotely delivered programs, as well as a fruitful collaboration and discourse generated through online learning networks and communities.

Importance of Distance Education in Science Teaching

According to Bahtiar & Dukomalamo (2019), the process of science learning requires the teacher to use teaching models based on discovery and problem solving to **ensure** that the learner reaches the full skills of a systematic, critical, and logical inquiry, to **manage** the learner to gain knowledge, and mental and practical skills by himself, and to **direct** him to carry out an experimental activity to obtain knowledge and skills relating to the learning subject. The teacher needs to focus on the practical aspects of the learning process to improve students' science skills and to develop conceptual and operational understanding and science knowledge.

The studies recommended the necessity for science teachers to integrate and develop different and integrated basic science process skills in their design of various teaching activities in the classrooms and science laboratories to raise the level of students' scientific skills. The teacher should give examples of how to use science processes such as scientific observation, formulating hypotheses, defining variables, interpreting, and experimenting with design when presenting the content (Derilo, 2019; Maison et al., 2019).

Nevertheless, distance teaching of science is a huge challenge because there are diverging viewpoints about the value of distance teaching of practical sciences such as laboratory experimentation where hands-on involvement is necessary. Other challenges include the lack of infrastructure, internet connection, high cost of software, and inequality in access to technology. However, some science processes such as observation, classification, measurement, and processing that are a prerequisite for the practice of laboratory or experimental activity can be enhanced in learning environments outside the classroom (Harsha, 2017).

Serevina et al. (2018) also indicated the importance of applying modern technological aspects in science teaching and designing an electronic science unit based on problem-based learning which improves students' ability to understand and improve science process skills in science and overcomes the difficulties of teaching it. The electronic unit provides a variety of presentations of animation and simulation that students can watch and facilitates their understanding of the presented material. Deshmukh et al. (2012) suggested that online teaching and learning contribute to creating a good learning environment in science and can achieve good standards through the suitable design and effective use of technology. It also helps in increasing students' science knowledge, develops a good understanding of the scientific concepts through the advantages offered by the latest web designs, and enables students to develop advanced computer skills. Woodfield et al. (2005) mentioned that students have a contradiction in their vision of online education, especially in the scientific aspects of organic chemistry.

Keeton (2004) pointed out that the teachers need to use effective educational strategies in distance teaching of science such as designing the online learning process in light of the constructivism principles, providing the learner with some choice or control over their learning, constructing online effective teaching practices, and using online teaching strategies which create a supportive and encouraging environment for inquiry, expanding the learner's experience towards the subject matter, and evoking learners' active and critical thinking.

Distance Education and Science Learning

DE is an organizational framework for providing distance learning. Technology is used to fill the educational gap by using different technological media including computers, fax, telephone, video, television broadcast, etc. (Willis, 1992). DE provides many opportunities such as reaching many students, meeting the needs of the students who are unable to attend classes face-to-face in terms of preferred content and learning styles, knowing their experiences, including them in an active and effective learning process, making them fully aware of new communication patterns, improving poor communication patterns, encouraging all students' critical thinking and active participation, and promoting some characteristics such as tolerance with ambiguity, independence, and flexibility (Threlkeld & Brzoska, 1994).

DE is defined as the use of new multimedia technologies and the Internet to improve the quality of teaching and learning by facilitating access to resources and services as well as distance exchange and cooperation (Saleem & Al-Suqri, 2015). According to Zhang and Cui (2010), DE is an alternative way to present education other than the traditional method of lectures and classroom activities. It generally refers to providing learners with distance learning resources. It depends on both distance teaching (the role of the teacher in the process) and distance learning (the role of the student). The elements of learning here include the separation between the teacher and the learner, the use of educational media to connect the teacher with the learner, implement and transfer the curriculum, provide two-way communication between them, and students' voluntarily control of their learning instead of the teacher.

According to Honeyman and Miller (1993), DE provides access to learning when the source of information and the learners are separated by time or distance, or both. It also expands the scope of education, solves many problems such as illiteracy, opens new opportunities for further studies, and helps many professionals, dropouts, and others to achieve their goals due to its flexibility in contrast to traditional teaching. DE is also an important alternative for meeting the educational needs of people who are not able to benefit from the opportunities offered by the formal education system for certain reasons (Mondal & Das, 2015).

DE can be used to teach students who may not be always present in the classroom. It enables independent learning through extensive use of ICT and reflects the fact that all or most of the teaching is conducted by someone who is far from the learner. It also includes greater dimensions such as openness and flexibility in terms of access and curricula. It can be described as it is consisting of a set of components such as mission, programs and approaches, teaching/learning strategies and techniques, learning materials and resources, communication and interaction, support and delivery systems, students and teachers, staff and other experts, management, equipment, and assessments (Harsha, 2017).

The term DE and learning reflect the fact that e-learning is a widespread, applicable, and fully recognized method of distance teaching and learning of science. NSTA (2016) supports distance teaching and learning of science because it provides more effective ways to access science teaching. It provides science teachers with opportunities to directly **practice** the appropriate use of technology in teaching and learning; **increase** their confidence in using these tools in their own practices; **meet** the learners' needs with different learning preferences; **provide** learners with equitable access to the content, learning experiences and high-quality teaching by overcoming the barriers of space and time; **reduce** the science teachers' isolation by providing and expanding access to colleagues and experts; **provide** remote access to networks, data, and scientific tools that allow teachers and students to conduct scientific investigations; **provide** students with the necessary workplace skills of the 21st century; **enhance** science teaching and learning through digitally accessible content; **provide** active or constructive learning experiences that enable the learner to collect, analyze, present it and participate in simulated real-world problem contexts; **connect** learners and science teachers with experiments that simulate how science is practiced in the real world; and **promote** teachers/learners interaction to allow continuous monitoring and modification of the dynamic learning environment to ensure the highest possible quality of science education.

Science Teachers and Distance Education

A science teacher uses many teaching methods when teaching science online such as asking questions, analyzing data, drawing conclusions from evidence, using online discussions, promoting active student participation in the hands-on activities, using critical thinking, expressing, and reflecting on their scientific ideas, as well as using discussion boards, e-mail, and chat (Garrison et al., 1999).

Science teachers benefit from DE by achieving interactive roles, realizing the elements of social existence represented in personal responses such as verbal and non-verbal communication, formulating their scientific ideas in an online discussion, reflecting on their previous scientific ideas, thinking about students' scientific ideas, asking questions to the students about their scientific ideas, analyzing and drawing conclusions from data, observations, and other forms of scientific evidence, and providing evidence to support scientific ideas (Wallace, 2003). Wallace (2003) found that there was an increasing correlation over time between the social and emotional interactions of science teachers and the learning assistance interactions with students. Offir et al. (2003) confirmed that students' understanding of "science" content occurs when the teacher's social and emotional interactions are linked during distance teaching (such as facilitating a range of online activities that support student learning; counseling to help them gain the most benefits of their engagement in learning; verifying the learner's performance; participating in the production of the new knowledge related to the content being taught; adopting technological options that improve the learner's environment, acceptance, and social interest) with learning assistance interactions associated with presenting types of learning support (such as asking questions; directing teaching; modeling; giving examples; constructing cognitive task; presenting cognitive explanations and extensions; motivating discovery, and promoting thinking and dialogue).

According to many teachers, online science education allows them to place their notes online which in turn helps students learn effectively (Seiber, 2005). Several studies mention that online learning environments motivate the professional development of science teachers; and promote the integration of teachers and students into an online community of scientific inquiry where they interpret the results and think continuously about the process and outcomes through scientific inquiry (Garrison et al., 1999).

In distance teaching of science, teachers should promote education based on the scientific phenomenon and the purposeful scientific discourse. **In education based on the scientific phenomenon**, the content revolves around natural phenomena, in which science teachers prepare students to learn through interactive websites, videos, and other technological tools, that are used as inferential tools to investigate these phenomena. In the **scientific discourse,** there is a more extensive scientific discussion, which allows the learners to examine the explanations and evidence and reach a common understanding. DE should aim to provide and build explanations of the natural world within the student community, provide them with opportunities to share experiences about the natural world, provide insights, clarify their ideas, and enhance interaction through meeting tools such as Zoom, Google Meet, and Microsoft Teams. In DE, science teachers should foster a set of important characteristics such as tolerance for ambiguity, independence, the ability to be flexible, risk-taking, and curiosity. In light of this, science teachers benefit from DE in formulating and reflecting on their scientific ideas, thinking about students' scientific ideas, and asking students about their scientific ideas.

There is evidence indicating that the success of DE in schools is highly dependent on the effectiveness of the teacher where the teacher's knowledge, skills, enthusiasm, commitment to innovation, and the adoption of integrating technology into teaching are important (Moore & Thompson, 1990). The success of DE also depends on teachers' understanding of the learning materials and their positive perceptions of DE (Deshmukh et al., 2012). Hackman and Walker (1990) added that the social presence dimension and the science teacher's engagement in behaviors reduce the psychological distance between them and the students, and that "distance presence" is attractive or what is known as personality attraction (Dede, 1990). Willis (1992) also added that the teacher's effectiveness dimension is demonstrated in the ability to understand students' needs and feelings, and to recognize and interact with students. According to Young and Norgard (2006), participants' satisfaction with the learning environment is a critical factor in online education, and the personal interactions and positive feedback with emotional components by the teachers positively affect students' motivation and satisfaction with distance learning (Andreatta, 2003).

Factors Affecting Teachers' Use of Distance Education

In general, many studies have been conducted to examine the factors that affect teachers' use of ICT in education, and the acceptance of technology in education or what is known as the intention to use (Baz, 2016). Technology acceptance theories are aimed to understand how and why users accept or reject new technologies (Stefl-Mabry, 1999). This is achieved by addressing the technological aspects (characteristics of technology, ease, or complexity of use), sociological aspects (the impact of closer and wider environments on acceptance, the voluntariness of use, etc.), and psychological aspects (perceived usefulness, perceived ease of use, etc.). These theories formed the basis for models, which begins by measuring the acceptance of technology so that it becomes a measurable and comparable phenomenon.

The success of presenting DE and the concepts of teaching based on new technologies are closely related to teachers' acceptance and readiness to use these technologies (Cutri & Mena, 2020). According to Aliano et al. (2019), tendency or predisposition and effort expectancy (EE), performance expectancy (PE), social influence (SI), the voluntariness of use, facilitating conditions (FC), and self-management of learning are among the most important factors that significantly affect the acceptance of technological tools (smart phones and tablets) in education. Azizi et al. (2020)

indicated that the successful use of DE requires science teachers' readiness to accept it, and the social, psychological, cultural, and pedagogical factors may affect the acceptance of DE. Davis (1989) suggested the technology acceptance model (TAM), which indicated that the main factors in teachers' adoption of the new technology (e.g., DE as a new method to present the educational content online) is its perceived usefulness and its ease of use.

Davis and Venkatesh (2004) also indicated that results expectancy, FC, and SI have a positive effect on the BI to use and adopt technology in the learning and teaching process. The perceived usefulness and the perceived ease of use in which the individual believes that the use of a particular technology is free from physical and mental effort, as well as the attitude towards using technology, are some of the most important factors affecting the individual's satisfaction to accept technology and the BI to use it. Crawford (2010) stated that faculty members' attitudes toward online teaching are a "social and political transformation" which affects their expectations and their acceptance of DE. Yeou (2016) also indicated that technological self-efficiency and perceived usefulness have an important role in accepting technology in the learning process. Wu and Liu (2013) mentioned that the positive impact of the perceived usefulness, the social interaction, and the PE affects students' satisfaction and acceptance of blended learning. Also, Radovan and Kristl (2017) emphasized that shaping the learning process depends largely on the characteristics of learning management system (LMS) tools and the perceived usefulness of the application which enhances the individual performance.

Some of the most important factors that affect teachers' use of DE are the teachers' beliefs and perceptions about the use of DE in teaching and learning. Saleem and Al-Suqri (2015), as well as Tolba et al. (2020), emphasized the importance of the teachers' beliefs about DE, and they hypothesized that there is a relationship between the skills or the levels of DE and the teacher's beliefs about it. Although most current online learning models are based on teachers' strong belief in practicing online teaching, it is shown that they direct student learning by using various strategies such as open-ended questions and summarizing comments during discussions; also, by guiding students towards deeper insights into knowledge in addition to knowing when to motivate students and knowing when to assist participants.

Al-Senaidi et al. (2009) indicated that five specific factors affect the teacher's adoption of using ICT in teaching and learning such as lack of computer equipment, lack of institutional support, lack of conviction in technological advantages, lack of personal confidence in using technology, and lack of time.

Hativa and Lesgold (1996) indicated that there are barriers from the first order that affect teacher's use of DE such as resources (equipment, time, training, and support) that are either missing or insufficiently available in teachers' implementation environments, then it hinders the process of integrating and adopting technology in education.

Ertmer (1999), in addition to Yang and Huang (2008), stated that there are barriers from the second order that hinder teacher's performance and the adoption and the integration of technology in education such as lack of educational design capabilities and lack of motivation. These barriers are usually rooted in their beliefs about teaching and learning. These beliefs are common among teachers and usually cause more difficulties than first-order barriers because they are personal and more profound.

Teachers' beliefs affect the adoption and the acceptance of integrating technology with education, and the second-order barriers may persist even when the first-order barriers are eliminated because overcoming teachers' second-order barriers requires challenging their beliefs systems and having technological self-efficiency that allows them to employ the knowledge, skills, and attitudes needed to perform the teaching profession effectively and efficiently. According to Ritchie and Wiburg (1994), traditional perceptions of what teaching, learning, and knowledge should look like are limiting factors for integrating and accepting technology in teaching and classroom practices.

Cutri and Mena (2020) stressed that online teaching may lead to stress and professional weakness among teachers, restricting their ability to achieve goals and weakening their sense of independence, as well as emotional exhaustion associated with the inability to deal with this professional weakness which leads to low technological self-efficiency. Consequently, it results in low performance. It is also associated with the lack of e-readiness or predisposition to practice it, as well as a lack of knowledge of how to teach online. This is reflected in the degree of their acceptance and adoption of DE.

Generally, teachers face obstacles in adopting and accepting the integration of technology in education. There are factors affecting teachers' use of DE, and these obstacles are represented in the lack of educational design capabilities, the lack of appropriate training, the lack of guidance and personal counseling, the lack of sufficient information and appropriate educational software, the lack of preparation time, the difficulty of supporting and managing devices (the inability to access to computers due to scheduling time constraints), the lack of motivation, the negative beliefs about the value of technology, and students' lack of adequate information literacy (Yang & Huang, 2008). Therefore, it becomes important to determine the main factors that affect science teachers' acceptance of DE, and therefore

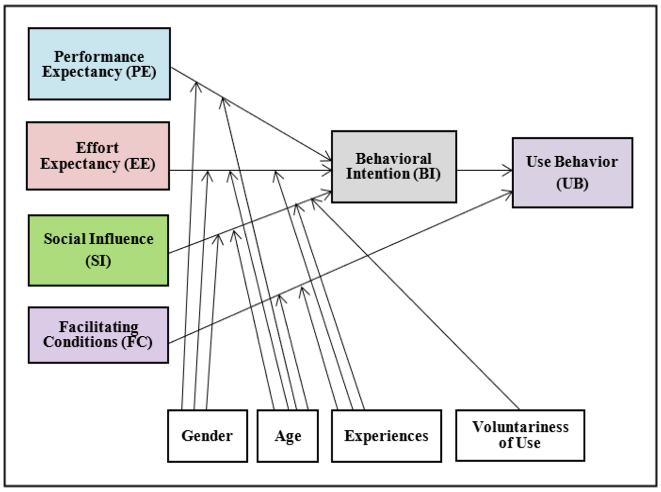

Figure 1. The UTAUT model (Venkatesh et al., 2003)

this research aimed to determine the factors that affect science teachers' BI to use DE in science education based on UTAUT, and developing hypotheses based on the UTAUT model and adopting a proposed model that considers the basic structures (PE, EE, SI, and FC) as it represents the technology features "DE", which are independent variables that affect the dependent variables (BI to use DE), taking into consideration the moderating factors (gender, experience, technological self-efficiency), this research different from other similar studies that it developed the hypotheses based on the UTAUT model that PE, EE SI, and FC determine science teachers' BI to adopt and use DE in science teaching.

The next section will discuss the structures of the UTAUT model and develop hypotheses (the research proposed model).

Unified Theory of Acceptance and Use of Technology

Many theoretical models have dealt with individuals' BI to use innovations, and their construction is based on information systems, psychology, and sociology (Davis et al., 1989; Venkatesh & Davis 2000). The theory of reasoned action is at the forefront of the most widely used theories in explaining human behavior to adopt and use technology, and it suggested that an individual's behavior is driven by one's BI (Venkatesh et al., 2003).

Davis (1989) developed the TAM theory to explain and accept BI and indicated that two important beliefs are affecting the use and acceptance of technology and information systems. These are perceived usefulness and perceived ease of use. Whereas the theory of planned behavior (TPB) indicates that an individual's intentions are affected by his attitudes toward behavior, subjective norms, and the perceptions of behavioral control (Ajzen, 1991, 2001). Then the decomposed theory of planned behavior (DTPB) appeared to bring the characteristics and the elements together in both TPB and TAM to build a more comprehensive understanding of technology adoption (Taylor & Todd, 1995). It deconstructs attitude, subjective norms, and behavioral control within the primary belief structure in the context of technology adoption (Venkatesh et al., 2003).

The common model of TAM, TPB (C-TAM-TPB) theory is a hybrid model that includes TPB predictions, and the perceived usefulness of TAM. Then the general motivation theory appeared to examine the individual behavior in understanding, adopting, and using new technology (Venkatesh & Brown, 2001). The model of PC utilization (MPCU) is also derived from the theory of human behavior (Triandis, 1977). To predict the behavior of use rather than BI, innovation diffusion theory (IDT) (Rogers, 1995) was influenced by sociology to study several innovations ranging from agricultural tools to organizational innovation and a set of structures used in accepting individual technology were formulated (Moore & Benbasat, 1991). Also, the social cognitive theory (SCT) has been widely used to explain human behavior.

Based on reviewing and analyzing the previous models, Venkatesh and others developed the UTAUT as a comprehensive synthesis of the previous theories of technology acceptance. UTAUT suggests four basic structures that are determinants of technology acceptance and use. These four basic structures are PE, EE, SI, and FC, in addition to some variables that have an indirect influence on these structures such as gender, age, experience, and the voluntariness of use (Venkatesh et al., 2003) (**Figure 1**).

CONSTRUCTIVE HYPOTHESES DEVELOPMENT "PROPOSED RESEARCH MODEL"

Venkatesh et al. (2003) developed the UTAUT, which combines the results of all the theories and models that dealt with the interpretation of human behavior. They identified the independent structures arising from those theories as to the basic determinants of BIs, explaining the behavior of users and predicting it or monitoring changes in factors that affect the behavior of an individual's use of technology when accepting technology in the educational process. These structures are PE, EE, SI, and FC. Venkatesh et al. (2003) added gender, age, experience, and the voluntariness of use to the model and hypothesized that they do not have a direct effect on the intention or the use of technology, but have indirect effects on cognitive-behavioral factors, that is, they moderate the effect of the four basic structures on the intention and behavior of use (as shown in **Figure 1**).

This research developed the hypotheses based on the UTAUT model that PE, EE SI, and FC determine science teachers' BI to adopt and use DE in science teaching (Venkatesh et al., 2012). The hypothesized research model is defined in the following structures.

Performance Expectancy

PE was defined as "the degree in which an individual believes that the use of the system "or technology" will help one achieve a performance gain or job performance gains, and in performing certain activities" (Venkatesh et al., 2012). In this research, the PE indicates the learners' belief that the use of DE is useful in teaching science. PE shows the degree to which teachers believe that using the e-learning environment will help them perform better in their profession, and this structure is the most important indicator of BI, regardless of whether the use of technology is voluntary or not (Radovan & Kristl, 2017). This structure is similar to the perceived ease of use (PEU) structure in the TAM; the extrinsic motivation structure in the motivational model (MM) (Davis, 1989); the job fit structure in the PC use model; the relative advantage structure in the diffusion of innovations theory (DIT) (Rogers, 1995), which expresses the extent of which an individual perceives the relative advantages of the new idea both economically and socially; and the result expectancies structure in social cognitive theory (SCT) (Venkatesh et al., 2003). The results of some studies indicated a positive effect of PE on the BI (Azizi et al., 2020; Gumusoglu & Akay, 2017; Raman & Rathakrishnan, 2018; Šumak & Šorgo, 2016; Tseng et al., 2019). Gender and age are playing a moderating role in the effect of PE on BI; it means that the effect of PE on BI will differ according to gender and experience. The effect is stronger for men and especially for younger men (Venkatesh et al., 2003).

The current research model aimed at exploring the effect of PE on the BI to use DE in science teaching, and to know the moderating effect of gender differences, teaching experience, and technological self-efficiency on the relationships between PE and BI to adopt the use of DE in science teaching. Therefore, this research tested the following hypotheses:

H1: PE has a positive effect on science teachers' BI to adopt the use of DE in science teaching.

H2: The effect of PE on science teachers' BI to adopt the use of DE in science teaching differs according to gender.

H3: The effect of PE on science teachers' BI to adopt the use of DE in science teaching differs according to the teaching experience.

H4: The effect of PE on science teachers' BI to adopt the use of DE in science teaching differs according to technological self-efficiency.

Effort Expectancy

EE is defined as "the degree of simplicity and ease associated with the use of the system technology" (Venkatesh et al., 2003). It is also defined as the level of teachers' belief about how easy it is to use technology in the e-learning environment, or whether this technology is user-friendly (Radovan & Kristl, 2017). Based on the UTAUT model, the use of technology in education depends on whether the technology is user-friendly or not (Gumusoglu & Akay, 2017). This structure is similar to the structure of PEU in the TAM; the complexity structure in the PC use model, which determines the extent to which the individual perceives the innovation or technology as being easy to understand and use (Triandis, 1977); and the ease-of-use structure in the DIT (Rogers, 1995; Venkatesh et al., 2003). Some studies indicated that EE may predict BI to use the e-learning system (Azizi et al., 2020; Tarhini et al., 2017). Many studies also have indicated that the effect of EE on BI depends on some demographic variables such as gender and age, so the effect is stronger in females, especially in older females (Venkatesh et al. 2003). Tseng et al. (2019) mentioned that **EE** fails to motivate teachers to adopt MOOCs, and Raman and Rathakrishnan (2018) suggested that **EE** correlates with a non-significant relationship to the BI towards web-based integrated learning systems. In general, an effort-oriented structure is expected to be more prominent in the early stages of new behavior (Davis et al., 1989). Since DE has not yet been used strongly and is still in its initial stages, EE will be a critical factor in the BI to use DE, and the effect of EE on the BI will be different according to gender and teaching experience so that the effect is stronger for women (Venkatesh et al., 2003). The current research model is aimed at exploring EE on the BI to use DE in science teaching and to know the moderating effect of gender differences, teaching experience, and technological self-efficiency on the relationships between EE and BI to adopt the use of DE in science teaching. Therefore, this research tested the following hypotheses:

H5: EE has a positive effect on science teachers' BI to adopt the use of DE in science teaching.

H6: The effect of EE on science teachers' BI to adopt the use of DE in science teaching differs according to gender.

H7: The effect of EE on science teachers' BI to adopt the use of DE in science teaching differs according to the teaching experience.

H8: The effect of EE on science teachers' BI to adopt the use of DE in science teaching differs according to technological self-efficiency.

Social Influence

SI is defined as "the degree to which an individual views that others (such as colleagues, supervisors, and managers) believe that he/she should use a new system, specific technology, or new approach to learning" (Venkatesh et al., 2003). It is also defined as the degree to which the teacher views that his/her colleagues and others view the use of e-learning as important and necessary in teaching (Radovan & Kristl, 2017). This structure is similar to the structure of subjective norms in the (TAM) (Davis et al., 1989), planned behavior theory (Ajzen, 1991), PC use models (Triandis, 1977), as well as the image structure in DIT that determines how new and other technological developments spread in societies and cultures. It also explains how and why new ideas and practices are adopted (Rogers, 1995; Venkatesh et al., 2003). It is also consistent with the self-image structure in the PC use model, which is related to the theory of interpersonal behavior. Self-image refers to a "person's ideas of who is he/her?" (Triandis, 1977). Self-concept refers to the idea a person has of himself/herself. Several studies have shown that social intelligence influences the formation of the BI to adopt the system and that the critical factor for teachers' acceptance of LMS is the direct social impact at work (Moorthy et al., 2019; Radovan & Kristl, 2017; Raman & Rathakrishnan, 2018; Tseng et al., 2019).

Based on the UTAUT model and previous studies, we assume that SI is a strong determinant of science teachers' BI to adopt and use DE in science teaching and that the effect of SI on the BI to adopt and use DE will differ according to gender and teaching experience. The current research aims at integrating SI into the research model to explore its effect on the BI to use DE and to know the moderating effect of gender differences, teaching experience, and technological self-efficiency on the relationships between SI and BI to adopt the use of DE in science teaching. Therefore, this research tested the following hypotheses:

H9: SI has a positive effect on science teachers' BI to adopt the use of DE in science teaching.

H10: The effect of SI on science teachers' BI to adopt the use of DE in science teaching differs according to gender.

H11: The effect of SI on science teachers' BI to adopt the use of DE in science teaching differs according to teaching experience.

H12: The effect of SI on science teachers' BI to adopt the use of DE in science teaching differs according to technological self-efficiency.

Facilitating Conditions

FC expresses "individuals' insights into the existence of the technological and organizational infrastructure and tools to support the system's use of resources and the available support to behave, or the extent of the users' belief that the infrastructure is needed to support the use of technology in education" (Moorthy et al., 2019). It is also defined as the degree to which the individual believes in the existence of an organizational and technical infrastructure that supports the use of the system (Venkatesh et al., 2003). The FC include the teacher's belief in the existence of an organizational and technical infrastructure to support the use of the e-learning environment. It is also the individual's point of view about the available resources (tools, equipment, experience, etc.) that are needed to use the system (Radovan & Kristl, 2017). The FC also include the necessary training for technology users and deals with organizational and technical support for users. This structure is similar to the structure of perceived behavioral control, found in reasoned behavior theory (Ajzen, 1991), the structure of FC in the PC use model (Trandis, 1977), and job fit in DIT (Rogers, 1995).

In this regard, Sattari et al. (2017) demonstrated that FC have a significant effect on BI and the use of the e-learning system. Gumusoglu and Akay (2017) also showed that the availability of the necessary resources and knowledge for using ICT and technical support helps in achieving tasks quickly and increases productivity, and makes up for the lack of technological experience, and individuals' inability to use the system in the required speed. Although Hoque and Sorwar (2017) indicated that FC do not have a significant effect on the users' BI to use the mobile health service, Raman and Rathakrishnan (2018) mentioned that FC have a positive effect on BI and that FC work on teacher's adoption of MOOCs (Tseng et al., 2019). Foon and Fah (2011) mentioned that FC affect BI even in the presence of EE. Falode (2018) also indicated that pre-service physics teachers have a high perception that the virtual laboratory package is easy to use and useful, and this affects their intentions to use the package in teaching and learning physics and that it is important to provide schools with appropriate ICT facilities that will help students and educators use virtual-based learning environments.

The current research model aimed at exploring the effect of FC on the BI to use DE in science teaching, and to recognize the moderating effect of gender differences, teaching experience, and technological self-efficiency on the relationships between FC and BI to adopt the use of DE in science teaching. Therefore, this research tested the following hypotheses:

H13: FC have a positive effect on science teachers' BI to adopt the use of DE in science teaching.

H14: The effect of FC on science teachers' BI to adopt the use of DE in science teaching differs according to gender.

H15: The effect of FC on science teachers' BI to adopt the use of DE in science teaching differs according to the teaching experience.

H16: The effect of FC on science teachers' BI to adopt the use of DE in science teaching differs according to technological self-efficiency.

Behavioral Intention

BI is defined as a measure of the strength of an individual's intention to do a certain behavior, and a person's probability to use the system. The actual use of

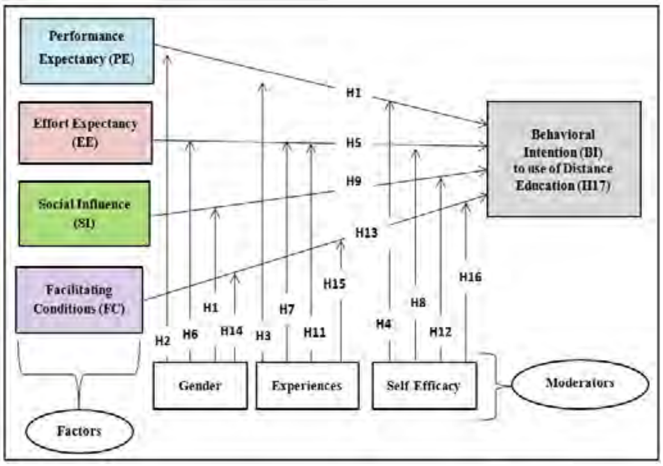

Figure 2. Proposed research model

the system occurs when a person intends to use it. It is the degree that which the person plans to do or not to do specific behaviors in the future. It indicates that the acceptance of BI expresses the desire or intention to use or adopt "technology to improve performance and results in the learning environments" (Davis et al., 1989). At the same time, Poong et al. (2017) suggested that self-efficiency indirectly affects the "moderating factor" on the intention to use through perceived ease of use. Sadeck and Cronjé (2017) also mentioned that self-efficiency in using online learning tools affects the adoption of online learning. Evidence indicates that BI has a direct effect on the actual use of the system, and it is a critical indicator or predictor of technology use (Azizi et al., 2020; Venkatesh et al., 2003). Hence, it can be expected that science teachers' BI has a direct and positive effect on using DE. Then the following hypothesis can be tested:

H17: Science teachers' BI has a positive direct effect on using DE in science teaching.

In the light of the proposed model as shown in **Figure 2**, its four basic structures can be viewed as representing: the features of technology, "DE" (i.e., PE and EE) and contextual factors (i.e., FC and SI), as they are viewed as the individuals' perceptions which related to technology and context. It explains the behaviors of individuals' adoption and use. These are considered independent variables that affect the dependent variables in this model. BI, which represents science teachers' intention to use the e-learning environment "DE", and (the behavior of using) which represents the extent to which science teachers use the e-learning environment "DE" in science education. Then it becomes important to search for the effect of independent variables on the dependent variables and to search for the cause-and-effect relationships to predict the level of acceptance of DE while considering the moderating factors that may indirectly affect these relationships such as gender, experience, and technological self-efficiency on intention and use behavior.

Table 1. Digital appreciation and mean of the acceptance degree of science teachers to use distance education

No	Acceptance degree	Digital appreciation	Mean
1	High	3	≤(2.33)
2	Intermediate	2	<(1.66) or >(2.3)
3	Low	1	≥ (1.66)

RESEARCH METHODOLOGY

Tools

The research included a tool for accepting the use of DE and it was prepared according to the following steps:

1. *Reviewing related literature.*
2. *Determining the objectives of the tool:* It aimed to reveal the science teachers' acceptance of using DE in the light of UTAUT.
3. *Preparing the initial form of the tool*: It consisted of three parts. The first part includes demographic data: (gender-years of experience), the second part includes five sub-dimensions (variables): PE (eight statements), EE (eight statements), SI (six statements), and FC (eight statements) adopted from Venkatesh et al. (2003); and self-efficiency (eight statements) adopted from Durak (2019) and Mookkiah and Prabu (2019). Finally, the third part includes two dimensions: the BI to use DE (eight statements), and the actual use of DE (four statements) (Venkatesh et al., 2003). Thus, the number of the tool statements is (50 statements).

The statements included in the second and the third parts were formulated according to the Likert triple scale (1-3), and the acceptance degree of using DE was digital appreciation, in addition to the mean in the tool according to **Table 1**.

4. *Validity and reliability of the tool*: The face validity of the tool was verified by administering it to a panel of specialists in teaching science, psychology, and educational technologies to evaluate it in terms of the scientific and linguistic validity of the tool, its relevance to the objectives, its importance, and its connection to the UTAUT, in addition to suggesting adding or modifying any statements. The tool was modified according to the opinions of the jury members, which were limited to rephrasing some statements. Reliability of the tool was verified by using the Cronbach's alpha method on a sample of 21 teachers. Reliability coefficient of tool as a whole was 0.89, and reliability coefficients of sub-dimensions of scale were determined, respectively (0.88, 0.89, 0.91, 0.86, 0.87, 0.92, and 0.90). This indicates that tool has a high degree of reliability.

And using the variables of gender and teaching experience, as the previous research showed that these two variables affect the individual's acceptance of technology and its use.

Table 2. Demographic information of participants (n=120)

Variables	Number	Percentage (%)
Gender		
Male	58	48.33
Female	62	51.67
Experiences		
≤5 years	40	33.33
>5 or <10	44	36.67
≥10 years	36	30.00
Total	120	100

The Research Sample

The research community consisted of 120 science teachers and this research adopted the non-random sampling method (taking appropriate sampling) to collect sample data. They received a questionnaire about accepting the use of DE, to respond to online. **Table 2** shows the characteristics of the participants.

RESULTS

The Acceptance Degree of Science Teachers to Use DE in light of the UTAUT

The instrument was applied to the research sample. Mean, relative weight, and ranks were calculated. **Table 3** shows these results, as follows.

Table 3 indicates that the degree of science teachers' acceptance of using DE in light of the UTAUT is high. The general mean of the scale was 2.38 with a general relative weight of 79.33%. The total acceptance degree of the variables was high; the mean was 2.36 with a relative weight of 78.80%. It is clear that the highly acceptable variables are the EE with a mean of 2.72 and a relative weight of 90.66%, then the SI with a mean of 2.56 and a relative weight of 85.33%, followed by the PE with a mean of 2.53 and a relative weight 84.33%, followed by the technological self-efficiency with a mean 2.50 and a relative weight 83.33%. These findings **agree** with Radovan and Kristl (2017) and Venkatesh et al. (2012), where they found that PE shows the degree to which teachers believe that using a distance learning environment will better help in developing their professional performance, achieving job performance gains, and using useful learning activities, and PE is an important indicator of the BI, Gumusoglu & Akay (2017); Radovan and Kristl (2017), and Venkatesh et al. (2003), which found that the availability of an appropriate level of teachers' belief about the ease of using technology in the e-learning environment affects their acceptance degree of using DE in teaching science; Poong et al. (2017) and Sadeck and Cronjé (2017), which found that self-efficiency indirectly affects the intention of use, then anticipates using DE when teaching science, and Venkatesh et al. (2003). These results also agree with Radovan and Kristl (2017) who argued that a teacher's belief about the use of a new system, a specific technology, or a new approach to learning is important in science teaching and that it is affected by others' perceptions about importance of using DE in teaching.

The acceptance degree of the FC variable was low where the mean was 1.51 with a relative weight of 50.33%. Although Moorthy et al. (2019) indicated the importance of providing good insights for the teacher about the existence of the technological and organizational infrastructure and equipment to support the use of DE in teaching science, it is a significant factor affecting the BI to use DE. Radovan and Kristl (2017) also emphasized the importance of the teacher having the available resources (tools, equipment, and experience) to use DE in teaching. This supports the results of Saleem and Al-Suqri (2015) which concentered on the necessity of having access to resources and services and using new multimedia technologies and the Internet that improve the quality of education and distance learning.

While the BI was high, the mean was 2.50 with a relative weight of 83.33%, and the AU was high with a mean of 2.34 and a relative weight of 78%. This result supports that enhancing teachers' BI towards using DE and the success of DE in science in schools depends largely on the EE, PE, and the teachers' technological self-efficiency. This in turn enhances the teachers' knowledge, skills, commitment to innovation, and the adoption of integrated technology into teaching (Moore & Thompson, 1990). It also depends on teachers' understanding of the learning materials and having positive perceptions of DE (Deshmukh et al., 2012).

Generally, this result can be explained that the teachers' accepting degree to use DE is due to their positive beliefs and perceptions about all the variables (PE, EE, SI, and technological self- efficiency) that affect

Table 3. Results of calculating the acceptance degree of science teachers for the use of DE in science teaching

	Variables	Number of items	Mean	Relative weight (%)	Ranks
1	Performance expectancy	8	2.53	84.33	3
2	Effort expectancy	8	2.72	90.66	1
3	Social influence	6	2.56	85.33	2
4	Facilitating conditions	8	1.51	50.33	5
5	Technology self-efficacy	8	2.50	83.33	4
The overall score for the main variables		38	2.36	78.80	
6	Behavioral intention	12	2.50	83.33	
7	Actual use	4	2.34	78.00	
The overall score of the scale		50	2.38	79.33	

Table 4. Results of confirmatory factor analysis between independent variables and BI to use DE, technological self-efficiency, PE, EE, FC, and between BI and AU

Variable	Variance	H.	Regression relationship to		VD	SE	RW	Sig.
Performance expectancy	35.879	H1	→	BI	0.323	0.033	5.126	0.001
Effort expectancy	56.887	H5	→	BI	0.155	0.054	7.455	0.001
Social influence	38.985	H9	→	BI	0.301	0.058	5.996	0.001
Facilitating condition	20.567	H13	→	BI	0.634	0.055	2.995	0.004
Self-efficiency	36.544	H4	→	PE	0.363	0.029	5.825	0.001
Self-efficiency	37.654	H8	→	EE	0.300	0.056	5.346	0.001
Technological self-efficiency	33.746	H16	→	FC	0.312	0.030	4.976	0.001
Behavioral intention	57.988	H17	→	Actual use	0.189	0.076	7.885	0.001

Note. VD: Variance difference; SE: Standard error; & RW: Regression weight

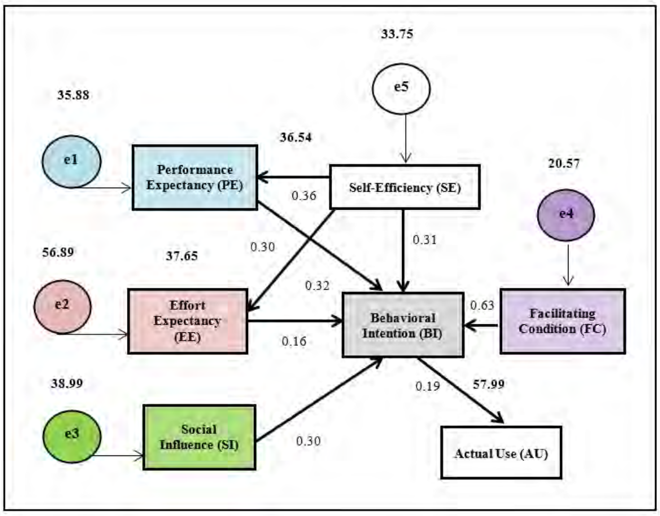

Figure 3. Estimates of regression weights (Chi-square=123.66 & p=0.000)

the BI to use DE (Deshmukh et al., 2012; Falode, 2018; Saleem & Al-Suqri, 2015; Tolba et al., 2020).

The Effect of Independent Variables on Science Teachers' Acceptance of Using DE

The research hypotheses (H1, H5, H9, H13, H4, H8, H16, and H17) were tested using the confirmatory factor analysis method through the analysis of moment structures (AMOS) program included in the SPSS package, to ensure the validity of the proposed model in the research. **Table 4** shows the results.

Table 4 shows that the regression relationship between all the variables of the proposed model (PE, EE, SI, FC, and TSE) and the field of BI was significant, which means the possibility of predicting the science teachers' BI to use DE, and the regression relationship between BI (AU) was significant, which also means that science teachers' BI is a strong indicator of AU to DE. As well as the regression relationship between TSE, PE, EE, and FC was significant. **Figure 3** shows the effects path between the variables of the proposed model.

In light of the previous results, it is clear that PE, EE, SI, FC, and SE have positive effects on science teachers' BI of using DE, and that SE has positive effects on the PE and EE and that BI has a positive effect on the use of DE in science, and therefore the hypotheses H1, H5, H9, H13, H4, H8, H16, and H17 were accepted, which confirm that the proposed model variables have positive effects on science teachers' BI to use DE in science.

This result agrees with previous studies that found the positive effect of PE on BI such as Gumusoglu and Akay (2017), Raman & Rathakrishnan, (2018), Šumak and Šorgo (2016), Tseng et al. (2019), and with studies indicating that EE predicts a BI to use e-learning systems (Azizi et al., 2020; Tarhini et al., 2017). However, the results differ from Tseng et al. (2019) which indicated that EE has a non-significant relationship to BI towards web-based integrated learning systems.

This result also agrees with the studies which argue that SI play a role in shaping the BI to adopt e-learning teaching systems; these studies include Moorthy et al. (2019), Radovan & Kristl (2017), Raman & Rathakrishnan (2018), and Tseng et al. (2019).

In addition, these results also agree with other studies such as Sattari et al. (2017) which demonstrated that FC have a significant effect on BI and the use of e-learning system; Gumusoglu and Akay (2017), which found that the availability of the necessary resources and knowledge for the use of ICT and technical support helps the teacher to achieve tasks quickly and increase productivity, and make up for his lack of technological experience, and his inability to use the system in the required speed; Raman and Rathakrishnan (2018) which mentioned that FC have a positive effect towards BI; Falode (2018), Foon and Fah (2011), and Tseng et al. (2019), which found that FC affects the BI even in the presence of EE. It, therefore, becomes important to provide schools with appropriate ICT facilities that would help students and teachers to use DE environments in the teaching and learning process. This result differs from Hoque and Sorwar (2017), where they showed that FC does not have a significant impact on users' BI.

Further, these results also agree with Gong et al. (2004), which found that the teachers' TSE affects their ability to use DE and their evaluation of this ability. The users' evaluation of their ability to use DE may affect their perception of PE, EE, using DE easily, and the decision to accept it. Thus, the science teacher who has a strong sense of TSE in using DE has difficulty in not

Table 5. Means and standard deviations of all variables of the proposed model by gender

Gender		PE	EE	SI	FC
Male (58)	X-	20.38	21.88	15.47	11.62
	SD	1.71	1.59	1.44	3.30
Female (62)	X-	20.13	21.65	15.29	12.50
	SD	1.56	1.55	1.29	3.78

adapting the use of DE in teaching science even in the presence of obstacles that prevent its use while doing their best to overcome those obstacles.

Generally, this result also agrees with previous studies that the independent variables: PE, EE, SI, FC, and SE have positive effects on the BI to use DE in science (Moorthy et al., 2019; Radovan & Kristl, 2017; Venkatesh et al., 2003).

Results Related to Gender

Table 5 shows that female science teachers have close values of means to science male teachers' means in the variables of the proposed model.

Table 6 also shows the analysis of the differences between the variables of the research model using one-way ANOVA according to gender.

To examine the moderating effect of gender, an analysis of differences between the two groups of male and female teachers was conducted. As shown in Table 6, the effect of PE, EE, SI, and FC on the science teachers' BI to adopt the use of DE does not differ according to gender. Hence, the hypotheses H2, H6, H10, and H14 are not supported.

This confirms that gender has no effect on BI and that there are no differences between science teachers (males and females) in seeing that PE, EE, SI, and FC have their effects on the BI to adopt the use of DE. This result is consistent with Saleem et al. (2016), which found that gender has less effect on the adoption of Moodle, and that both male and female staff members generally use the learning platform. This result differs from other studies such as one by Venkatesh et al. (2003), which found that BI depends on some demographic variables such as gender, that it plays a moderating role in the effect of PE on BI, and in the acceptance and the use of technology. Costa et al. (2012) revealed a gender effect on Moodle use; Padilla-Meléndez et al. (2013) found that there are differences between males and females in accepting play-based teaching/learning, attitudes, and intention to use the Moodle; Durak (2019) and Wang and Wang (2010) found that gender plays an important role in the adoption and the use of technology; Kripanont (2007) proposed that gender is an important variable in exploring technology adoption behavior; and Liu's (2013) found that gender can mediate PE, EE, and SI.

Results Related to Teaching Experience

Table 7 shows that there are differences between the means of science teachers according to the teaching experience in the variables of the proposed model.

Table 8 also shows the analysis of the differences between the variables of the research model using one-way ANOVA according to the teaching experience. **Table 8** shows that there are differences between the variables of the research model using one-way ANOVA according to the teaching experience. To find out the extent and direction of these differences, Tukey Method was used for multiple comparisons between means.

Table 6. Analysis of differences between the variables of the research model using one-way ANOVA according to gender

Main variable	H.		SS	df	MS	F	Sig	Conclusion
Performance expectancy	H2	BG	1.877	1	1.877	.700	.405	H2 is not supported
		WG	316.623	118	2.683			
		Total	318.500	119				
Effort expectancy	H6	BG	1.643	1	1.643	.668	.415	H6 is not supported
		WG	290.349	118	2.461			
		Total	291.992	119				
Social influence	H10	BG	.920	1	.920	.495	.483	H10 is not supported
		WG	219.205	118	1.858			
		Total	220.125	119				
Facilitating conditions	H14	BG	23.170	1	23.170	1.829	.179	H14 is not supported
		WG	1495.155	118	12.671			
		Total	1518.325	119				

Note. BG: Between groups; WG: Within groups; SS: Sum of squares; & MS: Mean square

Table 7. Means and standard deviations for all variables of the proposed model according to teaching experience

Teaching experience		PE	EE	SI	FC
≤5 years (40)	X-	21.53	22.43	16.55	14.23
	SD	1.47	1.28	0.99	3.98
>5 or <10 years (44)	X-	20.39	21.93	15.37	11.66
	SD	0.97	1.37	0.84	3.16
≥10 years (36)	X-	18.67	20.81	14.08	10.19
	SD	1.04	1.65	1.02	2.07

Table 8. Analysis of the differences between the variables of the research model using one-way ANOVA according to the teaching experience

Main variable	H.		SS	df	MS	F	Sig	Conclusion
Performance expectancy	H3	BG	156.093	2	78.047	56.226	<.001	H3 is supported
		WG	162.407	117	1.388			
		Total	318.500	119				
Effort expectancy	H7	BG	51.782	2	25.891	12.611	<.001	H7 is supported
		WG	240.209	117	2.053			
		Total	291.992	119				
Social influence	H11	BG	115.293	2	57.647	64.338	<.001	H11 is supported
		WG	104.832	117	.896			
		Total	220.125	119				
Facilitating conditions	H15	BG	319.825	2	159.912	15.611	<.001	H15 is supported
		WG	1198.50	117	10.244			
		Total	1518.33	119				

Note. BG: Between groups; WG: Within groups; SS: Sum of squares; & MS: Mean square

Table 9. Multiple comparisons between means of science teachers' groups in the variables of the research model

DV	(I) VAR.	(J) VAR.	MD (I-J)	Sig.
PE	1.00	2.00	1.13864*	.000
		3.00	2.85833*	.000
	2.00	1.00	-1.13864*	.000
		3.00	1.71970*	.000
	3.00	1.00	-2.85833*	.000
		2.00	-1.71970*	.000
EE	1.00	2.00	.49318	.260
		3.00	1.61944*	.000
	2.00	1.00	-.49318	.260
		3.00	1.12626*	.002
	3.00	1.00	-1.61944*	.000
		2.00	-1.12626*	.002
SI	1.00	2.00	1.18636*	.000
		3.00	2.46667*	.000
	2.00	1.00	-1.18636*	.000
		3.00	1.28030*	.000
	3.00	1.00	-2.46667*	.000
		2.00	-1.28030*	.000
FC	1.00	2.00	2.56591*	.001
		3.00	4.03056*	.000
	2.00	1.00	-2.56591*	.001
		3.00	1.46465	.108
	3.00	1.00	-4.03056*	.000
		2.00	-1.46465	.108

Note. DV: Dependent variable & MD: mean difference

Table 9 shows the results. **Table 9** shows that there are differences between the variables of the research model according to the teaching experience favoring the science teachers with teaching experience (≤5 years) group compared to the science teachers with teaching experience (>5 or <10 years) group, except for the EE variable.

There are also differences between the variables of the research model according to the teaching experience favoring the science teachers with teaching experience (>5 or <10 years) group compared to the science teachers with teaching experience (≥10 years) group, except for the FC variable. This result indicates that the teaching experience does not affect the science teacher's adoption and use of DE, and it can be concluded that the teachers' teaching experiences during the educational process do not enhance the science teachers' acceptance and use of DE. The differences are due to science teachers with less teaching experience and fresh graduates which can be attributed to the fact that they may have a high degree of technological experience as Bauwens et al. (2020) mentioned that technological experience plays an influential role in teachers' acceptance to use digital learning environments. Moreover, it also plays a role in the BI to use information technology and to accept using technology (Zhou et al., 2012).

Experience of using distance learning is an important factor and the effort in the initial stages of acquiring a new behavior plays an important role in the acceptance process (Venkatesh et al., 2003). This is consistent with NRC (2006) which noted that previous experience in social networks is effective in terms of accepting and using online social networks in education. Technological experience and knowledge are linked because technological knowledge constitutes the experience in using and managing certain technologies, and the skill of evaluating and understanding them, this is what fresh graduates and teachers with fewer years of teaching experience have.

This result differs from what has been confirmed by many studies that the main obstacles that prevent science teachers from accepting the use of technology in education are the lack of teaching experiences (Kaya & Usluel, 2011; Yildiz et al., 2013). It also differs from Saleem et al. (2016) which found that teaching experience is one of the factors that motivate teachers toward accepting and adopting the Moodle and the use of learning platforms.

This result can be explained in light of what Stone and Chapman (2006) indicated that faculty staff members with teaching experience up to, more or less than 10 years believe that the more realistic and effective interactions can only be achieved through face-to-face instruction. In addition, older teachers are more subjective in setting up the learning environment, and their style of learning is more passive (Venkatesh et al., 2003). This may also stem from the lack of experience and practice in using ICT despite the presence of teaching experience.

This result also confirms that the more consistent an innovation with users' prior technological experience, current values and needs is, the more likely users are to accept this innovation (Liu, 2013), and this is available to science teachers with teaching experience (≤5 years), where they have prior experience in technological innovations that support their use in education. Thus, technological experience (available to science teachers with teaching experience ≤5 years) can make a difference in EE, SI, and FC. And it refers to the degree of technical proficiency that the user acquires over some time. For individuals who are with little experience with a new system (science teachers with ≥10 years of teaching experience), the EE is a more prominent factor in predicting BI. The SI also plays an important role in reinforcing BI during the early stages of technological experience, while its effect will disappear as people's experience of the new technology develops to a later stage (Agarwal & Prasad, 1997). FC become a more important factor compared to BI with increasing experience with the new systems (Bergeron et al., 1990).

The results indicate the necessity to improve the technological experience of teachers with more experience in teachings, as Raza et al. (2020) indicated that experience of LMS increases the user's BI, and the AU behavior is enhanced if individuals have previous experience with the system (Taylor & Todd, 1995).

This result is consistent with Chaaban and Moloney (2016), where they showed that many factors hinder the systematic implementation of technology integration such as insufficient training, blended strategies, access to technology, shared vision, and mastery. This explains the low mean scores of science teachers (with teaching experience ≥10 years) in the research model variables. It also explains the high mean scores of science teachers with teaching experience ≤5 years, and teaching experience >5 or <10 years in the research model variables as they integrate technology and its use in teaching and conduct practical experiments (Chaaban & Moloney, 2016). This result confirms that teachers with the least years of teaching experience have real experiences with technology-based teaching and the use of technological tools, and these real experiences provide pre-service teachers with experiences in problems solving and decision-making associated with applying technological tools in teaching (Ottenbreit-Leftwich et al., 2010).

Hence, the more experienced science teachers must actively observe and participate in the effective uses of technology, participate in integrating technology in education to teach difficult topics, gain indirect experiences that reinforce self-efficiency beliefs about technology to make up for their lack of technological experience and their inability to use the system in the required speed (Raman & Rathakrishnan, 2018; Radovan & Kristl, 2017). More experienced science teachers should have the resources and knowledge necessary for using ICT and technical support that helps them to complete tasks in a reasonable time and use DE in teaching.

Implications and Limitations

This research came to address the need mainly of the importance of teachers' acceptance of using DE. The results indicate that the degree of science teachers' acceptance of using DE in light of the UTAUT is high. The highly acceptable variables are the EE, the SI, the PE, and the technological self-efficiency, but the acceptance degree of the FC variable was low. Also the results indicate that the BI was high, and the AU was high, the gender has no effect on BI and that there are no differences between science teachers (males and females) in seeing that PE, EE, SI, and FC have their effects on the BI to adopt the use of DE, and the teaching experience does not affect the science teacher's adoption and use of DE, and it can be concluded that the teachers' teaching experiences during the educational process do not enhance the science teachers' acceptance and use of DE.

In light of the results the research recommends the necessity of training science teachers to adopt and use DE, especially older teachers, and to enhance their technological self-efficiency because it plays an effective role in adopting DE and improving more experienced science teachers' technological experience and paying an attention to applying the UTAUT model before taking any decision to adopt any new technology in the field of science education. This study also recommends reconsidering the science teachers' professional preparation programs so that they support education trends towards the use of DE in science.

One limitation of the research was related to the sample; It was small in size, not randomly selected, and all respondents were public school teachers .We therefore expect their perspectives and responses about the questionnaire for accepting the use of DE could differ from other in-service teachers in private or international schools. However, we tried to overcome this limitation and reach the highest number of science teachers by sending the research questionnaire online. Also, we included clear instructions in the consent form and at the beginning of the questionnaire.

Future research should consider utilizing qualitative tools for collecting data about teachers' acceptance of using DE. Furthermore, it is important to know how the relationship between teachers' acceptance of using DE relates to science teaching effectiveness, therefore, researchers are planning to investigate it in the following research. It is also important to search for the moderating factors that most affect the nature of the relationship between the independent variables in the UTAUT model such as (PE, EE, SI, and FC) and the dependent variables (BI to use DE).

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Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

REFERENCES

Agarwal, R., & Prasad, J. (1997). The role of innovation characteristics and perceived voluntariness in the acceptance of information technologies. *Decision Sciences, 28*, 557-582. https://doi.org/10.1111/j.1540-5915.1997.tb01322.x

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211. https://doi.org/10.1016/0749-5978(91)90020-T

Ajzen, I. (2001). Nature and operation of attitudes. *Annual Review of Psychology, 52*, 27-58. https://doi.org/10.1146/annurev.psych.52.1.27

Aliano, A., Hueros, A., Franco, M., & Aguaded, I. (2019). Mobile learning in university contexts based on the unified theory of acceptance and use of technology (UTAUT). *Journal of New Approaches in Educational Research, 8(*1), 7-17. https://doi.org/10.7821/naer.2019.1.317.

Al-Senaidi, S., Lin, L., & Poirot, J. (2009). Barriers to adopting technology for teaching and learning in Oman. *Computers & Education, 53*(3), 575-590. https://doi.org/10.1016/j.compedu.2009.03.015

Andreatta, P.B. (2003). *The effect of affective corrective feedback variation in Web-based instruction on community college student satisfaction and retention* [Ph.D. thesis, University of San Francisco].

Azizi, S. M., Roozbahani, N., & Khatony, A. (2020). Factors affecting the acceptance of blended learning in medical education: Application of UTAUT2 model. *BMC Medical Education, 20*(367), 2-9. https://doi.org/10.1186/s12909-020-02302-2

Babateen, H. M. (2011). *The role of virtual laboratories in science education*. IACSIT Press.

Bahtiar, B., & Dukomalamo, N. (2019). Basic science process skills of biology laboratory: Improving through discovery learning. *Biosfer: Jurnal Pendidikan Biologi* [*Biosphere: Journal of Biological Education*], *12*(1), 83-93. https://doi.org/10.21009/biosferjpb.v12n1.83-93

Bauwens, R., Muylaert, J., Clarysse, E., Audenaert, M., & Decramer, A. (2020). Teachers' acceptance and use of digital learning environments after hours: Implications for work-life balance and the role of integration preference. *Computers in Human Behavior, 112*, 106479. https://doi.org/10.1016/j.chb.2020.106479

Baz, E.H. (2016). Attitudes of Turkish EFL student teachers towards technology use. *The Turkish Online Journal of Educational Technology, 15*(2), 1-10.

Bergeron, F., Rivard, S., & de Serre, L. (1990). Investigating the support role of the information center. *MIS Quarterly*, *14*(3), 247-260. https://doi.org/10.2307/248887

Chaaban, Y., & Moloney, R. (2016). Educating pre-service teachers in technology use: A study of provision at Lebanese universities. *International Journal of Education, 8*(2), 14-31. https://doi.org/10.5296/ije.v8i2.9188

Costa, C., Alvelos, H., & Teixeira, L. (2012). The use of Moodle e-learning platform: A study in a Portuguese university. *Procedia Technology, 5*, 334-343. https://doi.org/10.1016/j.protcy.2012.09.037

Crawford, C. M. (2010). Social and political transformation within a university environment framework: The impact of" anytime" and" anywhere" virtual learning expectations upon the professoriate and the altering views of time and effort expectations. *International Journal of Technology, Knowledge & Society*, *6*(1), 199-211. https://doi.org/10.18848/1832-3669/CGP/v06i01/56071

Cutri, R., & Mena, J. (2020). A critical reconceptualization of faculty readiness for online teaching. *Distance Education, 41*(3), 361-380. https://doi.org/10.1080/01587919.2020.1763167

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319-340. https://doi.org/10.2307/249008

Davis, F. D., & Venkatesh, V. (2004). Toward pre-prototype user acceptance testing of new information systems: Implications for software project management. *IEEE Transactions on Engineering Management, 51*(1), 31-46. https://doi.org/10.1109/TEM.2003.822468

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science, 35*, 982-1003. https://doi.org/10.1287/mnsc.35.8.982

Dede, C. J. (1990). The evolution of distance learning: Technology-mediated interactive learning. *Journal of Research on Computing in Education*, 22(3), 247-264. https://doi.org/10.1080/08886504.1990.10781919

Derilo, R. (2019). Basic and integrated science process skills acquisition and academic in science achievement of seventh-grade learners. *European Journal of Education Studies, 6*(1), 281-294.

Deshmukh, V., Forawi, S. A., & Jaiswal, A. (2012). The role of e-learning in science education vis-a-vis teacher training institutes in Middle East. *US-China Education Review, 2*, 142-148.

Durak, H. (2019). Examining the acceptance and use of online social networks by preservice teachers within the context of unified theory of acceptance and use of technology model. *Journal of Computing in Higher Education, 31*, 173-209. https://doi.org/10.1007/s12528-018-9200-6

Falode, O. (2018). Pre-service teachers' perceived ease of use, perceived usefulness, attitude and intentions towards virtual laboratory package utilization in teaching and learning of physics. *Malaysian Online Journal of Educational Technology, 6*(3), 63-72. https://doi.org/10.17220/mojet.2018.03.005

Foon, Y. S., & Fah, B. C. Y. (2011). Internet banking adoption in Kuala Lumpur: An application of UTAUT model. *International Journal of Business and Management, 6*(4), 161-167. https://doi.org/10.5539/ijbm.v6n4p161

Garrison, D., Anderson, T., & Archer, W. (1999). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education, 2*(2-3), 87-105. https://doi.org/10.1016/S1096-7516(00)00016-6

Gong, M., Xu, Y., & Yu, Y. (2004). An enhanced technology acceptance model for web-based learning. *Journal of Information Systems Education, 15*(4), 365-374.

Gumusoglu, E., & Akay, E. (2017). Measuring technology acceptance level of teachers by using unified theory of acceptance and use of technology. *International Journal of Languages' Education and Teaching, 5*(4), 378-394. https://doi.org/10.18298/ijlet.2239

Hackman, M., & Walker, K. (1990). The impact of system design and instructional style on student reactions to distance education. *Research in Distance Education, 37*, 7-9.

Harsha, T. (2017). Learning science through distance education–A challenge at Karnataka State Open University. *The Online Journal of Distance Education and e-Learning, 5*(1), 62-65.

Hativa, N., & Lesgold, A. (1996). Situational effects in classroom technology implementations: Unfulfilled expectations and unexpected outcomes. In S. T. Kerr (Ed.), *Technology and the future of schooling: Ninety fifth yearbook of the national society for the study of education* (pp. 131-171). University of Chicago Press. https://doi.org/10.1177/016146819609700607

Honeyman, M., & Miller, G. (1993). Agriculture distance education: A valid alternative for higher education? In *Proceedings of the 20th Annual National Agricultural Education Research Meeting* (pp. 67-73). National Book Foundation.

Hoque, R., & Sorwar, G. (2017). Understanding factors influencing the adoption of mHealth by the elderly: An extension of the UTAUT model. *International Journal of Medical Informatics, 101*, 75-84. https://doi.org/10.1016/j.ijmedinf.2017.02.002

Kaya, G., & Usluel, Y. K. (2011). Content analysis of factors affecting ICT integration in teaching–learning process. *Buca Faculty of Education Journal, 31*, 48-67.

Keeton, M. T. (2004). Best online instructional practices: Report of phase I of an ongoing study. *Journal of Asynchronous Learning Network, 8*(2), 75-100. https://doi.org/10.24059/olj.v8i2.1829

Kripanont, N. (2007). *Examining a technology acceptance model of internet usage by academics within Thai business schools* [Doctoral dissertation, Victoria University]. https://doi.org/10.15209/jbsge.v1i2.72

Liu, J. (2013). *E-learning in English classroom: Investigating factors impacting on ESL (English as second language) college students' acceptance and use of the modular object-oriented dynamic learning environment (Moodle)* [PhD thesis, Iowa State University].

Maison, M., Darmaji, D., Astalini, A., Kurniawan, D., & Indrawati, P. (2019). Science process skill and motivation. *Humanities & Social Sciences Reviews, 7*(5), 48-56.https://doi.org/10.18510/hssr.2019.756

Mondal, P., & Das, M. (2015). Acceptability of distance education among students' society. *International Journal of Social Science and Humanities Research, 3*(1), 234-239.

Mookkiah, M., & Prabu, M. (2019). Teachers self-efficacy scale: Development and validation. *Review of Research, 8*(6), 1-8.

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research, 2*(3), 192-222. https://doi.org/10.1287/isre.2.3.192

Moore, M. G., & Thompson, M. M. (1990). The effects of distance learning: A summary of literature (research monograph No. 2). *Southern Ohio Telecommunications Consortium*. https://files.eric.ed.gov/fulltext/ED330321.pdf

Moorthy, K., Yee, T., T'ing, L., & Kumaran, V. (2019). Habit and hedonic motivation are the strongest influences in mobile learning behaviours among higher education students in Malaysia. *Australasian Journal of Educational Technology, 35*(4), 174-191. https://doi.org/10.14742/ajet.4432

NRC. (1996). *National science education standards: Observe, interact, change, learn*. National Academy Press.

NRC. (2006). *America's lab report: Investigations in high school science*. National Academies Press.

NSTA. (2016). NSTA position statement: The role of e-learning in science education. *National Science Teachers Association*. https://static.nsta.org/pdfs/PositionStatement_E-learning.pdf

Offir, B., Barth, I., Lev, J., & Shteinbok, A. (2003). Teacher–student interactions and learning outcomes in a distance learning environment. *Internet and Higher Education*, *6*(1), 65-75. https://doi.org/10.1016/S1096-7516(02)00162-8

Ottenbreit-Leftwich, A., Glazewski, K., & Newby, T. (2010). Preservice technology integration course revision: A conceptual guide. *Journal of Technology and Teacher Education, 18*(1), 5-33.

Padilla-Meléndez, A., del Aguila-Obra, A., & Garrido-Moreno, A. (2013). Perceived playfulness, gender differences and technology acceptance model in a blended learning scenario. *Computers and Education*, *63*, 306-317. https://doi.org/10.1016/j.compedu.2012.12.014

Poong, Y. S., Yamaguchi, S., & Takada, J. (2017). Investigating the drivers of mobile learning acceptance among young adults in the World Heritage town of Luang Prabang, Laos. *Information Development*, *33*(1), 57-71. https://doi.org/10.1177/0266666916638136

Radovan, M., & Kristl, N. (2017). Acceptance of technology and its impact on teacher's activities in virtual classroom: Integrating UTAUT and CoI into a combined model. *The Turkish Online Journal of Education, 16*(3), 11-22.

Raman, A., & Rathakrishnan, M. (2018). Frog VLE: Teachers' technology acceptance using UTAUT model. *International Journal of Mechanical Engineering and Technology, 9*(3), 529-538.

Raza, S. A., Qazi, W., Khan, K. A., & Salam, J. (2021). Social isolation and acceptance of the learning management system (LMS) in the time of COVID-19 pandemic: An expansion of the UTAUT model. *Journal of Educational Computing Research*, *59*(2), 183-208. https://doi.org/10.1177/0735633120960421

Ritchie, D., & Wiburg, K. (1994). Educational variables influencing technology integration. *Journal of Technology and Teacher Education, 2*(2), 143-153.

Rogers, E. M. (1995). *Diffusion of innovations*. The Free Press.

Sadeck, O. G., & Cronjé, J. C. (2017). A continuum of teachers' e-learning practices. *Electronic Journal of e-Learning*, *15*, 395-408.

Saleem, N. E., & Al-Suqri, M. N. (2015). Investigating faculty members' beliefs about distance education: The case of Sultan Qaboos University, Oman. *International Journal of Distance Education Technologies, 13*(1), 48-69. http://doi.org/10.4018/ijdet.2015010103

Saleem, N., Al-Saqri, M., & Ahmad, S. (2016). Acceptance of Moodle as a teaching/learning tool by the Faculty of the Department of Information Studies at Sultan Qaboos University, Oman based on UTAUT. *International Journal of Knowledge Content Development & Technology*, *6*(2), 5-27. https://doi.org/10.5865/IJKCT.2016.6.2.005

Sattari, A., Abdekhoda, M., & Zarea, G. (2017). Determinant factors affecting the webbased training acceptance by health students, applying UTAUT model. *International Journal of Emerging Technologies in Learning*, *12*(10), 112-126. https://doi.org/10.3991/ijet.v12i10.7258

Seiber, J. E. (2005). Misconceptions and realities about teaching online. *Science and Engineering Ethics, 11*, 329-340. https://doi.org/10.1007/s11948-005-0002-7

Serevina, V., Sunaryo., Raihanati., Astra, M., & Sari, I. (2018). Development of e-module based on problem based learning (PBL) on heat and temperature to improve student's science process skill. *TOJET: The Turkish Online Journal of Educational Technology, 17*(3), 26-36.

Stefl-Mabry, J. (1999). Professional staff development: lessons learned from current usability studies. *Journal of Information Technology Impact, 1*(2), 81-104.

Stone, S. J., & Chapman, D. D. (2006). *Instructor presence in the online classroom*. https://files.eric.ed.gov/fulltext/ED492845.pdf

Šumak, B., & Šorgo, A. (2016). The acceptance and use of interactive whiteboards among teachers: Differences in UTAUT determinants between pre- and post adopters. *Computers in Human Behavior, 64*, 602-620. https://doi.org/10.1016/j.chb.2016.07.037

Tarhini, A., Masa'deh, R., Al-Busaidi, K. A., Mohammed, A. B., & Maqableh, M. (2017). Factors influencing students' adoption of e-learning: A structural equation modeling approach. *Journal of International Education in Business*, *10*(2), 164-182. https://doi.org/10.1108/JIEB-09-2016

Taylor, S., & Todd, P. A. (1995). Understanding information technology usage: A test of competing models. *Information Systems Research, 6*(2), 144-176. https://doi.org/10.1287/isre.6.2.144

Threlkeld, R., & Brzoska, K. (1994). Research in distance education. In B. Willis, (Ed.), *Distance education: Strategies and tools* (pp. 41-66). Educational Technology Publications.

Tolba, E. G., Youssef, N. H., Hassan, H. F., ALsamaloty, A. N., & Alotaibi, N. A. (2020). Investigating teacher's beliefs about entrepreneurship distance education in light of the demographic variables in the Kingdom of Saudi Arabia. *Journal of Entrepreneurship Education, 23*(S2).

Triandis, H. C. (1977). *Interpersonal behavior.* Brooks/Cole Publishing Company.

Tseng, T. H., Lin, S., Wang, Y.-S. & Liu, H.-X. (2019). Investigating teachers' adoption of MOOCs: The perspective of UTAUT2. *Interactive Learning Environments*. https://doi.org/10.1080/10494820.2019.1674888

Venkatesh, V., & Brown, S. A. (2001). A longitudinal investigation of personal computers in homes: Adoption determinants and emerging challenges. *MIS Quarterly*, *25*(1), 71-102. https://doi.org/10.2307/3250959

Venkatesh, V., & Davis F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science, 46*(2), 186-204. https://doi.org/10.1287/mnsc.46.2.186.11926

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, *27*(3), 425-478. https://doi.org/10.2307/30036540

Venkatesh, V., Thong, J. Y. L., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. *MIS Quarterly*, *36*(1), 157-178. https://doi.org/10.2307/41410412

Wallace, R., M. (2003). Online learning in higher education: A review of research on interactions among teachers and students. *Education, Communication & Information*, *3*(2), 241-280, https://doi.org/10.1080/14636310303143

Wang, H.-Y., & Wang, S.-H. (2010). User acceptance of mobile internet based on the unified theory of acceptance and use of technology: Investigating the determinants and gender differences. *Social Behavior and Personality: An International Journal*, *38*(3), 415-426. https://doi.org/10.2224/sbp.2010.38.3.415

Willis, B. (1992). Effective distance education: A primer for faculty and administrators. Monograph series in distance education, No. 2. *Alaska University System, Fairbanks*. https://files.eric.ed.gov/fulltext/ED352447.pdf

Woodfield, B. F., Andrus, M. B., Andersen, T., Miller, J., Simmons, B., Stanger, R., Waddoups, G. L., Moore M. S., Swan, R., Allen, R., & Bodily, G. (2005). The virtual ChemLab project: A realistic and sophisticated simulation of organic synthesis and organic qualitative analysis. *Journal of Chemical Education*, *82*(11), 1728-1735. https://doi.org/10.1021/ed082p1728

Wu, J., & Liu, W. (2013). An empirical investigation of the critical factors affecting students' satisfaction in EFL blended learning. *Journal of Language Teaching and Research*, *4*(1), 176-185. https://doi.org/10.4304/jltr.4.1.176-185

Yang, S. C., & Huang, Y. F. (2008). A study of high school English teachers' behavior, concerns and beliefs in integrating information technology into English instruction. *Computers in Human Behavior, 24*(3), 1085-1103. https://doi.org/10.1016/j.chb.2007.03.009

Yeou, M. (2016). An investigation of students' acceptance of Moodle in a blended learning setting using technology acceptance model. *Journal of Educational Technology Systems*, *44*(3), 300-318. https://doi.org/10.1177/0047239515618464

Yildiz, H., Saritepeci, M., & Seferoglu, S. S. (2013). A study on the contributions of the in-service training activities within the scope of FATIH project to teachers' professional growth in reference to ISTE teachers' standards. *Hacettepe University Journal of Education, Special Issue, 1*, 375-392.

Young, A., & Norgard, C. (2006). Assessing the quality of online courses from the students' perspective. *Internet and Higher Education*, *9*(2), 107-115. https://doi.org/10.1016/j.iheduc.2006.03.001

Zhang, X., & Cui, G. (2010). Learning beliefs of distance foreign language learners in China: A survey study. *System: An International Journal of Educational Technology and Applied Linguistics*, *38*(1), 30-40. https://doi.org/10.1016/j.system.2009.12.003

Zhou, Z., Fang, Y., Vogel, D. R., Jin, X.-L., & Zhang, X. (2012). Attracted to or locked in? Predicting continuance intention in social virtual world services. *Journal of Management Information Systems*, *29*(1), 273-306. https://doi.org/10.2753/MIS0742-1222290108